THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1915

Vol. XL.

WITH FIFTY-NINE PLATES.

SYDNEY:

PRINTED AND PUBLISHED FOR THE SOCIETY

BY

W. A. PEPPERDAY & CO., 119A PITT STREET

AND

SOLD BY THE SOCIETY

1916.

W. A. PEPPERDAY AND CO.,
GENERAL PRINTERS,
119a PITT STREET, SYDNEY.

CONTENTS OF PROCEEDINGS, 1915.

PART I. (No. 157).

(Issued 16th June, 1915).

PART I. *(Continued).*

CORRIGENDA.

The legend of Plate xxx. should read—

1-2.*Sertularella ritchiei*, nom.nov. 3-7.*Halicornaria goniodes*, n.sp.

On p.833 of Part 4 of Proceedings for 1914, the names of the analysts were inadvertently omitted. These should read—Analysis i. (J. C. H. Mingaye); ii. (L. A. Cotton); iii. (L. de Launay).

PART II. (No. 158).

(Issued 15th September, 1915).

PART II. *(Continued).*

CORRIGENDUM.

Page 256, Table v., in the heading at the top of the right-hand double column—*for* Temperature of air, *read* Temperature of animal.

PART III. (No. 159).

(Issued 10th December, 1915).

CORRECTION.

The blocks above the legends of Text-figures 1 and 3 on pp.215 and 217 of Mr. Tillyard's Paper (*antea*) were inadvertently transposed. The figures above the legend of Text-fig.3 (p.217) should have appeared above the legend of Text-fig.1 (p.215); and those on p.215, above that of Text-fig.3 (p.217).

PART IV. (No. 160).

(Issued 23rd February, 1916).

NOTICE.

The six Plates (liv.-lix.) illustrating this Part of the Volume, were inadvertently bound up, and issued with those of the preceding Part iii.

CORRIGENDA.

Page 100, line 2—for *H. Taylori*, read *C. Taylori.*

Page 114, last line—for *Limax maximns*, read *Limax maximus.*

Page 174, line 2—for *Bacillns*, read *Bacillus.*

Page 185, line 28—for *polystona*, read *polystoma.*

Page 202—the legend for Plate xxx., should read:—
1-2. *Sertularella ritchei*, nom.nov. 3-7. *Halicornaria goniodes*, n.sp.

Pages 215 and 217—the blocks above the legends of Text-figs. 1 and 3 on these pages were inadvertently transposed. They are correctly reprinted on pp.751, 752.

Page 256, Table v., in the heading at the top of the right-hand double column—*for* Temperature of air, *read* Temperature of animal.

Page 313, lines 1-2—for *Phymatodosis*, read *Phymatodocis.*

Page 392, lines 30-31—for *T. retusum*, read *C. retusum.*

Page 466, line 15—for *Ph felix*, read *Ph. felix.*

Page 474, line 3—*for* F.L.S., *read* F.Z.S.

Page 474, line 28—for *P. ocultaria*, read *P. occultaria.*

Page 476, line 30—the word omitted after nearly is—straight.

Page 480, line 3—*for* joint, *read* joining.

Page 483, line 7—for *P. argocentra*, read *T. argocentra.*

Page 484, line 18—for *P. crassinervis*, read *N. crassinervis.*

Page 689, line 9—*for* Bohemann (Schönn....), *read* Boheman (Schön....).

Poge 705, line 31—*for* Androssan, *read* Ardrossan.

Page 775, line 21—*for* Bohemann, *read* Boheman.

Page 776, lines 1, 4, 15, 23, 24, 26—*for* Bohemann, *read* Boheman.

Page 778, line 26—*for* Bohemann's, *read* Boheman's.

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PROCEEDINGS, 1915.

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES.

WEDNESDAY, MARCH 31st, 1915.

The Fortieth Annual General Meeting, and the Ordinary Monthly Meeting, were held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, March 31st, 1915.

ANNUAL GENERAL MEETING.

Mr. W. S. Dun, President, in the Chair.

The Minutes of the preceding Annual General Meeting (March 25th, 1914) were read and confirmed.

The President delivered the Annual Address.

PRESIDENTIAL ADDRESS.

On this occasion, the fortieth anniversary of the Society's first Meeting, we assemble under the shadow of the great crisis in human affairs, which developed so unexpectedly last August, and the end of which is not yet; though the outlook, while still serious, is hopeful. We certainly were in the dark, at the outset, as to its real significance. But we have had so much enlightenment since then, that we are now able to understand that the great war which is convulsing Europe, and is so profoundly disturbing the rest of the world, is, at bottom, the clash of national ideals, aims, and aspirations of an antagonistic and irreconcilable character. One of many bewildering aspects of the Tragedy of Europe in Arms is the way in which Universities, men of science, theologians, philosophers, and other intellectuals, on the other side, have combined in defence of the war-spirit, and the war-principle as "an indispensable factor of culture" and as a "necessary element in the life of nations."

But if the theories put forward by the champions of the opponent-in-chief of the Allies have astounded other nations, their reduction to practice in Belgium and Northern France has stirred the heart of the world, as it has never been stirred before; and, for those responsible for it, has provided the materials for a ruthless and inglorious chapter in the history of an otherwise great nation.

I recall, with some pleasure, at this stage, an item of the Society's early history known to few of us. The Society was bereft of everything it possessed, in the conflagration of the Garden Palace, in September, 1882. At this time, it had not yet completed eight years of work; and the seventh volume of the Proceedings was in course of publication. Thereafter, the Society received many letters of sympathy from far and near; and these, in some cases, were accompanied by donations of Journals towards the replacement of losses. The most notable of these, because it was a collective gift, the outcome of co-operative effort, in a sense even a national gift, was received on April 18th, 1884; and is recorded in the donations for the month [Proceedings, Vol. ix., p.256] as "A very large and valuable collection of the publications of Belgian Scientific Societies. From M. Th. Lefèvre, Secretary of the Royal Malacological Society of Belgium," at Brussels. As a matter of fact, it comprised about 120 volumes of the publications issued by eight Scientific or other Societies in Belgium, selected so that the Society might ultimately have complete sets of these publications as far as possible, or at least for a period corresponding to the currency of the Society's Proceedings. In addition to these, there were numerous reprints of papers, pamphlets, and scientific reports, some of the latter being Government publications. Up to this time, the Society had exchanged publications with three Belgian Societies, of one of which M. Lefèvre was Secretary. On receipt of a copy of the circular explaining the difficulties in which the Society temporarily found itself through the disaster, issued to its correspondents by the Council, the day after the fire, this gentleman very courteously replied, under date 17th November, 1882, expressing sympathy, intimating also that at the next Meeting of his Council he intended to propose that a complete set of the Society's Annales should be sent to replace what had been destroyed; and, further, that he was about to communicate with the principal Scientific Societies of Belgium, suggesting that they, too, should show their sympathy in like manner; and that, in due course, he would undertake to forward the collective results—as he most kindly did when the time came. Another outcome of M. Lefèvre's effort, was that the names of five additional Societies were added to the Belgian section of our exchange list, and we have had the pleasure and profit of exchanging publications with them ever since, until the outbreak of war. Surely, in view of what has happened during the last few months, this record of kindness and courtesy, and genuine sympathy on the part of M. Lefèvre and the Belgian Scientific Societies, when the Society was suffering from a calamity which pecuniarily was serious enough, but which, thanks to Sir William Macleay, did not ultimately seriously interfere with its progress, acquires a new interest and a new suggestiveness to present-day Members.

In a calmly expressed, and temperate article, entirely free from bitterness or anger, on "The Soul of Belgium," in the Hibbert Journal for January, 1915 (p.233), the Abbé Noël, a Belgian in refuge at Oxford, writes thus hopefully of the future of his country—"Numerous signs justify the expectation that Belgium, on emerging from the present crisis, will again witness that union of parties which founded the national life in 1830. In the common effort which will presently remake our country, the four Universities will, I hope, find their part enlarged. The disaster which has overtaken the oldest of them [Louvain] and struck down to the heart of its intellectual life, and fallen upon the memorials of the past, can have but one outcome: it will cause our scientific activities and our ideal life to be born again, enlarged and broadened. . . . . And yet no task will exceed the forces of our national energy. Twenty times in the course of history, Belgium has been the battlefield of Europe. Twenty times Belgium has rebuilt her ruined cities, and found a new prosperity. . . . . In the Europe which is to be, it will be hers to extend the reign, of Faith, Justice, and Freedom."

When justice has been done, and all possible reparation has been made to Belgium—and the Allies have expressed their determination on these points—we look forward to the beginning of the fulfilment of the Abbé Noël's aspirations. But when Belgium is again in undisputed possession of what is left of her own, we have good reason to fear, after what has happened at Louvain, and what is known of the fate that befell private libraries there or elsewhere, that Belgian Scientific Societies and Institutions may find themselves sorely in need of books and scientific journals. As soon as ever the time is ripe, and communications are restored, the Society may rely on the Council to take the necessary steps to endeavour to repay, with interest, the kindness that was extended to this Society more than thirty years ago. Nevertheless, when the Society has done its very best, it will not be disappointed to find that it has not been able to do any more than the Scientific Societies of the world have been ready to do. But in the meantime, the pressing need of the Belgians, who have not been driven from their country, is for food. Wide publicity has been given to the pathetic appeal cabled from London to the Australasian press. Response to this appeal is a matter for every one of us, not merely as a duty, but as a matter of gratitude for the great services to the cause of the Allies so freely rendered, at so fearful a cost, by the Belgians. The Society's revenue is almost entirely derived from trust funds, and its expenditure must be regulated by the terms of the trust. It remains, therefore, for us as individuals to do our share, and to do it whole-heartedly, and to keep on doing it as long as the need for it continues. On the present occasion, I think it is fitting that I should, on behalf of the Society, place on record our deepest sympathy, not only with the Scientific Societies of Belgium with whom we have been so pleasantly and so profitably associated for so many years, but with the Sovereign and the entire nation, who have so bravely and so nobly acted up to their ideals without counting the cost.

As members of a Scientific Society, we cannot but view with deep concern the way in which the accumulated scientific knowledge of all the ages is being used, in so far as it is possible to make use of it, for the destruction of human life and property, and the wastage of the world's resources. The theory that the application of Science to warfare under the most modern conditions might be looked upon as security for peace, because the results would be too terrible for nations to risk, has broken down. The fruits of armed peace have turned out to be war, on a most stupendous scale, and of the most destructive character. Moreover, this great upheaval, in which Science, the benefactress of the human race, has been commandeered for destructive purposes, is exercising a disturbing influence on the normal scientific activity of not only the belligerent nations, but also apparently of some neutral countries. This aspect of the war is brought home to us directly by the fact that, almost immediately after the outbreak of hostilities, our correspondence and exchange relations with Societies abroad forthwith largely entered into a state of suspension. For the Session 1912-13, the total number of donations and exchanges resulted in 1,285 additions to the library, including 401 for the four months, August November. For the Session 1913-14, the corresponding numbers are 1,166, and 264. The significance of this seems to be, that the war has entirely stopped, or has curtailed to a greater or less extent, the work to which Scientific Societies ordinarily devote themselves; though the interruption or interference with the ordinary means of transmission may have something to do with it. Journals in England, which specially concern themselves with bibliographical records, have announced that a diminished supply of publications is hampering their work; so that our experiences are not singular. The outlook for the immediate future is also serious, as statistics now available show that the drain entailed by the war upon the human resources of Universities and other centres of scientific work in the belligerent countries, both in the shape of actual or potential workers, and the consequent general upset of the usual arrangements, threatens to be serious, here as elsewhere.

The visit of the British Association for the Advancement of Science in August, 1914, to which we had been looking forward with so much interest as the scientific event of the year, took place under favourable conditions. It is gratifying to learn that the visitors consider the Australian Meeting to have been an unqualified success, notwithstanding the outbreak of hostilities in Europe; that they appreciated the hospitality offered; and that the arrangements generally, possible only by the co-operation of the Commonwealth and State Governments, Civic authorities, Universities, the local Officers and Members, and prominent citizens, met with cordial approval. The Federal Handbook, as well as those provided by the several States, also received warm commendation. Our thanks and appreciation for this excellent series, likely to be our standard works of reference until the British Association makes its second visit, as we hope it will, are no less due to all those who co-operated in their production, and to the Governments which provided for their publication. From our point of view, the Meeting was no less successful. We had looked forward to the opportunity of meeting and hearing distinguished British representatives of Science, as well as some from other countries, and of discussing Australian problems or the Australian aspect of larger problems. But we also hoped that seeing something of Australia for themselves, might lead to a better appreciation, on the part of our visitors, of the disabilities which attend Australian workers—the immense field of work open to us, the paucity of workers and their almost unavoidable centralisation in the capital cities, the remoteness of these not only from the great centres of intellectual activity in distant lands but from each other, with concomitant drawbacks arising from our isolation from the great libraries and reference-collections of older countries. We may hope that the British Association will continue to visit Australia periodically, for such visits may be expected to have educational results of the two-fold character indicated, as well as to promote a wider sympathy and a more systematic co-operation between the workers of the Empire, and with other countries whose representatives may be able to take part in the Meetings.

From our point of view, it was a happy coincidence that the President happened to be a biologist; and that the subject of his address, Heredity in its relation to evolutionary theory, should have been one which made such a wide appeal to others besides biologists. In a newly settled country, almost the first work for the biologist is the cataloguing of the fauna and flora; an undertaking which, in Australia, is not yet complete in all groups. This Society has been more closely identified with this aspect of biology than any other Australian Society. Now the systematist is apt to become so immersed in his classificatory tables and dichotomous keys, in nomenclatural puzzles, and in applying new names and labels to specimens in collections, as to be sometimes in danger of losing sight of the larger aspects of the subject which interests him, and of mistaking the means for the end. Doubtless Professor Bateson's remarks on the artificiality of systematic zoology and botany, and to the effect that, without the tests of experimental breeding, much guesswork is involved in distinguishing specific limits, and in declaring this to be a species, and that a variety, and that museum-species may be rather different things from the "little species" that breed true, will not be wholly lost sight of, but may have a stimulating, not to say a tonic, effect upon Australian systematists. At any rate, his remarks suggest new ways of attacking old problems, as well as new lines of work worth following up.

The Presidential Addresses throughout, as well as the evening discourses, were of a high order of merit, and appealed to many sections of the intellectual life of Australia. The Meeting has had a cheering and encouraging effect on us; and has furnished a most instructive and valuable supplement to our experiences gained at the various Meetings of the Australasian Association.

Notwithstanding the disturbance of the business-life of the community by war, the Society has been able to carry out its publishing work on the usual scale. Printers, like other business-men, are feeling the strain; and it is satisfactory that the Society has been able to avoid increasing any unemployment for which the war may be responsible. The thirty-ninth volume of the Proceedings, for last year, has been completed in good time, and distributed, as far as circumstances will permit. It amounts to 924 pages, and is illustrated with fifty text-figures, and ninety-four plates—the maximum number for any volume of the entire series. We begin the Session again with a sufficient number of papers in hand to provide for several Meetings.

The Council is again indebted to Mr. C. Hedley, F.L.S., for his generosity in providing the blocks for the illustration of his papers—in this case seventeen blocks illustrating three papers in the Proceedings for 1913 and 1914; a very acceptable help, as the demand for illustrations has been in excess of the average.

Two new Members were elected during the year, five Members resigned, and five senior Members have been removed by death, so that our numbers have been diminished somewhat.

Mr. Edward G. W. Palmer, who passed away on May 15th, joined the Society in 1885. For a number of years he was Secretary of the Civil Service Board, until this was replaced by the Public Service Board. Mr. Palmer was a Member of the Council from 1891-94; and subsequently, from 1895-1909, he was good enough to act as one of the Society's Honorary Auditors. He was interested in Natural History, and particularly in Anthropology, as he had had the opportunity of seeing a good deal of the Blacks in his younger days. Until lately, he frequently attended the Meetings, and occasionally exhibited specimens of interest. Mr. Palmer, as far as he could, was ever ready to forward the Society's interests; just as much of his time, in his later years, was ungrudgingly devoted to philanthropic and other good work.

Mr. Henry J. Brown, who died on 12th August, at the advanced age of over 80 years, had been a Member of the Society since 1887. He resided at Newcastle, where he had practised as a Solicitor for many years, and was well known. Mr. Brown seems to have maintained his interest in Natural History to the end of his life; but as he lived at a distance from Sydney, and was unable to attend the Meetings, he was personally known to but few Members.

Sir Normand MacLaurin, one of Sydney's most distinguished citizens, one of the leaders of the medical profession, an active Member of the Legislature, Chancellor of the University of Sydney since 1896, a welcomed accession to the directorate of several important corporate bodies, passed to his rest on 24th August, in his seventy-ninth year. As he playfully reminded us at the Meeting held in June, 1913, when he kindly attended to unveil a portrait of the late Professor J. W. Stephens, he was the "Father" of the Society. A preliminary meeting to consider the question of starting a new Scientific Society in Sydney was held on October 13th, 1874, and at this meeting the advisability was affirmed. At a second meeting held on November 5th, the name of the Society and the Rules were settled. The first meeting for scientific business was held on January 13th, 1875. All those who enrolled themselves between the second and last of the dates mentioned, constituted the Original or Foundation-Members, of whom there were eighty-six. First on the list stands the name of Dr. Alleyne, enrolled, with ten others, on November 11th, 1874. The forty-fourth name is that of Dr. H. N. MacLaurin, enrolled December 8th, 1874. Of the forty-three whose names precede Sir Normand's, only one survives, but was not a Member after 1878. Of the forty-two whose names follow, only one of the survivors has retained his membership - may he long be spared to us. Sir Normand's interest in the Society grew out of his friendship with those who were most actively concerned with its establishment, and from a desire to support a deserving institution such as has a recognised place among the educational agencies of every enlightened country, We may be glad that so interesting a link between present and past was spared to us so long; and that, less than two years ago, we had the pleasure of welcoming him on the occasion of a special visit, and of being stimulated by his genial presence, and by his impressive words.

Mr. W. J. Clunies Ross, who joined the Society in 1904, died on 7th November, in his sixty-fourth year. He had almost completed thirty years' service in the Technical Education Branch of the Department of Public Instruction in this State, first as

Science Master of the Technical College at Bathurst from its commencement; and, later, as Lecturer in Chemistry and Metallurgy at the Sydney Technical College. Mr. Ross was the author of a number of chemical papers contributed to the Royal Society of New South Wales. He was interested also in Natural History; and, during his residence in Bathurst, he collected and studied the plants of the district, especially in relation to the geological formations on which they occur. The results were embodied in an important paper, "Notes on the Flora of Bathurst, and its connection with the Geology of the district," which will be found in the Report of the Seventh Meeting of the Australasian Association for the Advancement of Science (Sydney, 1898), p.467.

Mr. James R. Garland, deceased on 5th February, 1915, had a special claim upon our regard. He was educated at the Sydney Grammar School, and entered Sydney University as an undergraduate in 1857, one of the fifth batch of students. At this time, Sir Charles Nicholson was Chancellor, and William Charles Wentworth was a member of the Senate; so that Mr. Garland's recollections went back to a very interesting period of both University and New South Wales history. He took his B.A. degree in 1859, and his M.A. in 1862. After serving his articles in Sydney, he was admitted as a Solicitor on July 1st, 1865, and practised with a Sydney firm for some time, until, in 1870, he took up practice in Wagga, where he continued to practise until his removal to Sydney in 1890. Perhaps before, but more probably during the early part of his residence in Wagga, Mr. Garland came to know Sir William Macleay, who, from 1855 until November, 1874, represented the Murrumbidgee electorate in the Legislative Assembly, or its predecessor. Wagga was the headquarters of his electioneering campaigns, and Mr. Garland became one of Sir William's active supporters. Somewhat later, Mr. Garland, as Sir William's Solicitor, undertook the business oversight of some property near Wagga in which the latter was interested. Whatever the details may be, it is certain that their association, at this early period, ripened into warm regard on both sides. In February, 1880, Mr. Garland joined the Society. In 1892, shortly after his removal to Sydney, on the initiative of Sir William Macleay, he was elected to the Council. From 1902-08, when ill-health necessitated his retirement, he was fourth Hon. Treasurer; and at the Adjourned Annual General Meeting, on April 29th, 1908, it was resolved that a record of the Society's appreciation of Mr. Garland's valuable services should be entered in the Minutes. He was present at the Meeting of Council on November 14th, 1914, apparently in his usual health; and the news of his decease was received with deep regret. Mr. Garland was a most helpful member of the Council, and worthily maintained the reputation of the Society's Honorary Treasurers. Beneath a modest and quiet demeanour, there was hidden a rich fund of knowledge and experience, a very kind heart, and a desire and a readiness to help the Society and forward its interests in every way that Mr. Garland could. He was very much interested in Natural History, and paid considerable attention to the plants of the Wagga district. One of his favourite localities for botanising was the Hanging Rock, a rocky eminence near the Rock Station, on the Southern Line between Wagga and Albury. On this hill, which may be regarded as a botanical and geological outlier, there was to be found a very remarkable assemblage of coastal as well as western species of plants, different from those of the surrounding level country. The most interesting of the latter, which Mr. Garland was instrumental in bringing to the notice of botanists, were *Ricinocarpus Bowmani* F.v.M. (recorded in the Flora Australiensis, from the Lower Macquarie River, and from the desert north of the Arbuthnot Range; and from Queensland), and *Grevillea floribunda* R.Br., (recorded in the Fl. Aust. from the Goulburn and Hunter Rivers; ravines near Mount Owen and Mount Clift; and also from Victoria; and by Mr. Clunies Ross from the Bathurst District). Mr. Garland found the former also near Adelong; and he exhibited specimens from this locality at a Meeting of the Society on August 30th, 1893. The latter, together with *G. parviflora* (recorded from New South Wales, only from the coast), Mr. Garland found also at Mimosa, between Wagga and Temora; and he presented specimens of these to the Society's herbarium.

Dr. R. Greig-Smith, Macleay Bacteriologist to the Society, has continued his investigation of problems relating to soil-fertility and cognate matters, during the past year. Three papers, entitled "Note on the Bacteriotoxic Action of Water," "Note on the Destruction of Paraffin by *Bacillus prodigiosus* and Soil-Organisms," and "Contributions to a Knowledge of Soil-Fertility. No. xii. The Action of Toluene upon the Soil-Protozoa," were contributed, and have been published in last year's Proceedings. In the first of these, it is demonstrated that the typhoid-bacillus is diminished in numbers when introduced into porcelain-filtered tap-water. If the water has been boiled, the reduction is greater, and not more than one per cent. of the bacilli survive in twenty hours at summer-temperature. In the second, it is shown that toluene, a volatile disinfectant, does not destroy certain typical protozoa when the moisture-content of the soil is less than about one-tenth of the water-holding capacity. While the destructive action of the toluene appears to be direct, there is a possibility of the protozoa being indirectly poisoned by the formation of sulphuretted hydrogen in the soil. This results from the destruction of the sulphur-oxidising bacteria by the disinfectant. And in the third, it is reported that *Bac. prodigiosus*, like certain soil-bacteria and moulds, can attack and destroy solid paraffin.

Dr. J. M. Petrie, Linnean Macleay Fellow in Biochemistry, has not had so fruitful a year as usual, in consequence of his being laid aside by illness during part of it. He has continued his cyanogenetic work on various plants; and has investigated some difficult problems in the technique of the methods for preparing plant-proteins, and for obtaining the latter in a condition suitable for the study of precipitin-reactions, and the relationships of plants by biochemical methods. The completion of a paper on the alkaloids of the native Duboisias waits on the acquisition of additional material; whilst a second paper, discussing the methods of stating results in ash-analyses of plants, is in preparation.

Mr. E. F. Hallmann, Linnean Macleay Fellow in Zoology, contributed three papers comprising his "Revision of the Monaxonid Sponges described as new in Lendenfeld's 'Catalogue of the Sponges in the Australian Museum'," the results of his work for the two previous years. They were published in Part 2 of last year's Proceedings. Having completed this complicated and perplexing piece of work, Mr. Hallmann has been enabled to start anew on his investigation of the Monaxonida; and he has a paper almost ready for publication.

Mr. W. N. Benson, Linnean Macleay Fellow in Geology, who has completed his first year's work, contributed a short paper entitled "Petrological Notes on various New South Wales Rocks," which has been published in Parts 2-3 of last year's volume. His time has been devoted chiefly to the continuation of his study of the geology and petrology of the Great Serpentine-Belt of New South Wales; and Part iv., of his series of papers, dealing with the dolerites, spilites, and keratophyres of the Nundle District, has been completed, and will be taken at the Meeting in May. About eighty square miles in the Tamworth-Moonbi District have been mapped topographically and geologically, special attention being given to the stratigraphical succession. Later on, Mr. Benson hopes to extend the horizons discovered, northward into the Attunga District, and southwards towards Bowling Alley Point. This investigation, when completed, should pave the way for a revision of the stratigraphy of the Nundle District, which, in the light of new facts, promises to be more complex than was at first supposed Professor David, who has recently had the opportunity of accompanying Mr. Benson over the specially critical portion of the area which the latter is studying, has been good enough to inform the Council that he can speak in the highest terms of the work which Mr. Benson is undertaking, and of the way in which he is carrying it out.

For the second time, the Council was able to offer four Linnean Macleay Fellowships in October, 1914. Four applications were received. I have now the pleasure of making the first public announcement of the Council's re-appointment of Dr. J. M. Petrie, Mr. E. F. Hallmann, and Mr. W. N. Benson to Linnean Macleay Fellowships in Biochemistry, Zoology, and Geology, and the appointment of Mr. R. J. Tillyard, M.A., B.Sc., to a Linnean Macleay Fellowship in Zoology, for one year from 1st proximo; and, on the Society's behalf, of congratulating them on their appointment, and of wishing for them a prosperous and successful year.

Of the qualifications of Mr. Tillyard, as the new member of the Society's research-staff, I can speak in the highest terms. He took his B.A. degree at Cambridge, in 1903, with honours in Mathematics, and his M.A. in 1907. From 1904-13 he was Assistant Mathematical Master at the Sydney Grammar School. In 1903, Mr. Tillyard was admitted as a Research Student in the University of Sydney; and, at the same time, he was awarded one of the Government Research Scholarships, which he has held for two years. He completed the course of General Zoology, passing with high distinction; and gained his B.Sc., by research, the title of his thesis being "On some Problems concerning the Development of the Wing-venation of Odonata," which has been published in last year's Proceedings. Mr. Tillyard is well known to us, and I need only add that thirty-three of his papers have been published in the Society's Proceedings; one has appeared in the Transactions of the New Zealand Institute for 1912; and that three others are in course of publication elsewhere. He has also completed the manuscript of a book on the Odonata, shortly to be published at Cambridge.

Since the Society owes the establishment of Fellowships to Sir William Macleay's liberality, and his interest in Science began primarily in entomology, though it soon broadened wonderfully, it is eminently fitting that, in the fulness of time, an entomologist should be appointed. Mr. Tillyard, though an entomologist, is not merely a cabinet-drawer specialist. He is interested in a small and manageable group, which had been neglected locally, and, with which, the specialist abroad, with incomplete material, had not had too much to do. There was no representative series of specimens in any museum; and he had to start by making his own collection, which now contains the majority of the types. He has enlarged his knowledge of the group by collecting in every one of the States, except the Northern Territory. But Mr.

Tillyard is specially interested in the bionomics of the Odonata: and his studies are, as far as possible, faunistic studies. The larvæ are aquatic, and a knowledge of life-histories may be expected to throw more light on phylogenetic problems, than in the case of most groups of insects. Mr. Tillyard will continue his studies in the biology of Australian Odonata, particularly the life-histories of the Zygoptera, and the breathing-organs of the larvæ. In addition, he hopes to prepare the ground for the study of other aquatic neuropterous subdivisions, particularly the Perlida and allied groups, on similar lines.

On the morrow, then, we may look forward to the inauguration of Sir William Macleay's completed scheme for the advancement of post-graduate research in this State. The realisation of his plans has come about somewhat later than he expected, because of unforeseen obstacles; but these have now been surmounted. This will mean the opening of another notable chapter in the Society's history. In ten years' time, if all goes well, the Society may look forward to opening still another chapter, by the celebration, with appropriate ceremonies, of its Jubilee, an anniversary of recognised importance in the history of Scientific Societies. That occasion will provide an opportunity for stock-taking in all branches of the Society's work, and for a review of its first half-century of progress. Among other things, all being well, the President may expect to be in a position to say that, by the foresight and liberality of Sir William Macleay, the Society had been able to expend a sum of about £35,000 in salaries to its investigators, in publishing the results of their work, and in the establishment and maintenance of a bacteriological laboratory, spread over a period of about twenty-seven years. The resulting volume of work may be expected to be the equivalent of, approximately, what eighty-three qualified investigators could accomplish during one year. For this, there is not likely to be any parallel in the Southern Hemisphere.

His provision for the endowment of bacteriological research-work, and of Fellowships, was Sir William Macleay's way of setting the seal to his belief in the answer that could be given to the questions, Does research pay; is it worth while making special provision for it? The value of the results certainly cannot be gauged entirely, or even mainly, from the commercial point of view of so much money spent, and the equivalent of so many volumes of Proceedings produced. But, unless research-work of the character in question is to be regarded as largely an expensive luxury, the cost of production—the business man's point of view—cannot be left wholly out of sight.

Since their numbers are now complete, it behoves the Society's investigators to remember that upon them devolves their share of the responsibility of justifying Sir William's belief in the importance and efficacy of research-work matters in which he was very seriously in earnest; and of keeping in mind Huxley's words, quoted by Dr. T. Storie Dixson in his Presidential Address of March 30th, 1904, Fellowships "are aids to do work; not rewards for such work as it lies within the reach of an ordinary, or even an extraordinary, young man to do." If so, then we may look to them with confidence, to carry out their work earnestly in the true spirit of the scientific investigator.

The acquisition of eight of the plates [Nos. 1, 2, 3, 7, 8, 9, 10, 11] of the rare coloured issue of Ferdinand Bauer's "Illustrationes floræ Novæ Hollandiæ, &c." (1813), presented by the Rev. J. Lamont, F.L.S., in May of last year, which now adorn the Society's Hall, stimulated anew our interest in the beautiful work of Robert Brown's artist-companion during a visit to Australia in the early part of the last century. On this occasion, I am able to direct your attention to a very important paper, entitled "Ferdinand Bauer's Drawings of Australian Plants," by James Britten, in the Journal of Botany for 1909 (Vol. xlvii., p.140), which was not contained in the Society's library when Mr. Lamont's gift was received. It appears, from this paper, that there are 203 of Bauer's Australian drawings in the British Museum, which were presented to the Department of Botany by the Admiralty in 1843; together with 49 (of which 16 are duplicates of a corresponding number of the Admiralty series) were bequeathed by Robert Brown: or a total of 236. A list of these is given. Others are in the possession of the Naturhistorisches Hofmuseum in Vienna. Mr. Britten also gives a list of the drawings which are the originals of plates published in various works. Six of them are represented in the Illustrationes. This paper gives the most complete account of Bauer's artistic work, ever published. As the drawings are thirteen thousand miles away, Australian botanists will be glad of, and thankful for the information which Mr. Britten has supplied.*

We have to deplore the mysterious disappearance of the Federal Trawling Steamer "Endeavour," with all on board, including Mr. H. C. Dannevig, Commonwealth Director of Fisheries, and a biological colleague, while engaged in fishery-work on a cruise to the south, towards the end of the year. The Commonwealth Government sent out two steamers, which have returned after an extended but vain search for tidings of the missing vessel; and the authorities have now given up all hope. We profoundly regret the loss of those on board, and deeply sympathise with the bereaved. We have received from the Commonwealth Fisheries Branch, during the year, the concluding Part of Vol. i., and Vol. ii. of the "Biological Results of the Fishing Experiments carried on by the F.I.S. Endeavour, 1909-10, under H. C. Dannevig"; and also Parts 1-2 of Vol. iii. of Biological Results, 1909-14. It is a grievous loss to Science that the continuation of these important contributions to knowledge must shortly come to an end because of the loss, under most distressful circumstances, of the only Australian officers and the only Australian vessel engaged in deep-sea fishery work.

I have pleasure in noting that the "David Syme Research Prize" for 1915 has been awarded by the University of Melbourne to one of our Members, Mr. E. C. Andrews, of the Geological Survey staff; and of congratulating him on his success.

The award of the Wollaston Medal for 1915, by the Geological Society of London, to Professor David, is a matter of genuine gratification to Members of this Society, as this is the first time

* The paper on "Ferdinand Bauer and some of his Drawings," by Dr. Woolls, in the "Rural Australian," May, 1889, to which Mr. Fred Turner called attention, at the Meeting of the Society, in July, 1914, has not been accessible. Possibly it will be found to refer only to the "Illustrationes," and other published drawings.

an Australian geologist has been thus honoured. I have great satisfaction in offering to him the Society's most cordial congratulations. The Wollaston Medal has been awarded annually since 1831—except for one short interval, 1832-34; and the list of recipients includes the names of many distinguished men of science. We value highly this appreciation of the work of our senior University instructor in Geology, well known to us not only as an inspiring teacher, but as a field-geologist of repute, and a leading authority on the branches of the subject with which he is particularly identified.

The local output of non-serial scientific liturature during last year - in addition to the Federal and State Handbooks prepared for the British Association Meeting in Australia, of which mention has already been made includes some important works, to which I may briefly refer, beeause they are contributions to knowledge which will be helpful to students, and may be expected to stimulate a new or extended interest in the groups or subjects of which they treat. Such are Waterhouse and Lyell's "Butterflies of Australia: a Monograph of the Australian Rhopalocera"— Dr. H. I. Jensen's much-needed treatise on "The Soils of New South Wales," published by the Department of Agriculture of New South Wales—Volume ii. of Miss F. Sulman's "Popular Guide to the Wild Flowers of New South Wales," which, it may be hoped, will arouse interest, especially on the part of women, in the native plants—A new and up-to-date edition of the Geological Map of New South Wales, prepared under the direction of the Government Geologist, and issued by the Department of Mines.

We are glad to welcome one new, and one improved serial, in Part i. of the "Australian Zoologist," issued by the Royal Zoological Society of New South Wales; and No. i. of Vol. xx., of the "Scientific Australian," the Publishers of which hope to extend its scope, so as to offer an opportunity for the publication of short, popular papers on Science of general interest. The facilities for the publication of scientific work done by unofficial individuals have not materially improved in this State since this Society was founded forty years ago, whereas the number of such workers has steadily increased. New Journals which come to stay, are deserving of consideration; and we wish that the two referred to above, may be found to fulfil wants, and to be as successful as their promoters can reasonably wish.

The remainder of the Address was devoted to a consideration of the relations of the Permo Carboniferous fauna of Australia to those of other parts of the world.

Mr. J. H. Campbell, Hon. Treasurer, presented the balance sheet for the year 1914, 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. *Abstract:* GENERAL ACCOUNT, Balance from 1913, £279 9s 0d.; income, £1,209 14s. 0d.; expenditure, £955 7s. 8d.; transfer to Bookbinding account, £2 2s. 0d. (making £71 8s. 0d. available); balance to 1915, £531 13s. 4d.; BACTERIOLOGY ACCOUNT, income, £529 6s. 10d.; expenditure, £542 5s. 0d.; debit balance to 1915, £18 10s. 1d. LINNEAN MACLEAY FELLOWSHIPS ACCOUNT, Income, £1,999 13s. 2d.; expenditure, £1,178 17s. 7d.; transfer to Capital account, £820 15s. 7d. (See pp. xxi.-xxiv.).

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

PRESIDENT : Mr. A. G. Hamilton.

MEMBERS OF COUNCIL (to fill six vacancies): Messrs. R. T. Baker, F.L.S., J. E. Carne, F.G.S., W. W. Froggatt, F.L.S., C. Hedley, F.L.S., T. Steel, F.L.S., and G. A. Waterhouse, B.Sc., B.E., F.E.S.

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

ORDINARY MONTHLY MEETING.

MARCH 31st, 1915.

Mr. A. G. Hamilton, President, in the Chair.

The Donations and Exchanges received since the previous Monthly Meeting (25th November, 1914), amounting to 18 Vols., 205 Parts or Nos., 42 Bulletins, 17 Reports, 14 Pamphlets, and

1 Map, received from 88 Societies, etc., and 3 private donors were laid upon the table.

NOTES AND EXHIBITS.

A large specimen of the fossil *Ulodendron* was exhibited by Professor David. This interesting genus had been discovered, for the first time in the Southern Hemisphere, last January, by Mr. A. Pain, Demonstrator in the Geology Department of the University, when, in company with Mr. W. R. Browne, B.Sc., of the same Department, and the exhibitor, a systematic search was being made for plant-fossils at the scene of the discovery, Welshman's Creek, near Wallarobba, between West Maitland and Dungog. Attention had first been directed to the locality through Mr. W. J. Enright, B.A., of West Maitland, who on enquiring whether any specimens of Lepidodendron had been found in the neighbourhood, obtained, through the kindness of Miss O'Brien, Mistress of the Wallarobba Public School, and her pupil, Miss Nellie Schäfer, an exquisitely preserved specimen of Lepidodendron with the minutest cell-structure preserved, replaced in chalcedonic silica. This was found at Welshman's Creek. Further search at this locality, in company with Professor Lawson, and Mr. C. A. Süssmilch, led to the discovery of several large stems of a tree allied to *Pitys antiqua*, hitherto unrecorded from Australasia. Still later, the *Ulodendron* was unearthed by Mr. Pain. The stem is at least 18 inches in width, and the scars marking the spots from which the cones, or sessile strobili, have fallen off, are in two straight rows on opposite sides of the tree. The scars are between 3 and 4 inches in diameter, about 15 inches apart, and are alternate. The genus *Ulodendron* is well known in the Carboniferous rocks of the Northern Hemisphere, being specially characteristic of the Lower Carboniferous horizon. The locality at Wallarobba is evidently the site of an old fossil forest, the oldest as yet found in Australasia. Professor Lawson will later contribute a detailed description of the *Ulodendron*.

Mr. Fletcher, on behalf of Mr. Musson and himself, exhibited a series of lantern-illustrations of the modification of the natural growth-habit of certain plants, due to parasitic organisms.

The Linnean Society of New South Wales.

GENERAL ACCOUNT.

Balance Sheet at 31st December, 1914.

Liabilities.	£	s	d
Capital: Amount received from Sir William Macleay during his lifetime	14,000	0	0
Further Sum bequeathed by his Will, £6,000, less Probate Duty, £300	5,700	0	0
	£19,700	0	0
Bookbinding A/c	71	8	0
Income A/c, at 31st December, 1914	531	13	4
	£20,303	1	4

Assets.				£	s	d
Society's Freehold				1,600	0	0
Investments: Loans on Mortgage...				18,100	0	0
Cash:						
Commercial Banking Co. of Sydney, Ltd. (Current A/c)	98	4	4			
Government Savings Bank	504	17	0			
				603	1	4
				£20,303	1	4

Examined and found correct. Securities produced.

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

Sydney, 15th February, 1915.

J. H. Campbell, Hon. Treasurer.

INCOME ACCOUNT, year ended 31st December, 1914

Dr.

	£	s	d	£	s	d
To Salaries and Wages				458	10	0
,, Printing (Publications)	276	7	0			
,, Illustrations	145	9	11			
				421	16	11
,, Rates	23	16	9			
,, Insurance...	7	13	8			
				31	10	5
,, Postage, Telegrams, Advertising and Petties...	32	0	0			
,, Printing (sundries), Stationery, etc.	5	11	6			
,, Maintenance Fee, Sir Wm. Macleay's Grave	1	10	0			
,, Audit Fee (proportion of)	1	15	0			
,, Legal Costs	1	11	6			
,, Bank Charges	1	2	4			
				43	10	4
,, Bookbinding A/c				2	2	0
,, Balance to 1915				531	13	4
				£1,489	3	0

Cr.

	£	s	d	£	s	d
By Balance from 1913				279	9	0
,, Subscriptions—						
1914...	140	14	0			
Arrears...	10	10	0			
In advance	3	3	0			
				154	7	0
,, Entrance Fees				2	2	0
,, Interest on Investments				928	6	6
,, Sales (including 100 copies of Proceedings purchased by the Govt. of N.S.W.)...				108	18	6
,, Rent (Bacteriology A/c)				16	0	0
				£1,489	3	0

BACTERIOLOGY ACCOUNT

Balance Sheet at 31st December, 1914.

Liabilities	£	s	d	Assets.	£	s	d	£	s	d
Capital: Amount bequeathed by Sir William Macleay, £12,000, less Probate Duty, £600 … … … …	11,400	0	0	Investments: New South Wales Inscribed $3\frac{3}{4}$% Stock … … … … … … … …				13,900	0	0
Accumulated Interest ordered by Council to be added to Capital	1,600	0	0	Income A/c at 31st Dec., 1914…				18	10	1
Interest invested … … … … … …	900	0	0							
	13,900	0	0							
Commercial Banking Co. … … …	18	10	1							
	£13,918	10	1					£13,918	10	1

INCOME ACCOUNT, year ended 31st December, 1914

Dr. / Cr.

Dr.	£	s	d	Cr.	£	s	d	£	s	d
To Balance from 1913 … … … … … …	5	11	11	By Interest on Investments				522	13	6
,, Salary and Wages … … … … … …	458	0	0	,, Tuition Fees … … … … …	20	0	0			
,, Rent … … … … … … … … … …	16	0	0	,, Less Bacteriologist's proportion … … … …	13	6	8			
,, Rates… … … … … … … … … …	7	18	11					6	13	4
,, Insurance … … … … … … … …	1	5	4	,, Balance to 1915 … … … … … …				18	10	1
,, Gas … … … … … … … … … …	7	18	1							
,, Apparatus and Chemicals … … …	30	15	8							
,, Journals and Printing … … … …	1	14	6							
,, Telephone … … … … … … … …	4	7	6							
,, Audit Fee (proportion of) … … …	1	15	0							
,, Bank Guarantee Fee … … … … …	0	10	0							
,, Petty Cash … … … … … … … …	12	0	0							
	£547	16	11					£547	16	11

Examined and found correct. Securities produced.
Sydney, 15th February, 1915.
F H Rayment, F.C.P.A., Auditor.

J. H. Campbell, Hon. Treasurer

LINNEAN MACLEAY FELLOWSHIPS' ACCOUNT.

Balance Sheet at 31st December, 1914.

Liabilities.		£	s	d	Assets.				£	s	d
Capital: Amount bequeathed by Sir William Macleay, £35,000, less Probate Duty, £1,750		33,250	0	0	Investments: Loans on Mortgage	34,450	0	0			
Balance of Income Account capitalised in terms of bequest or available for such purpose—					New South Wales Inscribed 3¾% Stock...	7,715	0	0	42,165	0	0
To 31st Dec., 1913	8,260 9 9				Cash:						
At 31st Dec., 1914	820 15 7	9,081	5	4	Savings Bank of N.S.W				189	4	4
		42,331	5	4							
Commercial Banking Co.		22	19	0							
		£42,354	4	4					£42,354	4	4

INCOME ACCOUNT, year ended 31st December, 1914.

Dr.	£	s	d	Cr.	£	s	d
To Salaries of Linnean Macleay Fellows...	1,100	0	0	By Interest on Investments	1,999	13	2
,, Cost of publishing Fellows' Papers	77	2	7				
,, Audit Fee (proportion of)...	1	15	0				
,, Amount transferred to Capital A/c	820	15	7				
	£1,999	13	2		£1,999	13	2

Examined and found correct. Securities produced.
F. H. Rayment, F.C.P.A., Auditor.
Sydney, 15th February, 1915.

J. H. Campbell, *Hon. Treasurer*

THE GENUS *TRACHELOMONAS*.

By G. I. Playfair, Research Scholar of the University of Sydney in Hydrobiology and Plankton.

(Plates i.-v.; and Text-figs.1-20.)

Very little attention has been given to this interesting genus of freshwater flagellates. Senn, in his "Anhang zu den Flagellata" (Engler & Prantl," Die Natürlichen Pflanzenfamilien, 1900) gives the number of species as six. Stein, however, in "Die Naturgeschichte der Flagellaten" (Abt. iii., H. i. of his "Organismus der Infusionsthiere," 1878), had already figured 10 species. Half of these date back to Ehrenberg, viz., *Tr. volvocina*, *Tr. cylindrica*, *Tr. lagenella*, *Tr. armata*, and *Tr. caudata*, though often under other generic names. *Tr. hispida* Perty, *Tr. acuminata* Schmarda, *Tr. bulla* Stein, *Tr. rugulosa* Stein, and *Tr. eurystoma* Stein, make up the remainder. Kent, "Manual of the Infusoria," 1878, gives descriptions of those mentioned by Stein, but figures of five only. Stokes, "Freshwater Infusoria of the United States" (Journ. Trenton Nat. Hist. Soc., 1888), describes five other species, *Tr. verrucosa* Stokes, *Tr. acanthostoma* Stokes, *Tr. torta* Kellicott, *Tr. piscatoris* (Fisher) Stokes, and *Tr. urceolata* Stokes, with figures of the last three. In "Notices of New Freshwater Infusoria" (Amer. Phil. Soc., 1890), the same author proposed four other species, viz., *Tr. cervicula*, *Tr. similis*, *Tr. obovata*, *Tr. spinosa*. Other publications containing notices of new forms are: Klebs, "Organization einiger Flagellatengrupper" (Bot. Inst. zu Tubingen, 1881-85), *Tr. reticulata* Klebs; Dangeard, "Recherches sur les Eugléniens" (Botaniste, 1902), *Tr. intermedia* Dangeard, with notes and figures of *Tr. volvocina*, *Tr. rugulosa*, *Tr. lagenella*, *Tr. hispida*, *Tr. caudata*, *Tr. armata*, and *Tr.*

reticulata; Lemmermann, "Reise nach der Pacific" (Abh. Nat. Ver. Bremen, Bd. xvi., 1899), *Tr. oblonga*, n.sp.; Lemmermann, "von Dr. Volz gesammelten Süsswasseralgen" (*ibid.*, Bd. xviii., 1904), *Tr. Volzii*, n.sp., with observations on *Tr. volvocina*, *Tr. oblonga*, *Tr. euchlora* (*Tr. lagenella*), *Tr. hispida*, *Tr. armata*, and *Tr. bulla*, figures and descriptions of new forms; Bruno Schröder, "Alg. der Versuch. zu Trachenberg" (Plöner Berichte Th.v., 1897), figures of two variations of *Tr. hispida;* Maskell, "On Freshwater Infusoria" (Trans. New Zealand Inst., 1886), figure and description of *Tr. crenatocollis*, n.sp.; *ibid.*, 1887, *Tr. teres*, n.sp.

As I have not access to either Ehrenberg, "Die Infusorienssthiere," 1838; Perty, "Kleinster Lebensformen in der Schweiz," 1852; or Schmarda, "Neue Formen von Infusorien," 1850, I have been obliged to accept Stein's excellent figures as typical of the seven species described in these memoirs. *Tr. armata*, however, is excepted, in whose case, Ehrenberg's original description is quoted by Lemmermann, *l.c.*, Bd. xviii, p.165. I know of no publications, other than the above, containing new forms of *Trachelomonas.*

These memoirs give a total of 25 published species of greater or less validity, and 8 variations, the majority of which are discussed in this paper, in addition to a large number of types and variations apparently never before noted. In many cases, unfortunately, the exact European type has not been observed by me, but only a very similar form, showing, however, the specific characteristics sufficiently well for identification. It is, indeed, through these "very similar forms" that what is truly characteristic and what is not, become most clearly discernible.

The present paper deals with forms of *Trachelomonas* found in New South Wales during the past seven years, and even then only in the two districts of Sydney and Lismore. Whatever may be the case in Europe, our waters here are very rich in forms of the genus, exhibiting a great variety of types. Ground-gatherings are best, out of swampy places, and especially out of shallow rainwater pools on grass-lands, the favourite haunt of green flagellates of all descriptions. Gatherings out of weeds are not, as a rule, so good.

LOCALITIES referred to in this paper; the numbers correspond to samples deposited in the National Herbarium, Sydney.

In the Sydney district.

Auburn 56, 135, 139, 148, swampy ground on railway opposite Ritchie's; 57, 68, pool in the angle of meat-works siding; 119, 120, 140, 163, swampy ground on railway towards Rookwood.

Botany 37, 92, water-reserve, weeds; 51, 152, ditto, ground-collection; 91, 151, swampy ground near tram-terminus; 108, 142, 145, Gardener's Road, swamps.

Botanic Gardens 3, 137, 150, gardeners' tank, weeds; 158, duck-pond, weeds.

Canley Vale 110, pool on railway towards Cabramatta, weeds.

Centennial Park 11, 133, weeds out of ponds.

Coogee 4, sphagnum-bog on cliffs, ground-collection.

Fairfield 79, swampy ground on railway towards Guildford; 143, weeds, Orphan School Creek.

Guildford 60, pool on railway, weeds; 45, 70, 77, 88, 146, ditto, ground; 76, 114, pool on railway nearer Merrylands, ground.

Parramatta Park 96, lake, weeds; 136, ditto, plankton; 165, 166, rainwater pools.

In the neighbourhood of Lismore.

Casino 189, weeds, Richmond River.

Kyogle 218, 219, lagoons, ground-collection.

Lismore 176, 183, 225, weeds, Richmond River; 240, swamp on railway towards Woodlawn; 241, lagoon behind Foley's; 236, 237, lagoon near North Lismore Station; 238, 254, lagoon on Goolmangar Road; 242, rainwater pools foot of Girard's Hill; 244, ditto, near Drill Hall; 245, 246, ditto, vacant ground in Conway Street.

SYDNEY GATHERINGS.—Out of 116 mixed gatherings, 40 contained species of *Trachelomonas* in some quantity, with a varying number of forms. Of these 40, 28 were off the ground, and only 12 out of weeds, to which must be added that, in the latter, the forms of *Trachelomonas* present were almost invariably very sparsely distributed. The larger number of samples contained from 1 to 5 forms, but a few were very rich, yielding 10, 11, 12, 14, 15, 21, and even 24 varieties. The last mentioned (151) was from a shallow, insignificant rainwater-pool on grass-land, and almost every one of the 24 varieties was in profusion.

LISMORE GATHERINGS.—Only 12 forms were noted in the Richmond River, out of 20 very rich squeezings from weeds, and of these 12, the larger number were out of one sample (225), and extremely scarce. Of 23 ground-gatherings, only 9 contained *Trachelomonas* in any quantity, but these were very fine. They were taken in the winter of 1914, from shallow rainwater-meres, and small pools on level grass-lands. One of them (237), besides 18 varieties of *Trachelomonas*, yielded *Euglena viridis*, *Eu. acus*, *Eu. pisciformis*, *Eu. deses*, *Eu. tripteris* and var., *Eu. oxyuris*, *Phacus pleuronectes*, *Ph. longicauda*, *Ph. pyrum*, *Ph. monilata* var. *suecica* Lemm., *Phacus*, sp.n., *Chlamydomonas globulosa*, *Gonium pectorale*, *Pandorina morum*, and *Spondylomorum quaternarium*, all in great profusion. Twenty-one varieties of *Trachelomonas* had been obtained from the same place a week before.

Another noteworthy Lismore sample is No.242, from a muddy rainwater-swamp by the roadside at the foot of Girard's Hill. It yielded 20 forms of *Trachelomonas*, *Volvox Bernardii*, *Euglena tripteris* var., 5 varieties of *Lepocinclis* (*Chloropeltis*), *Synura uvella*, *Eudorina elegans* and var., *Pandorina morum*, *Chlamydomonas globulosa*, and *Chl. intermedia*, all in quantity.

SPECIES.—Altogether, 104 forms of *Trachelomonas* are mentioned below as occurring in this country. Of these, 38 are common to both Sydney and Lismore, 37 have, so far, been found only in Sydney, and 29 at Lismore only. At the former, the total number of varieties noted was 75, at the latter 67. The surface-soil, in districts where gatherings were made, was of three different kinds: at Botany, Coogee, and Centennial Park, sand; at Auburn, Canley Vale, Fairfield, Guildford, and Parramatta, clay (often right up to the surface); in the Lismore district, deep black loam. Yet, under all circumstances, the forms described retain their characteristics and dimensions, and all the common forms noted originally round Sydney are found also at Lismore, though the two districts are 350 miles apart. These species and variations, therefore, may be relied upon to be of some fixity of character. The Lismore forms are rarer, more interesting and distinct than those from Sydney, e.g., *Tr. bulla* var. *australis*, *Tr. conica* vars., *Tr. Lismorensis*, *Tr. verrucosa* Stokes, *Tr. scabra* and vars., *Tr. eurystoma* Stein, and vars., *Tr. caudata* var. *australica*, *Tr. urceolata* var. *Girardiana*. On the other hand, the tailed forms were almost confined to Parramatta Park, and Duck Creek, Auburn.

NOMENCLATURE.—With regard to the nomenclature, of those mentioned, 25 are ranked as species, 75 as variations, and 4 as forms. The species, of course, are the *conventional* species current in microscopical studies for purposes of classification. I use the terms "species," "variation," and "form" as merely three degrees of comparison in distinctness of outward configuration—in *Trachelomonas*, the shape of the lorica. In the forms and variations there is generally some biological connection with the type, though not always, e.g., *Tr. clavata* var. *spinosa*, *Tr. urceolata* var. *Girardiana*, and *Tr. caudata* var. *australica*; these are each variations of a type-*form*, but probably are not developed from the type itself. They are neither found in company with it nor replacing it, but are collateral Australian types. The conventional species, on the other hand, are merely type-forms, and are not indicative of any biological distinctness. They do not generally, indeed, develop one into another, but each comes into existence by development from the root-form of the true species. I recognise only two biological species in *Trachelomonas*—(1) comprising all the rounded forms, (2) the tailed (stipitate) forms, and of these two even, the latter is of doubtful distinctness (*cf.* Stein, T.xxii., f.22, where *Tr. hispida* is portrayed with a tail; also *Tr. subglobosa* mihi, Pl. v., f.20, 21, which simulates *Tr. volvocina*, and of which one form is obscurely tailed). Among the rounded varieties, *Tr. volvocina* is the root-form, and in the stipitate, some minute form like *Tr. sessilis* var. *minima*, the conventional species being merely polymorphic forms of growth developed from them. I have come to realise, however, that any system of nomenclature based on polymorphism is futile. Some attempt of this kind was made by me in "Polymorphism and

Life-history in the *Desmidiaceæ*" with regard to the Desmids, and also in "Plankton of the Sydney Water-Supply" with forms of *Lagerheimia* and *Peridinium*. While answering very well for genera like *Docidium*, where the forms comprised in one true species are very much alike, a system of nomenclature which makes each conventional species a variation of the oldest published type, is inconvenient for general use on account of the intricate and extensive polymorphism that prevails. And this for four reasons :—(1).It seems absurd to make widely differing types variations one of the other, even while admitting their position in the same species. (2).The oldest type is very often not the root-form of the true species, and many of the variations are more closely connected with one another than with the nomenclatural type, so that the system has not even the merit of indicating the exact biological position of the variations concerned. (3).So many of the variations have other forms intimately connected with them that it necessitates the frequent use of three-term nomenclature, which is exceedingly cumbrous. (4). The forms biologically connected together in one true species are so widely different in appearance, that only after prolonged observation can the fact of their relationship be determined; and as older and still older forms are correlated, the nomenclatural type keeps changing, to the confusion of the nomenclature. While holding, therefore, just as strongly to the position that the recognised species are mere polymorphic forms (subspecies of vastly broader true species), with regard to the nomenclature, I have returned to the generally accepted scheme. I see no reason why, for convenience' sake, we should not work in species which are frankly conventional, provided that the true state of affairs in Nature is freely recognised. The species, it is true, is a biological entity, not a conventional one, but the polymorphism of the lower orders of microscopic vegetable and animal life being as wide-spreading as it is, it is impossible to reconcile the exigencies of nomenclature (simplicity and conciseness) and biology (true connection of forms by life and growth) so that the name of an organism shall be the index of its biological position in Nature.

Reproduction.—The polymorphic character of the various accepted species of *Trachelomonas* is best shown in the reproduction. It is true, no doubt, that, in permanent waters, propagation takes place largely by self-division, but it has been shown above (and indeed it is a commonplace of my experience) that the home of *Trachelomonas*, and of the green flagellates generally, is in shallow rainwater-pools which become entirely dry at longer or shorter intervals. Under these circumstances, the Infusoria, flagellate and ciliate alike, reproduce themselves by micro-zoospores formed by the splitting up of the whole body. These micro-zoospores, settling down, form resting-cells, and when their habitat is revivified by rain, the type is reproduced from the resting-cell after a longer or shorter period of vegetative growth. The vegetative stages of *Euglena* and *Phacus* are well-known. If the various forms of *Trachelomonas* were specifically distinct, there would be a distinct resting-cell and course of development for each. But though I have paid special attention to localities such as I have mentioned, I have never found any other resting-cell than that which is directly associated with the very smallest sizes of *Tr. volvocina*. Compare my remarks on the Peridinieæ, "Plankton of the Sydney Water-Supply," p.541. I have not seen the micro-zoospores, but the act of emission is figured by Stein, *l.c.*, T. xxii , f.10 and 31. The pale colour of the lorica, in forms found in newly-filled rainwater pools or swamps, forbids the idea that the organisms have survived the dry season; they are quite evidently a new growth.

Lorica.—With regard to the composition of the lorica, Stokes, *l.c.*, p.88, quotes some remarks by Fisher (Proc. Amer. Soc. Micros., 1880) as follows :—" On testing with solution of potash or soda . . . . the spines are detached from their bases, whilst the lorica remains unaffected, either in form or rigidity. Thus the probability is established that these spines, again like those of the Echinodermata, are articulated to the lorica by an organised membrane which yields to the action of the salt, and the separation is effected. On testing with hydrochloric acid, brisk effervescence immediately takes place; the main body of the lorica is dissolved. . . . . The chief constituent of the lorica is, therefore, shown to be calcareous."

Nearly all the forms described in this paper have been observed in a living condition, the character of the flagellum and of the body in each case leaving no doubt that the organism was a genuine *Trachelomonas*. The specimens were carefully measured in detail, and drawn mostly to the scale of 1500 diameters, which has been reduced in the reproduction to 1000. The magnification employed in observation was that of $\frac{1}{6}$ inch objective with 15 diam. ocular.

INFUSORIA.

Family EUGLENIDÆ Stein.

Genus TRACHELOMONAS Ehr.

Synonyms :—*Lagenella* pro parte, *Chætoglena* p.p., and *Chætotyphla** Ehrenberg; *Lagenella* Schmarda; *Cryptomonas* Dujardin p.p., *Chonemonas* and *Trypemonas* Perty; *Cryptoglena* Clap. et Lachmann; *Laguncula* Fisher, Proc. Amer. Soc. Micros., 1880.

TRACHELOMONAS VOLVOCINA Ehr. (Pl. i., f.1).

Diam. 5, 10, 12, 16, 18, 20, 22, 24, 25, 26, 27, 30 μ.

Everywhere, very common.

Lorica perfectly spherical, with smooth clear membrane pale yellow to dark red. Very seldom found with a neck. Sizes over 27 μ diam. are very rare; I have observed only a single specimen. Dangeard, Les Eugléniens, p.128, has included oval forms in this species; these, however, belong to *Trach. intermedia* Dang., *q.v.*, var. *levis* mihi.

Var. PELLUCIDA Playf.

Diam. 4-10 μ. Lorica quite colourless.

Botanic Gardens 158; Auburn 139; Lismore 176, 183.

Cf. Biol. Richm. R., these Proceedings, 1914, p.141, Pl. viii., f.3. Klebs, Organis. einig. Flagellatengr., p.319, has noted a variety, γ *hyalina*, but, in his form, it is the body that is colourless, without chlorophyll.

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* Senn, Flagellata, p.176, gives the name as *Chætophlya* Ehr.; Stein and Lemmermann refer to it as *Chætotyphla* Ehr.

Var. PUNCTATA, n.var. (Pl. i., f.2).

Lorica levis sed crasse et densissime punctata. Diam. obs. 13, 14 μ.

Botanic Gardens 3a; Parramatta 165, 166. Rarissime.

Var. GRANULOSA, n.var. (Pl. i., f.3).

Lorica minute sed densissime granulata, plerumque achroa. Diam. 11, 12 μ.

Botany 151; Lismore 241. Rarissime.

Var. CERVICULA (Stokes) mihi. (Pl. i., f.4).

This form has the neck produced inwardly. *Cf.* Stokes, Proc. Amer. Phil. Soc., 1890, fig.11(*Trach. cervicula*). Only two specimens seen.

Diam. 32 μ.

Auburn 139, 140. Very rare.

TRACHELOMONAS INTERMEDIA Dang. (Pl. i., f.5).

Lorica ovalis vel subglobosa, punctata; collo nullo.

Long. 19-22, lat. 15-17 μ.

Lismore 236, 245.

Cf. Dangeard, Recherches s. l. Eugléniens, p.135, f.42, who gives 20 × 16 as dimensions. The type very rare here.

Var. LEVIS, n.var. (Pl. i., f.6-8).

Lorica ovalis vel subglobosa, vulgo sine collo, levis; ore sæpe introrsum levissime producto.

Long. 15-22, lát. 12-19, lat. oris 3 μ.

Auburn 120, 135, 139, 140, 163; Guildford 114; Botany 145; Lismore 236, 237, 238, 240, 242.

TRACHELOMONAS BOTANICA, n.sp. (Pl. i., f.9).

Lorica subglobosa, levis, vulgo sine collo; a tergo minuta, obscura papilla instructa.

Long. 40, lat 34, lat. oris 7 μ.

Botany 151. Rarissime.

Var. GRANULOSA, n.var.

Lorica formæ typicæ consimilis, minute autem granulata.

Long. 40, lat. 34 μ.

Botany 151. Cum priori, rarissime.

Var. MINOR, n.var. (Pl. i., f.10).

Long. 26, lat. 23 μ.

Auburn 163.

In this variation, if the papilla is wanting, a paler, weaker spot often marks its position.

TRACHELOMONAS OVALIS Playf. (Pl. i., f.11).

Lorica ovalis vel oblonga, collo nullo, perfecte glabra, achroa vel luteo-fusca.

Long. 30-44, lat. 22-34 μ.

Guildford 146; Casino 189; Lismore 237.

Trach. armata is probably the outgrowth of this form, as the posterior spines do not develop *pari passu* with the rest of the lorica, but later. It is also very likely that there is a connection between this species and *Trach. Botanica*, as a broad, circular, incrassate spot is sometimes noticeable at the hinder end. *Cf.* these Proceedings, 1914, p.141, Pl. viii., f.4 Syn. *Tr. lagenella* Dangeard, Les Eugléniens, p.131, f.40 (non Stein).

Var. LATA, n.var.

Lorica oblonga, præ forma typica latior, collo brevissimo instructa.

Long. 38, lat. 32; lat. oris 6; coll. alt. 1 μ.

Lismore 237.

For the same length of cell, the breadth in this form is one-fifth greater than in the type.

Var. SCROBICULATA, n.var.

Lorica crasse scrobiculata, translucens, candore carnoso.

Long. 31-40, lat. 22-30 μ.

Lismore 236, 237.

This variation, like many other Australian forms, is of a pinky-yellow or very pale brown colour, quite distinct from the clear yellow of *Trach. volvocina* and others, and which I designate here by the name of buff.

Var. MINOR, n.var. (Pl. i., f.12).

Lorica levis sed scrobiculata, candore carnoso, ovalis vel oblonga, minor quam forma typica.

Long. 26-28, lat. 22-24 μ.
Lismore, 236, 237, 246.

TRACHELOMONAS BULLA var. AUSTRALIS, n.var. (Pl. i., f.13).

Lorica ovata, levis, quam forma typica magis acuminata, collo recto nec attenuato.

Long. 28-29, lat. 16; coll. alt. 2-3, lat. 3 μ.

Lismore 236, 237.

A very rare form of which I have seen but few specimens. Cf. *Trach. bulla* Stein, Naturg. d. Flagellaten, Hälfte i., T. xxii., f. 42. His figure works out at 50 x 21 μ.

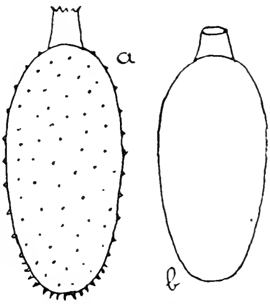


Fig. 1.—*Tr. bulla* Stein, × 650, after Stein.

TRACHELOMONAS OBLONGA Lemm. (Pl. i., f.14-16).

Long. 10-19, lat. 8-12; lat. oris 3 μ.

Coogee 4; Guildford 60, 114; Auburn 68; Botany 51, 142; Centennial Park 133; Canley Vale 110; Lismore 225, 237, 238, 240, 242, 245.

Cf. Lemmermann, Reise n. d. Pacific (Abh. Nat. Ver. Bremen, Bd. xvi., 1899), p.344. No figure is given, but the likeness of our forms to var. *truncata* Lemm., (*ibid.*, Bd. xviii., 1904, p.165, T. xi., f.7, 8) is so marked, that I think there can be no doubt about the identification. Lemmermann's description runs :—Lorica oval (*länglich rund*), yellow-brown, surface smooth, 13-16 μ long, 11-12 μ broad. Membrane 1 μ thick. This description would make the type oval, yet the name "*oblonga*" has been chosen; both the published figures of var. *truncata*, l.c., are distinctly oblong, not oval, and the same expression (*länglich rund*) is used of the variation as of the type, nor is any difference in outline noted. I take it, therefore, that "*länglich rund*" here is equivalent to "*oblonga ubique rotundata.*"

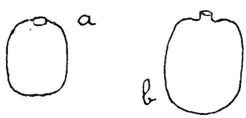


Fig. 2. — *Tr. oblonga* var. *truncata* Lemm., × 1000, after Lemmermann.

Var. AUSTRALICA, n.var. (Pl. i., f.17-21).

Lorica globosa vel plus minusve quadrata, angulis rotundatis; collo lato humillimo semper instructa; membrana levi.

Long. 11-22, lat. 10-20; coll. alt. 1, lat. 3-6 μ.

Auburn 120, 139, 140, 163; Botany 142, 145, 152; Canley Vale 110; Guildford 114; Lismore 236, 237, 238, 241, 245.

The very broad ring-shaped neck is characteristic of this form, which ranges in shape from globose to quadrate or oblong, and varies considerably in size.

Var. ATTENUATA, n.var. (Pl. i., f.22, 23).

Lorica levis, fronte quadrata angulis rotundatis, postice leviter attenuata et late-rotundata; vulgo collo brevi.

Long. 11-20, lat. max. 8-13 μ.

Coogee 4; Guildford 60; Centennial Park 133; Botany 142, 151; Lismore 236, 242.

Var. SCABRA, n.var. (Pl. i., f.24).

Lorica ubique scabra granulis humillimis obscuris sparse dispositis.

Long. 24, lat. 19; coll. alt. 2, lat. 6 μ.

Auburn 120.

TRACHELOMONAS PUSILLA, n.sp. (Pl. i., f.25).

Lorica minuta, levis, modice cordiformis, fronte levissime deplanata, postice paullulo acuminata; collo nullo; ore lato.

Long. 10-16, lat. 9-16 μ.

Canley Vale 110; Guildford 114; Botany 142, 151, 152; Lismore 242, 245.

Var. ROTUNDA, n.var. (Pl. i., f.26).

Lorica levis ubique rotundata, nec acuminata, globosa, fronte levissime deplanata; ore lato.

Long. 11-12, lat. 10 μ.

Auburn 163; Botany 151; Guildford 114; Lismore 238, 242.

Var. PUNCTATA, n.var. (Pl. i., f.27).

Long. 15, lat. 14 μ. Botany 145.

TRACHELOMONAS CYLINDRICA Ehr. (Pl. i., f.28, 29).

Lorica smooth, cylindrical with parallel sides, broadly rounded behind, more or less shouldered in front, but our forms are not generally so rectangular as those figured by Stein, with a low ring-shaped neck.

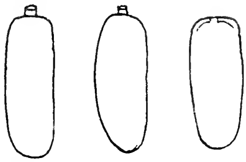


Fig. 3.—*Tr. cylindrica* Ehr., ×650, after Stein.

Long. 16 20, lat. 8-10; coll. alt. 1, lat. 3 μ.

Botanic Gardens 3; Auburn 120; Botany 142, 145, 152; Lismore 236, 237, 241, 242.

Var. DECOLLATA, n.var. (Pl. i, f.30).

Lorica levis, cylindracea, plerumque latior; collo nullo.

Long. 16-20, lat. 8-10 μ.

Botanic Gardens 3.

Var. PUNCTATA, n.var. (Pl i., f.31).

Lorica major, punctata, fronte posticeque vulgo late-rotundata; collo brevi humillimo.

Long. 26-38, lat. 12-14; coll. alt. 1, lat. 4 μ.

Botany 142, 152; Lismore 242.

This form is not only punctate, but larger than the type, the breadth of which is commonly about 8 μ, while var. *punctata* is just as regularly about 12 μ.

TRACHELOMONAS PULCHERRIMA, n.sp (Pl. i., f.32, 33).

Lorica levis, candore carnoso, anguste-elliptica; apicibus late-rotundatis; lateribus leniter arcuatis; collo humillimo aut nullo.

Long. 20-26, lat. 9-12; coll. alt. 1-2, lat. 4 μ.

Centennial Park 11; Botany 91, 151, 152; Lismore 240, 241, 242.

Var. LATIOR, n.var. (Pl i., f.34, 35).

Lorica levis sed sæpe punctata, præ forma typica latior, æqualiter elliptica; apicibus late-rotundatis; collo plerumque nullo.

Long. 20-27, lat. 12-14 μ.

Botany 151; Lismore 236, 237, 238, 245.

Differs from the type principally in its relatively greater breadth; long. : lat. = 1·5 to 1·8 : 1 but, in the type, 2·0 to 2·4 : 1. The neck also is generally wanting and the lorica often punctate.

Var. OVALIS, n.var. (Pl. i., f.36).

Lorica var. *latioris* dimensionibus sed ovalis, polos versus magis acuminata, lateribus magis arcuatis, apicibus rotundatis: collo nullo; membrana dilute fulva interdum punctata.

Long. 22-23, lat. 13-15; lat. oris 4 μ.

Botany 151; Lismore 245.

Oval-elliptic, instead of linear-elliptic, with sides converging from the centre to the ends.

Var. MINOR, n.var. (Pl. i., f.37, 38).

Lorica minor, cetera ut in formis duabus precedentibus.

Long. 12-19, lat. 8-12 μ.

Botany 151, 152; Lismore 240, 242.

Includes both the preceding forms in smaller sizes.

Var. LISMORENSIS, n.var. (Pl. i , f.39, 40).

Lorica collo quadrato valido instructa.

Long. 25-26, lat. 10-11; coll. alt. 2½-3, lat. 3-4 μ.

Lismore 236, 237, 241.

Var. GRANULOSA, n.var. (Pl. i., f.41).

Lorica minute granulata; collo humillimo.

Long 25-28, lat. 11-14; coll. alt. 1, lat. 4 μ.

Botany 142.

Trach. pulcherrima is a close connection of *Trach. cylindrica*, from which it differs in the gently arched, not parallel, sides. It is also much more variable than that species.

TRACHELOMONAS VOLZII var. PELLUCIDA, n.var. (Pl. ii., f.1).

Lorica ut in forma typica, levis autem et pellucida, nec punctata nec granulata; candore carnoso pæne hyalino.

Long. 34, lat. 18 μ.

Botany 142; rarissime.

Lemmermann gives 32 × 15 μ, Dr. Volz gessam. süssw. Alg., p.166, T. xi., f.9. *Trach. Volzii* is ovate, broader behind than before, neck with pointed sides in optical section. The type is described as granulate (the figure, however, has a smooth outline) and yellow-brown in colour. Var. *pellucida* is pale buff, almost colourless, and neither punctate nor granulate. Only one specimen noted. It is a young form of var. *australis*, infra, with which it is connected by var. *intermedia*. All three are stages of development.

Var. AUSTRALIS, n.var. (Pl. ii., fig.2).

Lorica levis, subovata, postice latior, collo quadrato valido semper instructa; parte majore corporis suboblonga, fronte usque ad collum attenuata, a tergo latissime-rotundata: collo ad basin annulo incrassato plerumque ornato.

Long. 34-38, lat. 16-20; coll. alt. 4, lat. 4 μ.

Botany, 108, 142, 152; Lismore 225, 240, 241.

This is the full-grown form of *Trach. Volzii*, and a very distinct type; the colour is generally a clear yellow.

Var. INTERMEDIA, n.var. (Pl. ii., f.3).

Lorica in ambitu ut in var. *australi* sed angustior, collo autem ad formam typicam potius pertinente.

Long. 34; lat. fronte 11, postice 15; coll. alt. 3, lat. 3 μ.

Botany 142. Cum forma typica.

I had var. *australis* down as a separate type (it is much more common than the other two forms) when I came across *Tr. Volzii* and this variation, both in the same gathering, showing unmistakably the connection of all three. Var. *intermedia* has the thin outer primordial membrane of the lorica stretched between the shoulder and the tip of the neck as in *Tr. Volzii*, type.

Var. CYLINDRACEA, n.var. (Pl. ii., f.21).

Lorica modice cylindracea, lateribus parallelis; a tergo laterotundata; a fronte conica, lateribus ad collum convergentibus; collo recto valido, annulo basali ornato, instructa; membrana levis.

Long. 34-38, lat. 16; coll. alt. 4-5, lat. 4 μ.

Centennial Park 133; Botany 152.

This form has not, so far, been noted at Lismore, but it is almost certain to turn up eventually. It lies between var. *intermedia* and var. *australis*. The latter is broader and more ovate.

TRACHELOMONAS EUCHLORA (Ehr.) Lemm., forma. (Pl. iii., f.1).

Lorica ovalis vel oblonga, semper autem minus rectangularis quam forma typica.

Long. 29-30, lat. 19-20; coll. alt. 5, lat. 4 μ.

Lismore 236, 237, 242, 245.

Syn., *Lagenella euchlora* Ehr., *Trachelomonas lagenella* Stein, *Chonemonas Schrankii* var. *glabra* Perty. The name *lagenella* is not admissible, having been used in a generic sense both by Ehrenberg and by Schmarda. Our forms are more rounded, less rectangular, than Stein's type,(Naturg. d. Flagell., H.i., T. xxii., f.14-16) which works out at 30 × 17 μ over all. The characteristic curved neck is still present, however. This form is rather local, apparently, as I have not observed it in any of the many rich gatherings from the suburbs of Sydney, but it is found sparsely distributed round Lismore, and is even frequent in Nos. 236 and 245. *Tr. similis* Stokes, Proc. Am. Phil. Soc., 1890, p.76, f.12, should be arranged here as *Tr. euchlora* var. *similis* (Stokes) mihi.

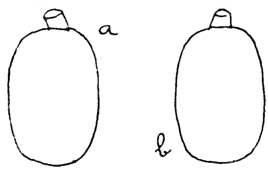


Fig. 4.—*Tr. euchlora* (Ehr. Lemm., × 650, after Stein.

Var. MINOR, n.var. (Pl. ii., f.4, 5).

Lorica levis, late-oblonga pæne quadrata, angulis late-rotundatis; a tergo interdum rotundata levissime attenuata; collo recto quadrato valido, ad basin annulo incrassato ornato.

Long. 18-23, lat. 15-18; coll. alt. 2-4, lat. 2-4 μ.

Botany 142, 151, 152; Canley Vale 110; Lismore, 225, 238, 241, 242, 245.

TRACHELOMONAS AMPULLULA, n.sp. (Pl. ii., f.6).

Lorica levis, subhexagona, medio lateribus pæne parallelis, extremis conica; collo quadrato recto, plerumque sine annulo basali, instructa.

Long. 24-30, lat. 10-16; coll. alt. 2-4, lat. 3 μ.

Canley Vale 110; Guildford 114; Botany 142; Parramatta 165, 166; Lismore 236, 237, 238.

A very distinct species with little or no variation in form or markings; some specimens are a little more markedly hexagonal than others, the sides more angular. The posterior end also is occasionally somewhat mammillate. It is the only form of *Tra-*

chelomonas that swims backwards, with the orifice and flagellum behind.

Var. MAJOR, n.var. (Pl. ii., f.7).

Lorica major, formæ typicæ similis, postice levissime retusa, mammillata; collo quadrato recto valido, plerumque annulo basali instructo.

Long. 34-41, lat. 15-18; coll. alt. 4-5, lat. 4 μ.

Botany 145; Lismore 263, 238, 241.

This larger form is rare round Sydney, but frequent in the neighbourhood of Lismore.

TRACHELOMONAS CONICA, n.sp. (Pl. ii., f.8, 9).

Lorica conica levis; parte anteriore subrectangulari, lateribus parallelis, angulis late-rotundatis; parte posteriore conica, lateribus levissime arcuatis, a tergo obtuse-rotundatis; collo nullo aut humillimo.

Long. 24-26, lat. 12-14; lat. oris 2-4; coll. alt. 1 μ.

Auburn 56; Botanic Gardens 3, 158; Guildford 146; Lismore 225, 238.

Always very uncommon in gatherings, though widely distributed; generally without a neck.

Var. GRANULATA, n.var. (Pl. ii., f.10).

Paullo major, minute granulata. Long, 36, lat. 12 μ.

Auburn 56. Cum forma typica.

Var. RICHMONDIÆ, n.var. (Pl. ii., f.11).

Lorica subelliptica angusta; polo anteriore late-rotundata, posteriore conica acuminata; spinis obtusis brevissimis (pæne granulis) ubique ornata; collo nullo.

Long. 34, lat. 14; lat. oris 4 μ.

Lismore 225. A river-form.

Var. OVATA, n.var. (Pl. ii., f. 12).

Lorica anguste-ovata, lateribus arcuatis; fronte late-rotundata, a tergo acuminata; ubique spinis brevissimis sparse ornata; collo humillimo.

Long. 37, lat. 18; coll. alt. 1, lat. 6; spin. long. ad $1\frac{1}{2}$ μ.

Lismore 236.

Var. CAUDATA, n.var. (Pl. ii., f.13, 14).

Lorica inæqualiter elliptica, interdum extremum versus paullo latior, a tergo in caudam brevissimam truncatam protracta; collo nullo, ore lato; membrana spinis minutis sparsis ornata.

Long. 38-42, lat. 18-20 μ.

Lismore 236, 241.

TRACHELOMONAS CLAVATA, n.sp. (Pl. ii., f.15).

Lorica lageniformis, clavata, levis; parte anteriore conica, in collo longo recto ore everso producta; parte posteriore subrectangulari, ad basin truncatam levissime attenuata, lateribus fere rectis.

Long. 54, lat. 20; coll. alt. c. 10, lat. 4 μ.

Botanic Gardens 3.

A very rare form; the specimen observed had a very tenuous membrane absolutely hyaline.

Var. SUBARMATA, n.var. (Pl. ii., f.16).

Lorica ut in forma typica sed luteo-fusca et scrobiculata; polo posteriore spinis minutis paucis instructa.

Long. 60, lat. 26; coll. alt. 10, lat. 6 μ.

Botanic Gardens 137.

TRACHELOMONAS CACTACEA, n.sp. (Pl. ii., f.17).

Lorica ovalis fronte autem quam levissime attenuata, granulis minutis sparse ornata, collo humillimo.

Long. 38, lat. 23; coll. lat. 6 μ.

Botanic Gardens 150.

A very rare form, only once noted. There might possibly be some connection between it and *Trach. bulla* var. *regularis* Lemm., Dr Volz gess. Alg., T. xi., f.6, but the latter is hardly rightly placed as a variation of *Trach. bulla* Stein.

TRACHELOMONAS GRANULOSA, n.sp. (Pl. ii., f.18).

Lorica ovalis, interdum plus minusve acuminata, granulis minutis dense obtecta; collo humillimo aut nullo.

Long. 17-26, lat. 13-22 μ.

Guildford 146; Centennial Park 133; Canley Vale 110; Fairfield 143; Botanic Gardens 150; Auburn 135, 139, 148; Botany 142, 145, 151, 152; Lismore 240, 242.

Common and widespread. The puncta-granules are minute, and merely give the edge a sandy appearance. It is possible that the forms of this species, which are generally oval and more rarely subglobose, should be arranged as granulate variations of *Trach. intermedia* Dangeard. There is nothing specifically characteristic in the condition of the membrane; smooth, punctate, and granulate are merely three degrees of development due to the age of the infusorian, and probably also to the stagnation of its habitat. Each of them may (and often does) occur in unmistakable forms of the same species, e.g., *Tr. volvocina*, *Tr. pulcherrima*, *Tr. conica*.

Var. SUBGLOBOSA, n.var. (Pl. ii., f.19).

Lorica subglobosa. Long. 19-28, lat. 17-26 μ.

Botany 142, 151; Lismore 236, 245.

Var. OBLONGA, n.var. (Pl. ii., f.20).

Lorica late-oblonga sed non quadrata. Long. 24, lat. 20 μ.

Guildford 114.

TRACHELOMONAS AUSTRALIS, n.sp. (Pl. iii., f.2).

Lorica cylindracea, lateribus parallelis, polis late-rotundatis; vulgo collo nullo; minute dense granulata; candore carnoso.

Long. 24-30, lat. 14-18; lat. oris 4 μ.

Botanic Gardens 150; Canley Vale 110; Guildford 70, 146; Fairfield 79; Botany 142, 145, 151, 152; Lismore 238, 240.

This form has the same minute granulation as *Tr. granulosa*, but its cylindrical shape makes it very distinct. It differs also in colour, being generally pale biscuit-colour or buff, whereas *Tr. granulosa* is generally deep yellow, reddish-yellow, or dark red.

Var. OBESA, n.var. (Pl. iii., f.3).

Lorica præ forma typica latior, minus cylindracea, lateribus modice arcuatis nec planis.

Long. 28-34, lat. 20-25; lat. oris 4 μ.

Botanic Gardens 150; Parramatta Park 96; Fairfield 79; Botany 151; Lismore 236, 237.

Broader and less cylindrical than the type, with slightly arched sides. Its finer granulation alone distinguishes it from *Trach. hispida* var. *granulata*.

Var. SPLENDIDA, n.var. (Pl. iii., f.4).

Lorica dimidio præ forma typica longior, strictius cylindracea; polis magis truncatis.

Long. 45, lat. 20 μ. Botany 37.

Var. ARCUATA, n.var. (Pl. iii., f.5).

Lorica oblonga nec cylindracea; lateribus arcuatis nec deplanatis; polis late-rotundatis.

Long. 20-27, lat. 14-17 μ.

Botany 151; Lismore 236, 238.

Var. CONICA, n.var. (Pl. iii., f.6).

Lorica a tergo paullo conica. Long. 30, lat. 18 μ.

Guildford 146; Lismore 237.

Var. SUBDENTICULATA, n.var. (Pl. iii., f.7).

Lorica modice cylindracea, major quam forma typica; granulis minutis acuminatis (pæne denticulis) sparse ornata.

Long. 36, lat. 22 μ.

Lismore 240. Cum forma typica.

It is doubtful whether this form should be placed under *Tr. australis* or *Tr. hispida*, forms of the latter being granulate. Of the two, only *Tr. australis* accompanied it in No.240, so I have arranged it under that species.

TRACHELOMONAS HISPIDA (Perty) Stein. (Pl. iii., f.8).

Long. 26-29, lat. 19 μ, sine spinis.

Lismore 238.

According to Stein, *l.c.*, T. xxii., f.20-34, the type is oval or oblong, and covered with sharp-pointed spines. Such a form is extremely rare in our waters; I find it only in No.238, and sparsely distributed even there. The dimensions, however, agree exactly with those of Stein, whose figures work out at 29 × 20, 26 × 20, 26 × 17, 27 × 19 μ, &c. *Tr. crenatocollis* Maskell, (Trans. New Zealand Inst., Vol.19, n.s., 1886, Pl. iii., f.3) is an oval form of *Tr. hispida*, with square, straight neck crenate at the end, corresponding to Stein's figs. 21, 24. *Tr. piscatoris* (Fisher) Stokes, Infus. U. S., p.88, Pl. i., f.25 (*Lagunculu piscatoris* Fisher, and *Laguncula Kellicottiana* Fisher, Proc. Amer. Micr. Soc., 1880) is the corresponding oblong form. If both are retained, they should stand as *Tr. hispida* var. *crenatocollis* (Maskell), and *Tr. hispida* var. *piscatoris* (Fisher), respectively; the latter has priority. I have not found either here yet.

Var. AUSTRALICA, n.var. (Pl. iii., f.9).

Lorica ovalis vel oblonga, collo nullo, spinis obtusis bacillaribus dense obtecta.

Long. 32, lat. 22 μ; dimensiones etiam var. *granulatæ*, infra.

Guildford 45, 76.

A form of *Tr. hispida* a little larger than the type and characterised by short, blunt, bacillar spines set, as usual in this species, very close together, and showing at the edge (as Maskell observes of *Tr. crenatocollis*) "a continuous border of points." This would be the Australian type of the species, were it not so rarely found; as it is, that honour falls to the succeeding variety, of which var. *australica* is the fully developed spinous form.

Var. GRANULATA, n.var. (Pl. iii., f.11, 12).

Lorica crasse denseque granulata nec spinosa; collo nullo.

Long. 27-42, lat. 17-35 μ.

Botany 142, 145; Guildford 45, 77, 114; Centennial Park 133; Casino 189; Lismore 236, 237, 238, 241, 242, 245.

The prevailing type in this country; it is a form of var. *australica* in which the granules have not developed into the usual bacillar spines of that variety. Intermediate states exist, and, even in granular forms, the polar granules are very often produced as very short spines. The dimensions most commonly observed are, long. 30-34, lat. 20-24 μ. In shape, the lorica is oblong or oval-oblong, more rarely distinctly oval, dark brownish-yellow in colour.

Var. RECTANGULARIS Br. Schröder. (Pl. iii., f.10).

Lorica rectangularis, lateribus planis, apicibus truncatis vel rotundato-truncatis, angulis rotundatis, spinis *vel granulis* dense ornata.

Long. 31-36, lat. 18 20 μ.

Botany 37, 142; Centennial Park 133; Lismore 238.

Cf. Stein, *l.c.*, T. xxii., f.34; Schröder, Fischereiv. z. Trachenberg, T. ii., f.8. This form is closely connected with var. *aus-*

tralica and var. *granulata*. It is found here sometimes with short, blunt, bacillar spines as in the former, or coarsely granulate as in the latter. Even in Stein's figure the spines are noticeably blunter and more bacillar in shape than those of the typical form. Stein's figure works out at 38 x 16, Schröder's at 48 x 21, without spines. The spines in all these forms, as far as my observations go, are never over 2 μ long.

TRACHELOMONAS BACILLIFERA, n.sp. (Pl. iii., f.13).

Lorica subglobosa, spinis obtusis bacillaribus dense obtecta; collo nullo; colore plerumque obscuro.

Long. 35-40, lat. 32-38, sine spinis; sp. long. ad 2 μ.

Auburn 68; Guildford 114; Botanic Gardens 150; Centennial Park 133.

The spines in all forms of this species are of the same character as those in *Tr. hispida* var. *australica*, supra. The type-form is almost spherical, and almost always very dark in colour, generally dark red or dark reddish-orange.

Var. OVALIS, n.var. (Pl. iii., f.14).

Lorica late ovalis, spinis ut in forma typica.

Long. 38-42, lat. 32-34, sine spinis; sp. long. ad 2 μ.

Auburn 68; Guildford 114; Canley Vale 110; Lismore 254.

Var. MINIMA, n.var. (Pl. iii., f.15, 16).

Lorica subglobosa, oblonga vel ovalis, sed minor; spinis ut in forma typica.

Long. 22-28, lat. 18-26, sine spinis; sp. long. ad 2 μ.

Auburn 148; Coogee 4; Botany 151, 152; Lismore 237, 238, 242, 245.

TRACHELOMONAS SYDNEYENSIS, n.sp. (Pl. iv., f.15, 16).

Lorica elliptica, lateribus interdum quam levissime deplanatis, polis rotundatis; collo humillimo crenato vel spicato semper instructa; spinis acutis brevibus, vel denticulis (regione equatoriali plerumque denticulis) sparse ornata; colore vulgo carnoso vel dilute flavescente.

Long., collo incl., 32-45, lat 22-26, s. sp.; sp. long. ad 4 μ, vulgo 2 μ; coll. alt. 1-3, lat. 6-10 μ.

Auburn 57, 119, 140, 148, 149, 163; Guildford 45, 114, 146; Botany 92, 145; Canley Vale 110; Centennial Park 133; Botanic Gardens 137; Lismore 225, 241, 245, 254.

Common and widespread; quite distinct from *Tr. hispida*, and easily distinguished from it under the microscope. The lorica is elliptic or long-oval, sometimes slightly flattened at the sides, whereas *Tr. hispida* (here at any rate) is nearly always oblong or oval-oblong. Its colour is characteristic also, being generally a pale straw-colour, the membrane thin and transparent. *Tr. hispida* is nearly always dark yellow or red, the membrane incrassate. The spines in *Tr. Sydneyensis* are sharp-pointed but very sparsely distributed, so that they do not show at the margin the "continuous border of spines" characteristic of *Tr. hispida*. Moreover, the spines, as a rule (almost invariably), are nothing more than mere denticulations not above 2 μ long, and reduced towards the centre; out of 20 records, I have only one with longer spines. The neck is a low band, broader above, with a crenate or spicate margin, and is nearly always present; in *Tr. hispida*, it is consistently wanting; I have only one record in 28 of a collar (2 × 5 μ) in that species. The spines are occasionally bacillar in character, in which case the denticulations are represented by minute granules.

Var. OBLONGA, n.var. (Pl. iv., f.17).

Lorica oblonga ubique rotundata, cetera ut in forma typica.

Long. 46-48, lat. 34-36 μ, sine spinis.

Botany 151; Kyogle 218, 219.

Var. MINIMA, n.var. (Pl. iv., f.18).

Lorica minor, late-ovalis vel subglobosa, cetera ut in forma typica.

Long. 26-28, lat. 21-24, sine spinis; coll. lat. 4 μ.

Auburn 135, 140; Botany 151.

Var. OBESA, n.var. (Pl. iv., f.19).

Lorica exacte late-ovalis, præ longitudine latior quam in f. typica, fronte et a tergo spinis minutis acutis sparsis vestita, in medio spinis ad denticulos reductis; collo humillimo ore dentato; membrana translucente dilute luteola.

Long. 36, lat. 25-26; coll. alt. 2, lat. 7; spin. long. ad 2 μ.

Guildford 45; Lismore 245.

A broader oval than the type, with minute spines sparsely distributed at each end, but reduced to denticulations, or entirely wanting, towards the middle. Found in quantity in rainwater pools on grass-land; interspersed were many specimens entirely smooth.

TRACHELOMONAS ARMATA (Ehr.) Stein.

Chl. corpore ovato subgloboso, utrinque rotundato, fusco, ubique setis brevibus hispido, corona apiculorum postice nigra.

The above is Ehrenberg's description of his *Chætotyphla armata*; it indicates a broadly ovate lorica covered with short spines, and with a ring of short, somewhat stouter spines behind. Such a form, I have never seen, the nearest to it being var. *longispina*, infra, which differs from Ehrenberg's description only in the great length of the posterior spines.

Var. GLABRA, n.var. (Pl. iii., f.17).

Lorica oblonga vel ovale-oblonga, perfecte glabra interdum punctata, a tergo corona spinarum validarum ornata, inter coronam interdum paucis spinis minutis.

Long. corp. 34-46, lat. 28-34; spin. c. 10-16, long. 2-8 μ.

Botany 151; Guildford 114; Parramatta 96, 165, 166; Lismore 241, 242.

This is Stein's, T. xxii., f.37. Upon f.38, Lemmermann has founded *Tr. armata* var. *Steinii* Lemm., which is smooth, but with small scattered spines at the anterior end, besides the posterior ring of larger awns. *Cf.* Dr. Volz gess. süssw. Alg. p.165, where he gives the size as 29 μ long and 22 μ broad. This is somewhat smaller than any I have noted. Stein's figures measure 37 × 27 μ without spines, corresponding almost exactly to the smallest sizes here. Australian forms are invariably smooth or granulate; excepting the very rare var. *longispina* described below, I have never seen a specimen that could be described as hispid.

Var. GRANULATA, n.var. (Pl. iii., f.18).

Lorica crasse denseque granulata, spinis posterioribus plerumque parvis.

Long. corp. 38-44, lat. 30-34; spin. c. 9-14, long. ad 5 μ.

Guildford 114; Fairfield 143; Parramatta 165, 166; Lismore 242.

Very often found in company with var. *glabra*. The forms of *Tr. armata* are all of large size; the dimensions of all its variations are about the same, viz., 40-46 μ long and 30-35 μ broad, with occasional specimens as low as 34 x 28 μ and as high as 50 x 36 μ; the most common length, without spines, is 40 μ.

Var. SPARSIGRANOSA, n.var. (Pl. iii., f.19).

Lorica ut in f. typica, sed granulis vel spinis obtusis brevissimis sparsissime (polos versus densius) ornata, granulorum vice interdum denticulis.

Long. corp 40-50, lat. 30-36; spin. c. 6, long. ad 6 μ.

Canley Vale 110; Guildford 114; Botanic Gardens 150; Lismore 236.

In this form, the short spines are merely elongated granules. Fairly dense at the poles, especially the anterior one, they become very scattered towards the equator, where they are reduced to granules.

Var. LONGISPINA, n.var. (Pl. iv., f.20).

Lorica ovata subglobosa, postice latior, ubique rotundata; spinis validis acutis brevibus ubique vestita, a tergo spinis gracilioribus; aculeis posterioribus magnis curvatis plerumque 4-6 instructa.

Long. corp. 43-44, lat. 32-34; spin. long. 5-6; acul. post. 4-10, long. ad 24 μ.

Botany 37; Botanic Gardens 137, 150.

Var. DUPLEX, n.var. (Pl. iii., f.20).

Lorica ovato-oblonga, postice paullo latior, crasse sparseque granulata, polum anteriorem versus glabra; fronte et a tergo corona spinulorum ornata, spinis anterioribus rectis obtusis bacillaribus circa 12, posterioribus longioribus acutis recurvatis circa 10, ad os dentibus 4; colore fusco.

Long. corp. 46, lat. max. 35; spin. anter. long. 8 μ, poster. 12 μ.

Lismore 240.

TRACHELOMONAS LISMORENSIS, n.sp. (Fig.5).

Lorica a vertice visa circularis, spinis radiantibus sparse ornata, ore minuto spinis minutis paucis circumcincto. A latere subglobosa, depressa, anteriore subplana, posteriore rotundata, spinis sparsis radiantibus, plerumque spinorum longiorum serie equatoriali singula. Colore atro luteo-fulvo.

Diam. corp. 20; spin. long. ad 4, oris diam. 2 μ.

Lismore 225.

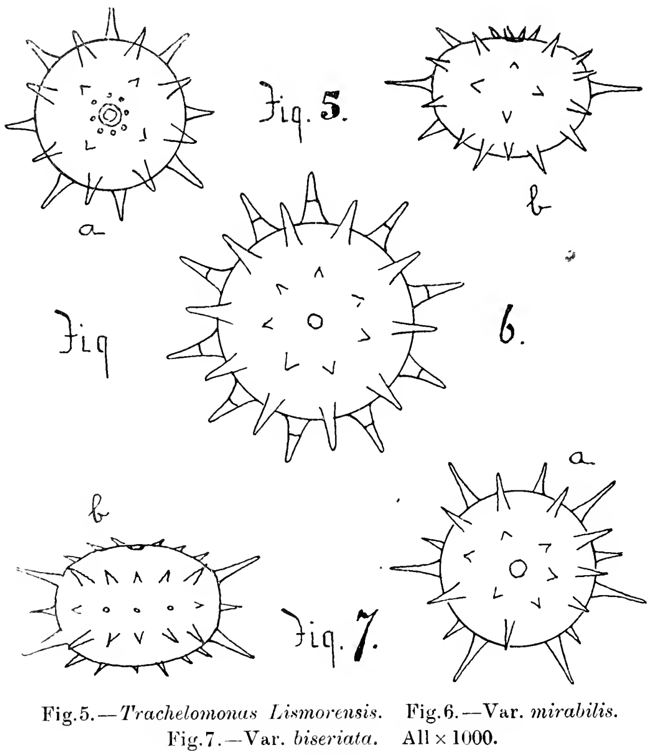


Fig.5.—*Trachelomonas Lismorensis*. Fig.6.—Var. *mirabilis*. Fig.7.—Var. *biseriata*. All × 1000.

Var. MIRABILIS, n.var. (Fig.6).

Lorica vertice visa spinis validis circa 10 regularius ordinata, spinarum parte externa achroa. Cetera ut in f. typica.

Diam. corp. 26, spin. long. ad 6 μ.

Lismore 241.

I have not seen this form in side-view, so cannot determine whether it inclines to the type or to the next variation. It is a little larger than usual, the spines stouter and more regular; the inner third of the spines is the colour of the lorica, the outer part is colourless.

Var. BISERIATA, n.var. (Fig.7).

Lorica depresso-ovalis, ubique rotundata, spinis minutis sparse ornata, spinarum longiorum seriebus binis utrinque ad medium circumcincta.

Diam. corp. 20; sp. long. ad 6 μ.

Lismore 241.

In this species, the type seems to be a form of *Tr. volvocina* which has developed the posterior spines of *Tr. armata.* This variation reproduces the anterior and posterior series of *Tr. armata* var. *duplex.* The two rows of spines are, of course, close together, and this is evidence of the fact that the growth of the lorica takes place mainly in the equatorial region.

Var. INERMIS, n.var. (Pl. iii., f.21).

Lorica ut in forma typica sed spinis nullis.

Alt. circa 14-18, lat. 17-22 (rarissime 34) μ.

Auburn 139, 140; Botany 142, 151; Lismore 236, 237, 241.

I found this form in my Sydney gatherings (notably Auburn 140, in which it occurs plentifully) before I discovered the mature form at Lismore. The latter is very rare, even where it is to be observed at all. Var. *inermis* is very liable to be overlooked in gatherings. Resting, as it does, always on one end, it appears circular from above, and may be mistaken for *Tr. volvocina*, in company with which it is often found.

Var. OBLONGA, n.var. (Pl. iii., f.22).

Lorica ut in var. *biseriata*, sed spinis nullis.

Diam., vertice visa, 12; alt., a latere, 8 μ.

Guildford 70. Very rare.

A smooth form of var. *biseriata.* Although I have seen no intermediate forms, yet there is such a close agreement in the side-view of all these forms, that I must consider them variations of the same species.

TRACHELOMONAS VERRUCOSA Stokes. (Pl. iv., f.1).

Lorica globosa, minutis papillis achrois sparse ornata; collo nullo.

Diam. 18 μ. Lismore 225; very rare.

Cf. Stokes, Infus. U. S., p.88. He gives diam. 24 μ. It should, perhaps, be arranged as a variation of *Tr. volvocina*, but I have seen only one specimen.

TRACHELOMONAS SCABRA, n.sp. (Pl. iv., f.2, 3).

Lorica ovalis æqualiter rotundata vel postice acuminata; collo lato brevissimo; membrana scabra non autem ordine granulata.

Long. 29-33, lat. 20; coll. alt. 2-4, lat. 4-5 μ.

Lismore 238, 242.

This species is very distinct; all its forms are easily recognised by the characteristic membrane. The surface is rough all over, not with granules but with minute protuberances irregularly disposed. The colour is generally pale yellow.

Var. LONGICOLLIS, n.var. (Pl. iv., f.4-6).

Lorica et membrana ut in forma typica, collo autem longissimo, recto vel obliquo vel curvato, interdum ore everso.

Long. 29-33, lat. 19; coll. alt. 6-7, lat. 3-5, lat. oris 6 μ.

Lismore 238.

Var. OVATA, n.var. (Pl. iv., f.7, 8).

Lorica ovata, anteriore ovalis, posteriore acuminata, extremo producta conica; collo quadrato vel brevissimo.

Long. 34-46, lat. 20-22; coll. alt. 2-6, lat. 5-6; caud. long. 4-6, lat. 3-4 μ.

Lismore 237, 238, 241.

Var. SCROBICULATA, n.var. (Pl. iv., f.9).

Lorica ut in var. *ovata*, glabra autem et crasse scrobiculata pæne reticulata; collum interdum annulo basali instructum.

Long. 36-42, lat. 20-22; coll. alt. 3-4, lat. 4-6; caud. long. 2-5 μ.

Lismore 236.

The outline in this form is smooth, showing that the surface is level, but the membrane itself is so perforated with wide scrobiculæ as to be almost reticulated.

Var. ELLIPTICA, n.var. (Pl. iv., f.10).

Lorica elliptica, a tergo acuminata: collo brevissimo plerumque obliquo; membrana scabra.

Long. 31, lat. 16; coll. alt. 2, lat. 7 μ.

Lismore 242.

Var. CORDATA, n.var. (Pl. iv., f.11).

Lorica cordata, a tergo acuminata; collo brevissimo recto.

Long. 21, lat. 18; coll. alt. 2, lat. 3-4 μ.

Lismore 242.

Var. PYGMÆA, n.var. (Pl. iv., f.21).

Lorica ovalis, a tergo in caudam brevissimam truncatam producta; collo lato humillimo; membrana inæqualiter scabra.

Long. 34-35, lat. 18-20; coll. alt. 2-3, lat. 9-10 μ.

Wyrallah, mere on grass-land.

TRACHELOMONAS EURYSTOMA Stein, forma (Pl. iv., f.12).

Lorica quam in f. typica magis rotundata, a tergo minus acuminata; collo paullo breviore, emarginato haud sulcato; membrana subtilissime et oblique striata, striis interdum undulatis; colore dilute fusco.

Long. 26, lat. 19; coll. alt. 1, lat. 9 μ.

Lismore 244.

Cf. Stein, Naturg. d. Flag., H. 1, Pl. xxii., f.35, whose figure measures 31 × 21. The form found here has a shorter neck, not sulcate, and with emarginate edge, the mouth not quite so wide. The lorica is pale brown, sometimes with a purple tinge, and is finely and faintly striate obliquely downwards from right to left, not *vice versâ*, as in Euglena and Lepocinclis. The striæ are lines of partly coalesced scrobiculæ.

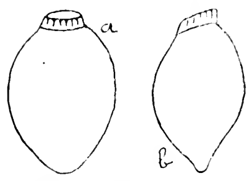


Fig. 8. — *Tr. eurystoma* Stein, × 650, after Stein.

Var. PRODUCTA, nom.nov. (Pl. iv., f.13).

Forma a tergo producta, conica, acuminata. *Cf.* Stein, *l.c.*, f.56.

Long. 27, lat. 18; coll. alt. 1, lat. 6 μ.

Lismore 244, cum priori.

Var. KLEBSII mihi. (Pl. iv., f.14).

Lorica ovata, a fronte rotundata, a tergo modice acuminata, oblique striata; collo nullo.

Long. 24-26, lat. 18; lat. oris 6 μ.

Lismore 244, cum prioribus duabus; 245.

Syn. *Tr. reticulata* Klebs, Organiz.ein.Flag., 1885, *cf.* Dangeard, Les Eugléniens, p.137, f.43. The name *reticulata* is unsuitable, as probably the type is reticulate also. Stokes' *Tr. obovata*, New Frw. Infus., Amer. Philosoph. Soc., 1890, p.76, f.13, is also almost certainly a form of this species; if it is really hispid, it might stand as var. *Stokesii* mihi, the type being just as much obovate. It is possible, however, that it is the same as *Tr. reticulata* Klebs, and the hispid appearance due to pores running through the walls of the lorica. The inner margin of the membrane is often very distinct, while the outer edge is extremely vague; the pores then show as fine granules or setæ upon what appears to be the surface.

TRACHELOMONAS CAUDATA var. AUSTRALICA, n.var. (Pl. v., f.1, 2).

Lorica ut in forma typica, corpore autem breviore, spinis nullis, membrana aspera.

Long. 62-96, lat. 18; coll. long. 14-20, lat. 5; caud. long. 18-30, lat. max. 4-6 μ.

Lismore 238. Wyrallah, mere on grass-land.

This is the nearest I have seen to Stein's *Tr. caudata*, l.c., Pl. xxii., f.39, 40. It has an entirely different surface, lacking the spines, and the body is shorter in proportion to the total length. Stein's f.40 agrees perfectly in general dimensions, working out at long. 64 (neck 9, body 41, tail 14), lat. $18\frac{1}{2}$ μ. The slender form of the same breadth was found at Wyrallah, alive. It is a genuine *Trachelomonas*.

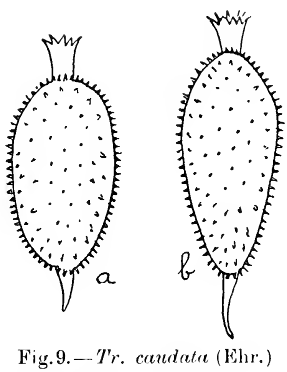


Fig. 9.—*Tr. caudata* (Ehr.) Stein, × 650, after Stein.

TRACHELOMONAS ACUMINATA var. AMPHORA, n.var. (Pl. v., f.3).

Lorica, ut in forma typica, corpore inferne latissimo sed lateribus late-rotundatis nec angulatis, ad collum sensim convergentibus.

Long. 46, lat. 28 ; coll. alt. 8, lat. 6 ; caud. long. 6 μ.

Parramatta 136.

Like the type, *Tr. acuminata* (Schmarda) Stein, *l.c.*, f.43, this form is smooth and broadest below, but it is regularly rounded at the sides, not angular. Also it shows the square neck with everted rim which is characteristic of these tailed varieties of *Trachelomonas*. Schmarda's form has an obliquely sliced-off neck. The figure given by Stein measures 55 × 32 μ.

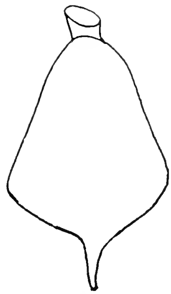


Fig. 10. *Tr. acuminata* (Schmarda) Stein, × 650, after Stein.

TRACHELOMONAS URCEOLATA Stokes, forma, (Pl. v., f.4),

Forma longior, corpore inferne modice attenuato; collo paullo oblique truncato; cauda paullulo oblique protracta.

Long. 54, lat. 20; coll. alt. 8, lat. 4; caud. long. 15 μ.

Parramatta 136.

Cf. Stokes, Frw. Infus. U. S., p.89, Pl. i.,f. 26. This is merely an irregular (probably growing) form of the type. The latter has an oblong body, not tapering to either end, with somewhat flattened sides. Size 44 × 20, Stokes.

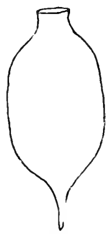


Fig. 11. *Tr. urceolata* Stokes, after Stokes.

Var. OVALIS, n.var. (Pl. v., f.5, 6).

Forma corpore ovali nec oblongo, lateribus rotundatis nec deplanatis; collo breviore, ore modice everso; cauda brevi interdum brevissima.

Long. 34-37, lat. 22; coll. alt. 4-6, lat. 6; caud. long. ad 6 μ.

Parramatta 136, 165, 166.

The tail in this form is only about one-third the usual length, and is sometimes reduced to a mere broad, triangular projection.

Var. GIRARDIANA, n.var. (Pl. v., f.7, 8).

Lorica corpore a latere subhexagono, a vertice circulari; lateribus objectis parallelis, planis vel interdum levissime retusis; collo modo brevi, ore obliquo, modo longo recto truncato, ore minute denticulato. Membrana aspera.

Long. 38-57, lat. 22-26; coll. alt. 4-6, lat, 6-8; caud. long. 16 μ.

Lismore 242.

There is some doubt whether this form should be placed under *Tr. urceolata*, as it comes from a different part of the country, and the membrane is distinct. The latter is irregularly and minutely rough, due probably to depressed scrobiculations, as in *Tr. scabra*, supra. Obtained from swampy ground at the foot of Girard's Hill.

TRACHELOMONAS ELEGANTISSIMA (G. S. West) mihi.

Syn. *Dinobryon elegantissimum* G. S. West, Yan Yean Res., p.82, fig.10K; *Trach caudata* var. *elegantissima* Playf., Sydney Water Supply, p.546.

From the figure of *Tr. caudata* given by Stein in his Naturgeschichte der Flagellaten, a copy of which has lately come into my hands, it appears that there are too many points of difference for this form to be conveniently arranged as a variation of *Tr. caudata* (Ehr.) Stein. I have made it, therefore, a separate type. West's dimensions are :—Long. (sine stip.) 34; long. stip. 28; lat. max. 13, lat. coll. 4, lat. oscul. 7·5 μ.

Fig. 12. *Tr. elegantissima* (G. S. West), × 1000, after West.

Var. OVATA, nom.nov. (Pl. v., f.9).

Minor quam forma typica, corpore ovato, superne rotundato, inferne acuminato lateribus pæne planis ad stipitem convergentibus; collo quadrato, lateribus parallelis, ore everso.

Long. 38, lat. 9 μ.

Sydney Water screenings.

Syn. *Trach. caudata* var. *elegantissima* Playf., *l.c.*, Pl.57, f.11. The Victorian form, which I have not yet noted here, is somewhat different in shape from mine; I am, therefore, describing the latter as a variation.

Trachelomonas napiformis, n.sp. (Pl. v., f.10).

Lorica corpore ovato, fronte rotundato, a tergo acuminato lateribus modice arcuatis; stipite nullo sed cauda brevi instructa; collo quadrato, lateribus parallelis, ore everso. Primum caudâ extremâ affixa, deinde exsoluta.

Long. 34, lat. 18; coll. alt. 8, lat. 6; caud. long. 6 μ.

Parramatta 136.

All these tailed varieties are plankton-forms. *Tr. napiformis* and all others in sample No.136, were obtained from a body of freshwater in Parramatta Park, by passing several gallons of water through filter-paper. Many specimens of this form were noted firmly fixed by the point of the tail, others were swimming free. Syn., *Tr. caudata*, these Proceedings, 1913, Pl.57, f.10.,

Forma.

Forma lateribus ad caudam convergentibus pæne planis; cauda brevissima, triangulari; collo oblique truncato nec ore everso; colore pæne hyalina.

Long. 36, lat. 22; coll. alt. 4, lat. 7 μ.

Botany 151.

Var. elegans, n.var. (Pl. v., f.11).

Major quam f. typica, corpore ovato superne valde angulato, lateribus arcuatis, paullo supra caudam quam levissime angulatis, ad caudam convergentibus: collo quadrato lateribus modice retusis, ore everso valde producto; colore dilutissime fulva.

Long. 60 (corp. 40), lat. 30; coll. alt. 8, lat. 8, lat. oris 16; caud. long. 12 μ.

Duck Creek near Clyde.

Several specimens observed in a sample obtained by filtering a considerable volume of water.

Trachelomonas sessilis, n.sp. (Pl. v., f.12).

Lorica corpore late-ovato pæne triangulari, superne latissimo, abhinc lateribus rapide ad basin convergentibus, inferne acute-rotundato, cauda nulla; collo longo recto, lateribus parallelis, ore everso; colore dilutissime fulva; primum sessilis.

Long. 26, lat. 20; coll. alt. 8, lat. 6 μ.

Parramatta 136.

Var. MINIMA, n.var. (Pl. v., f.13).

Forma minima nec ore everso.

Long. 9, lat. 5 μ.

Fairfield.

Noted in a gathering squeezed out of Myriophyllum in Orphan School Creek.

Var. ELEGANS, n.var. (Pl. v., f.14).

Lorica corpore breviore quam in var. *minima*; collo autem longiore, ore everso valde producto; basi per papillam affixa.

Long. 13, lat. $5\frac{1}{2}$ μ.

Guildford 88.

TRACHELOMONAS TRIQUETRA, n.sp. (Pl. v., f.15).

Lorica corpore superne exacte rectangulari lateribus rectis parallelis, inferne acuminato lateribus planis rapide ad caudam convergentibus; collo recto brevi; cauda brevi; membrana tenui scrobiculata(?). Lorica a vertice triquetra.

Long. 40, lat. 20 μ.

Parramatta 136.

Several of this shape seen alive among a great variety of other tailed forms (Parramatta 136). All these plankton-forms of *Trachelomonas* have thin transparent membranes, dull and rather irregular in texture (scrobiculate?) and are all very pale-coloured, pale brown, biscuit or flesh-colour.

TRACHELOMONAS GIBBEROSA, n.sp. (Pl. v., f.16-18).

Lorica inflata rhomboidea, utrinque valde angulata, in medio latissima, lateribus superne ad collum inferne ad caudam rapide convergentibus, pæne rectis; collo plerumque oblique truncato interdum ore everso; cauda acutissima; membrana hyalina vel dilutissime fulva.

Long. 32-56, lat. 16-30; coll. alt. 8, lat. 6-7; caud. long. ad 20 μ.

Parramatta 136, 165, 166. Auburn 120.

Almost all the tailed forms of *Trachelomonas* may be found now and again with obliquely truncate necks.

Var. ROTUNDA, n.var. (Pl. v., f.19).

Lorica corpore utrinque inflato, depresso, lateribus æqualiter rotundatis; collo quadrato ore everso; cauda obtusa subito e basi corporis oriente.

Long. 28, lat. 17; coll. alt. 8, lat. 6; caud. long. 10, lat. max. 4 μ.

Parramatta 136.

TRACHELOMONAS SUBGLOBOSA, n.sp. (Pl. v., f.20, 21).

Lorica inæqualiter subglobosa, fronte leviter deplanata, interdum inferne levissime acuminata; collo lato humillimo; membrana interdum scrobiculata, dilutissime fulva.

Long. 22-26, lat. 22; coll. alt. 2, lat. 6-8 μ.

Parramatta 136; Duck Creek near Clyde.

In spite of its obvious likeness to *Tr. oblonga* var. *australica*, this "species" is biologically connected with the tailed forms described above, in company with which the two specimens figured were found. All these forms have a tendency to be slightly irregular in outline, and this may be noted here also. The membrane, too, is similar, and the acuminate character of the hinder end in Fig.20 points in the same direction.

List of Synonyms.

Tr. reticulata Klebs, Organ. ein. Flag., p.320, 1881-85, = *Tr. eurystoma* var. *Klebsii* mihi. The name "*reticulata*" being unsuitable in a variation.

Tr. crenatocollis Maskell, Trans. N. Zeal. Inst., 1886, Pl.3, f.3, = *Tr. hispida* var. *crenatocollis* (Maskell) mihi; *cf.* Stein, *l.c.*, T.xxii., f.24; Dangeard, Les Eugléniens, p.135, f.41 A.

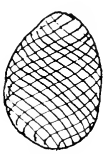


Fig. 13.

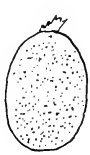


Fig. 14.

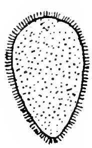


Fig. 15.

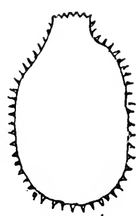


Fig. 16.

Fig.13.—*Tr. torta* Stokes. Fig.14.—*Tr. euchlora* var. *similis* (Stokes) mihi. Fig.15.—*Tr. eurystoma* var. *Stokesii* mihi. Fig.16.—*Tr. hispida* var. *piscatoris* (Fisher) mihi. All after Stokes.

Tr. torta Kellicott, in Stokes, Infus. U. S., p.87, Pl.1, f.24, 1888 = *Crumenula texta* Duj., = *Euglena viridis* larval form, *cf.* Stein, T. xx., f.26. Stokes, in his figure, has put in the striæ from both sides of the test; there is only one set of striæ, as shown by Stein. I have often found these empty tests in mixed gatherings.

Tr. piscatoris (Fisher) Stokes, Journ. Trenton Nat. Hist. Soc., 1886; Infus. U. S., p.88, Pl.1, f.25, 1888 (*Lagunculu piscatoris* Fisher, Proc. Amer. Soc. Micr., 1880), = *Tr. hispida* var. *piscatoris* (Fisher) mihi.

Tr. cervicula Stokes, Proc. Amer. Phil. Soc., p.75, f.11, 1890, = *Tr. volvocina* var. *cervicula* (Stokes) mihi.

Tr. similis Stokes, *ibid.*, p.76, f.12, = *Tr. euchlora* var. *similis* (Stokes) mihi.

Tr. obovata Stokes, *ibid.*, p.76, f.13 = *Tr. eurystoma* var. *Stokesii* mihi. The name "*obovata*" is unsuitable in the variation, as the type itself and var. *Klebsii*, supra, are both obovate.

Tr. volvocina var. *minuta* Lemm., Bot. Centralblatt, Bd. 76, p.152, 1898. Size not known, has probably been included here with the type.

Tr. lagenella Dangeard, Les Eugléniens, p.132, f.40, 1902 (not Ehrenberg nor Stein), = *Tr. ovalis* Playf., Biol. Richm. R., p.141, Pl. viii., f.4; but cf. *Tr. teres* Maskell. The decided neck, generally slanting, is characteristic of *Tr. euchlora* (*lagenella*). Such forms as depicted by Dangeard are just as likely to be smooth forms of *Tr. hispida* (Stein, T. xxii., f.23), or *Tr. armata*, or *Tr. teres* Maskell, without a neck. It is best to keep such forms by themselves where possible.

Forms not yet observed here.

The exact types were not observed of *Tr. euchlora* (*lagenella*) (Ehr.) Lemm., *Tr. armata* (Ehr.) Stein, *Tr. caudata* (Ehr.) Stein, *Tr. acuminata* (Schmarda) Stein, *Tr. bulla* Stein, *Tr. eurystoma* Stein, *Tr. urceolata* Stokes, *Tr. Volzii* Lemm., *Tr. elegantissima* (G. S. West) mihi, but only very similar forms.

Tr. volvocina β *rugulosa* (Stein) Klebs, = *Tr. rugulosa* Stein, *l.c.*, f.12, 13. *Cf.* Dangeard, *l.c.*, p.128, f.39. A form of *Tr. volvocina* with minute ridges in slanting lines across the surface.

Dangeard's form is so entirely different from Stein's *Tr. rugulosa*, that I propose to make it a distinct variety under the name of *Tr. volvocina* var. *Dangeardii*, nom.nov.

Tr. volvocina γ *hyalina* Klebs, Organ.ein. Flag., p.319. The body of the animalcule is devoid of chlorophyll.

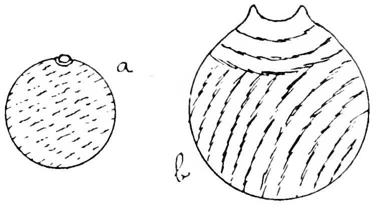
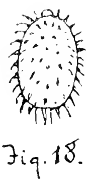


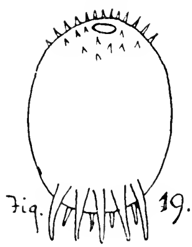
Fig. 17.—*Tr. volvocina* β *rugulosa* (Stein) Klebs. *a* × 650, after Stein; *b*, after Dangeard.

Tr. hispida β *cylindrica* Klebs, *l c.*; *cf.* Dangeard, *l.c.*, p.135 (no figure). This must be a smaller form of *Tr. hispida* var. *rectangularis* Br. Schröder, Plöner Berichte, Bd. v., T.ii., f.8; Stein, T.xxii, f.34. As Dangeard remarks that it is much smaller than the type, the dimensions of which are roughly 30 × 20 μ, it must be quite minute.

Tr. hispida var. *subarmata* Br. Schröder, *l.c.*, p.49, T.1, f.7. A broadly oval form a little larger than the type, with longer spines at each end. Schröder's figure gives dimensions of 37 × 29 μ,

Tr. hispida var. *punctata* Lemm., von Dr. Volz ges. Süsswasseralg., p.165, 1904 (no figure). Oval, closely and finely punctate, with a low, straight, truncate neck.





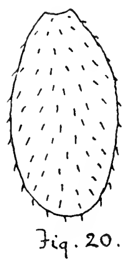


Fig. 18.—*Tr. spinosa* Stokes, after Stokes. Fig. 19.—*Tr. armata* var. *Steinii* Lemm., × 650, after Stein. Fig. 20.—*Tr. bulla* var. *regularius* Lemm., × 1000, after Lemmermann.

Tr. bulla var. *regularius* Lemm., *ibid.*, T.xi., f.6. Long elliptic, 30 × 14 μ, with numerous, very short scattered spines, no neck

I doubt whether this form is best arranged under *Tr. bulla* Stein. The characteristics of the latter are all wanting, viz, the ovate body, long neck, and smooth (or very slightly denticulate) membrane. *Tr. bulla* itself, indeed, is of very doubtful validity, and were it not for the fact that its forms are generally smooth, it would probably before this have been arranged as a tail-less variant of *Tr. caudata*. Lemmermann's form goes best under *Tr. spinosa* Stokes, *infra*; note that in both forms, and in these two only, all the spines point backwards.

Tr. oblonga var. *truncata* Lemm., *ibid.*, T. xi., f.7, 8; Reise n.d. Pacific, p.344, 1899. Lorica oblong, 12-13 μ long, 11 μ broad, truncate in front, squarely rounded below, with a short straight truncate neck, membrane smooth.

Tr. acanthostoma Stokes, Infus. U. S., p.89, no fig., 1888; Proc. Amer. Phil. Soc., 1887. Lorica subspherical, brown, two or more irregular rows of short conical spines round the orifice, no neck, membrane punctate, length 36 μ.

Tr. spinosa Stokes, Proc. Amer. Phil. Soc., 1890, p.76, f.14. Lorica oval, $1\frac{1}{3}$ times as long as broad; ends equally and evenly rounded; spines slightly recurved, pointing backwards, longest posteriorly; neck short, smooth, truncate, slightly narrowed above; length 42 μ. The recurved spines, pointing backwards, are characteristic of this type; cf. *Tr. bulla* var. *regularius* Lemm., *supra*.

Tr. teres Maskell, Trans. N. Zeal. Inst., 1887, T.1, f.7. Oblong-oval, smooth, with a low broad ring-shaped neck; length 35 μ, breadth about 20 μ. Very like *Tr. lagenella* Dangeard (non Stein), *l.c.*, p.132, f.40E, but with a low broad neck.

Tr. armata var. *Steinii* Lemm., see note on *Tr. armata* var. *glabra*, supra.

EXPLANATION OF PLATES I.-V.

All figures enlarged 1000 diams., unless otherwise specified.

Plate i.

Fig. 1.—*Trachelomonas volvocina* Ehr.
Fig. 2. ,, ,, var. *punctata*, n. var.
Fig. 3. ,, ,, var. *granulosa*, n. var.

Fig.4.—*Trachelomonas volvocina* var. *cervicula* (Stokes) mihi.
Fig.5. ,, *intermedia* Dangeard.
Figs.6-8. ,, ,, var. *levis*, n.var.
Fig.9. ,, *Botanica*, n.sp.; (× 660).
Fig.10. ,, ,, var. *minor*, n.var.; (× 660).
Fig.11. ,, *ovalis* Playf.
Fig.12. ,, ,, var. *minor*, n.var.
Fig.13. ,, *bulla* var. *australis*, n.var.
Figs.14-16. ,, *oblonga* Lemm.
Figs.17-21. ,, ,, var. *australica*, n.var.
Figs.22, 23. ,, ,, var. *attenuata*, n.var.; (Fig.23 × 1330).
Fig.24. ,, ,, var. *scabra*, n.var.
Fig.25. ,, *pusilla*, n.sp.
Fig.26. ,, ,, var. *rotunda*, n.var.
Fig.27. ,, ,, var. *punctata*, n.var.
Figs.28, 29. ,, *cylindrica* Ehr.
Fig.30. ,, ,, var. *decollata*, n.var.
Fig.31. ,, ,, var. *punctata*, n.var.
Figs.32, 33. ,, *pulcherrima*, n.sp.
Figs.34, 35. ,, ,, var. *latior*, n.var.
Fig.36. ,, ,, var. *ovalis*, n.var.
Figs.37, 38. ,, ,, var. *minor*, n.var.
Figs.39, 40. ,, ,, var. *Lismorensis*, n.var.
Fig.41. ,, ,, var. *granulosa*, n.var.

Plate ii.

Fig.1.—*Trachelomonas Volzii* var. *pellucida*, n.var.
Fig.2, ,, ,, var. *australis*, n.var.
Fig 3. ,, ,, var. *intermedia*, n.var.
Figs.4, 5. ,, *euchlora* var. *minor*, n.var.
Fig.6. ,, *ampullula*, n.sp.
Fig.7. ,, ,, var. *major*, n.var.
Figs.8, 9. ,, *conica*, n.sp.
Fig.10. ,, ,, var. *granulata*, n.var.
Fig.11. ,, ,, var. *Richmondiae*, n.var.
Fig.12. ,, ,, var. *ovata*, n.var.
Figs.13, 14. ,, ,, var. *caudata*, n.var.
Fig.15. ,, *clavata*, n.sp.
Fig.16. ,, ,, var. *subarmata*, n.var.
Fig.17. ,, *cactacea*, n.sp.
Fig.18. ,, *granulosa*, n.sp.
Fig.19. ,, ,, var. *subglobosa*, n.var
Fig.20. ,, ,, var. *oblonga*, n.var.
Fig.21. ,, *Volzii* var. *cylindracea*, n.var.

Plate iii.

Fig. 1.—*Trachelomonas euchlora* (Ehr.) Lemm., forma.
Fig. 2. ,, *australis*, n.sp.
Fig. 3. ,, ,, var. *obesa*, n.var.
Fig. 4. ,, ,, var. *splendida*, n.var.; (×660).
Fig. 5. ,, ,, var. *arcuata*, n.var.
Fig. 6. ,, ,, var. *conica*, n.var.
Fig. 7. ,, ,, var. *subdenticulata*, n.var.
Fig. 8. ,, *hispida* (Perty) Stein, type.
Fig. 9. ,, ,, var. *australica*, n.var.
Fig. 10. ,, ,, var. *rectangularis* Br. Schröder.
Figs. 11, 12. ,, ,, var. *granulata*, n.var.
Fig. 13. ,, *bacillifera*, n.sp.; (×750).
Fig. 14. ,, ,, var. *ovalis*, n.var.; (×750).
Figs. 15, 16. ,, ,, var. *minima*, n.var.; (×660).
Fig. 17. ,, *armata* var. *glabra*, n.var.; (×750).
Fig. 18. ,, ,, var. *granulata*, n.var.; (×750).
Fig. 19. ,, ,, var. *sparsigranosa*, n.var.; (×750).
Fig. 20. ,, ,, var. *duplex*, n.var.; (×660).
Fig. 21. ,, *Lismorensis* var. *inermis*, n.var.
Fig. 22. ,, ,, var. *oblonga*, n.var.; (×850).

Plate iv.

Fig. 1.—*Trachelomonas verrucosa* Stokes.
Figs. 2, 3. ,, *scabra*, n.sp.
Figs. 4-6. ,, ,, var. *longicollis*, n.var.
Figs. 7, 8. ,, ,, var. *ovata*, n.var.
Fig. 9. ,, ,, var. *scrobiculata*, n var.
Fig. 10. ,, ,, var. *elliptica*, n.var.
Fig. 11. ,, ,, var. *cordata*, n.var.
Fig. 12. ,, *eurystoma* Stein, forma.
Fig. 13. ,, ,, var. *producta* mihi.
Fig. 14. ,, ,, var. *Klebsii* mihi.
Figs. 15, 16. ,, *Sydneyensis*, n.sp.
Fig. 17. ,, ,, var. *oblonga*, n.var.
Fig. 18. ,, ,, var. *minima*, n.var.
Fig. 19. ,, ,, var. *obesa*, n.var.
Fig. 20. ,, *armata* var. *longispina*, n.var.
Fig. 21. ,, *scabra* var. *pygmæa*, n.var.

Plate v.

Figs. 1, 2.—*Trachelomonas caudata* var. *australica*, n.var.; (×660).
Fig. 3. ,, *acuminata* var. *amphora*, n.var.
Fig. 4. ,, *arceolata* Stokes, forma.

Figs. 5, 6.—*Trachelomonas*	*urceolata*	var. *ovalis*, n. var.
Figs, 7, 8.	,, ,,	var. *Girardiana*, n. var.
Fig. 9.	,,	*elegantissima* var. *ovata* mihi.
Fig. 10.	,,	*napiformis*, n. sp.
Fig. 11.	,,	,, var. *elegans*, n. var.; (×660).
Fig. 12.	,,	*sessilis*, n. sp.
Fig. 13.	,,	,, var. *minima*, n. var.; (×2000).
Fig. 14.	,,	,, var. *elegans*, n. var.; (×2000).
Fig. 15.	,,	*triquetra*, n. sp.; *a*, end view.
Figs. 16-18.	,,	*gibberosa*, n. sp.
Fig. 19.	,,	,, var. *rotunda*, n. var.
Figs. 20, 21.	,,	*subglobosa*, n. sp.

THE ANATOMICAL STRUCTURE OF SOME XEROPHYTIC NATIVE GRASSES.

By E. Breakwell, B.A., B.Sc.

(Thirteen Text-figures.)

The grasses examined were:—*Spinifex hirsutus* Labill., (male plant), *Panicum flavidum* Retz., *Themeda avenacea* Hackel, *Astrebla pectinata* F.v.M., *Neurachne Mitchelliana* Nees, *Panicum decompositum* R.Br., *Chloris acicularis* Lindl., *Panicum leucophaeum* H.B.K., *P. Benthami* Domin, *Eragrostis lacunaria* F.v.M., and *E. curvula* var. *valida* Stapf. These grasses, with the exception of the first, were obtained from the Nyngan district.

Spinifex hirsutus Labill., (male).

Hab.—On the sea-shores throughout Australia, New Caledonia, and New Zealand.

Growth-form.—Grows in the form of tufts. Stems creeping at the base. Leaves intensely hairy, felted in appearance, and soft. The ventral surface is much more hairy than the dorsal. The latter surface is thrown into depressions.

Leaf-anatomy (Fig.1).—A transverse section of a leaf shows a thick cuticle. The epidermal cells on the ventral surface are fairly regular in character, mostly rounded, and small-lumened. The stomata (St.) on this surface are numerous, and, in all cases, sunk in depressions. These depressions are formed by the cells bounding the stomata assuming a cylindrical shape, and being raised above the general level of the epidermal surface. The epidermal cells of the dorsal surface are larger than those of the ventral. The former surface is thrown into ridges of two distinct consecutive sizes, viz., a smaller one to be followed by one twice its depth.

The epidermal cells on the crests of the larger ridges are two-layered, and smaller than those bounding the smaller ridges.

TRANSVERSE SECTIONS OF LEAVES.

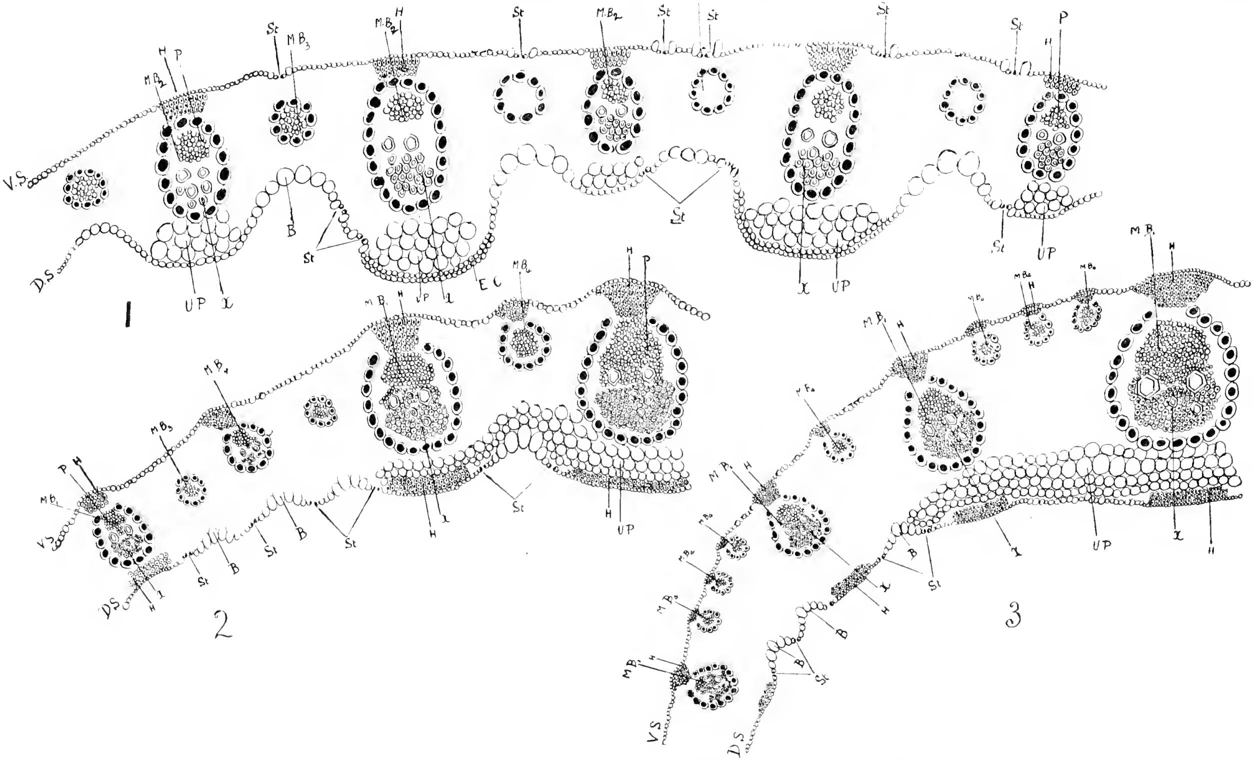


Fig. 1.—*Spinifex hirsutus* Labill. Fig. 2.—*Panicum flavidum* Retz. Fig. 3.—*Themeda avenacea* Hackel, (midrib).

The epidermal cells (B.) in the depressions are very large, and, although not distinctly bulliform in character, by their position and arrangement probably aid in the rolling of the leaf. The stomata are numerous, and invariably occur on the sides of the depressions. They are themselves sunk, being bounded by epidermal cells similar to those on the ventral surface. In the rolled-up position of the leaf, these stomata would be completely concealed.

There are two kinds of bundles, viz., those ($M.B_3$) in the narrow bands, closed, and not bounded by hypoderma; and those ($M.B_2$) in the wider bands, also closed, but bounded on the ventral surface by hypoderma. The smaller bundles ($M.B_3$) are completely surrounded by chlorophyll-bearing parenchyma, and contain no xylem-elements. The larger bundles ($M.B_2$) are similar in character. They are oval-shaped, and completely surrounded by chlorophyll-bearing parenchyma. The phloëm does not present any noteworthy features. The xylem, however, is characteristic in nature. All the vessels are extremely large, much larger than in any other grass examined, more or less uniform in size, and with very narrow lumens.

Between the epidermis of the dorsal face and the larger bundles are three to four rows of large, uncoloured parenchyma-cells, probably functioning as water-storage cells.

Conclusion.—The large, uncoloured parenchyma-cells, the extremely large xylem-elements, the depressed stomata, the narrow-lumened epidermal cells, the intensely hairy surfaces, all aid in the storage of water; to this purpose, the development of hypoderma (stereome) seems to be sacrificed.

Note.—The presence of hairs, which are extremely numerous, is not indicated in the diagram.

Explanation of References.

H., Hypoderma—P., Phloëm—X., Xylem—C.P., Chlorophyll-bearing parenchyma—B., Bulliform cells—M.S., Mestome-sheath—St., Stoma—U.P., Uncoloured parenchyma—$M.B_1$, Primary bundle—$M.B_2$, Special form of secondary bundle—$M.B_3$, Secondary bundle—$M.B_4$, Intermediate type of bundle—S.p.P., Sub-papillose protuberance—T., Trichome—V.S., Ventral surface—D.S., Dorsal surface.

Panicum flavidum Retz.

Hab.—New South Wales, Queensland, and tropical Asia. In this State, it is most common on the better class of soils.

Growth-form.—Tufted, bases of stems knotted but not bulbous; adventitious roots strong, long, and not typically fibrous. Leaves rigid, and often broad and scabrous.

Leaf-anatomy (Fig. 2).—The stomata (St.) are confined to the dorsal surface, while the bulliform cells are arranged in groups of six or seven, and occur in depressions.

The bundles are of three kinds ($M.B_1$), open below, but bounded on the dorsal and ventral surfaces by hypoderma. The secondary bundles ($M.B_3$) are completely enclosed by chlorophyll-bearing cells, and not bounded by hypodermal fibre. The bundles($M.B_4$) are open on the ventral surface, but bounded by hypoderma only on that surface. The bundles of this series contain xylem as well as phloëm. The xylem of the bundles is better developed than in any of the other Panicums examined.

The midrib is well developed, and contains three primary bundles ($M.B_1$), and two bundles ($M.B_4$) of an intermediate type. The uncoloured parenchyma-cells are in two or three bands.

The hypodermal development of the leaf is large, and raises the surface at these points above the general level of the epidermis.

Conclusion.—The dorsal position of the stomata, the bulliform cells, the well developed hypoderma, the large and numerous xylem-elements, are the principal xerophytic features of this grass.

Themeda avenacea Hackel.

Hab.—Throughout Australia (except Tasmania). In this State, it grows principally on the black soils of the northern tablelands and north-western interior.

Growth-form.—Very tussocky, with well developed root-system. Bases of stems not bulbous. Leaves extremely coarse and rigid, mostly confined to the base of the plant.

Leaf-anatomy (Fig. 3).—The epidermal cells are small. The stomata are confined to the dorsal surface. Groups of bulliform cells, in series of five or six, occur.

The grass has a very distinct midrib. The mid-primary bundle is very large, contains well developed xylem-elements, and is bounded dorsally and ventrally by a large development of hypoderma. There are three primary bundles in the midrib, and the development of uncoloured parenchyma-cells on the dorsal surface is large.

The bundles are confined mostly to the primary ($M.B_1$) or the intermediate ($M.B_4$) types. The latter are characteristic, being close to the ventral surface, open, and bounded by hypoderma. There is, thus, a large development of palisade-tissue towards the dorsal surface.

Conclusion.—This grass presents some characteristic features. The harsh, rigid character of the leaves in the field is due to the extreme development of hypodermal fibre, greater, perhaps, in this grass than in any other examined.

On this development of hard tissue, and on the bulliform cells, the grass evidently depends for its xerophytic characteristics.

Astrebla pectinata F.v.M.

Hab.—New South Wales, Queensland, Northern Territory, Western and South Australia. In this State, it is found both on the red and black soils in the northern and western interior.

Growth-form.—Tufted, bases of stems bulbous. It is particularly characterised by the rapidity with which leaf-growth takes place at the joints under moist conditions.

Leaf-anatomy (Figs.4-5).—The epidermal cells of the ventral surface are much larger than those of the dorsal. The cuticle is moderately thick, but not so thick as in *Spinifex hirsutus* Labill.

The stomata (St.) are confined solely to the dorsal surface, and are on the sides of groups of bulliform cells. The latter (B.) are in groups of five. The middle bulliform cell is the largest, and the two on each side of decreasing dimensions. There appears to be no doubt, from the shape and arrangement of these cells, that they aid in closing the leaf, in which case the stomata would be hidden.

The bundles are of three kinds, viz., primary ($M.B_1$), secondary ($M.B_3$), and a special form of secondary ($M.B_2$). The primary

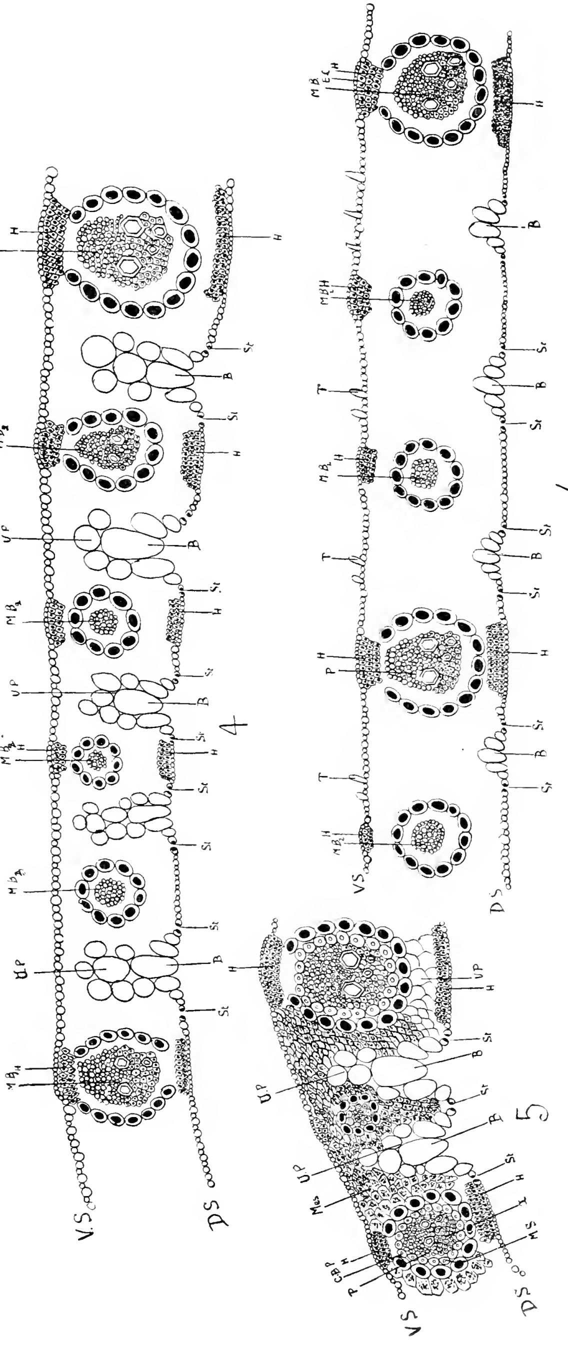


Fig. 4.—*Astrebla pectinata* F.v.M. Fig. 5.—*A. pectinata* F.v.M., (midrib). Fig. 6.—*Neurachne Mitchelliana* Nees.

bundles are open above and below, and bounded by hypoderma. The special forms of secondary bundles contain phloëm only, and are bounded, both on the dorsal and ventral surfaces, by hypoderma. These are the most numerous in the leaf. The secondary bundles are completely enclosed, contain phloëm only, and have no hypoderma either on the dorsal or ventral surfaces. As will be seen from Fig.4, the arrangement of the bundles is irregular; two primary bundles may occur consecutively, the only difference being in the larger size of one of them.

Between each pair of bundles, colourless parenchyma-cells extend for almost the whole distance between the two surfaces. These cells are large, irregular in size, and separated in all cases from the chlorophyll-bearing parenchyma by palisade-tissue.

Conclusion.—A comparison of the structure of the leaf of this grass with that of *Spinifex hirsutus* presents some interesting features. The development of hypoderma in *Astrebla pectinata* is much greater than in *S. hirsutus*. This hypoderma (stereome), besides aiding in the mechanical strengthening of the leaf, also helps to repress transpiration The characteristic bands of colourless parenchyma-cells, present in this grass, are absent in *S. hirsutus*. It is probable that these bands of cells are utilised for the assimilation of the palisade-tissue. In the field, a noteworthy feature of the grass is the rapid development of new leaves from every node of the stem. The arrangement and distribution of the colourless parenchyma would allow light to penetrate readily into the palisade-tissue, even in the rolled-up position of the leaf-bud, and thus materially aid in the development of the leaf.

Another feature distinguishing it from *S. hirsutus* is the undepressed nature of the stomata.

The means adapted for rigidity, assimilation, and xerophytism in *A. pectinata* are thus different from those of the halophytic Spinifex, previously under review.

NEURACHNE MITCHELLIANA Nees.

Hab.—Interior of all the States, except Tasmania and Western Australia. In this State, it seems to be more common on the red than on the black soils.

Growth-form.—Tufted, bases of stems extremely bulbous and hairy. Leaves rigid, pungent, and very hairy.

Leaf-anatomy (Fig.6).—In this grass, the stomata are confined to the dorsal surface. Groups of bulliform cells occur between the bundles.

There are only two kinds of bundles, viz., primary (M.B_1), and a special form of secondary (M.B_2). The hypoderma is thus well developed under all the bundles. The primary bundles are more numerous than in any of the other grasses examined. Trichomes are very numerous.

Conclusion.—The trichomes, the position of the stomata, the bulliform cells, the large number of primary bundles, and the well developed hypoderma, are the principal xerophytic characteristics of this grass.

PANICUM DECOMPOSITUM (R.Br.).

Hab.—Throughout Australia. It reaches its best development, in this State, on the red and black soils of the interior.

Growth-form.—Tufted. Stems very large and succulent. Base of stems bulbous. Leaves large, wide, and rather flaccid.

Leaf-anatomy (Fig.7).—The epidermal cells on the ventral surface are large, round, and fairly regular in size. Those developed over the hypoderma, however, are smaller and have thicker walls. Bulliform cells (B.), in groups of three, occur between the bundles. The stomata (St.) are, for the most part, arranged on the sides of the bulliform cells. Three kinds of bundles are present, viz., primary (M.B_1), secondary (M.B_3), and a special form of secondary (M.B_2). The secondary and the special form of secondary are about equal in numbers.

The hypodermal tissue (H.) is not as well developed as in *P. flavidum.* Groups of colourless parenchyma-cells (U.P.) extend between the bundles from the dorsal surface, about half the distance to the ventral surface.

Conclusion.—This is the only Panic-grass examined, in which the bands of colourless parenchyma occur, evidently adapted to aid assimilation. The grass, according to its leaf-anatomy, is not as xerophytic as *P. flavidum*, and this is also borne out by its behaviour in the field.

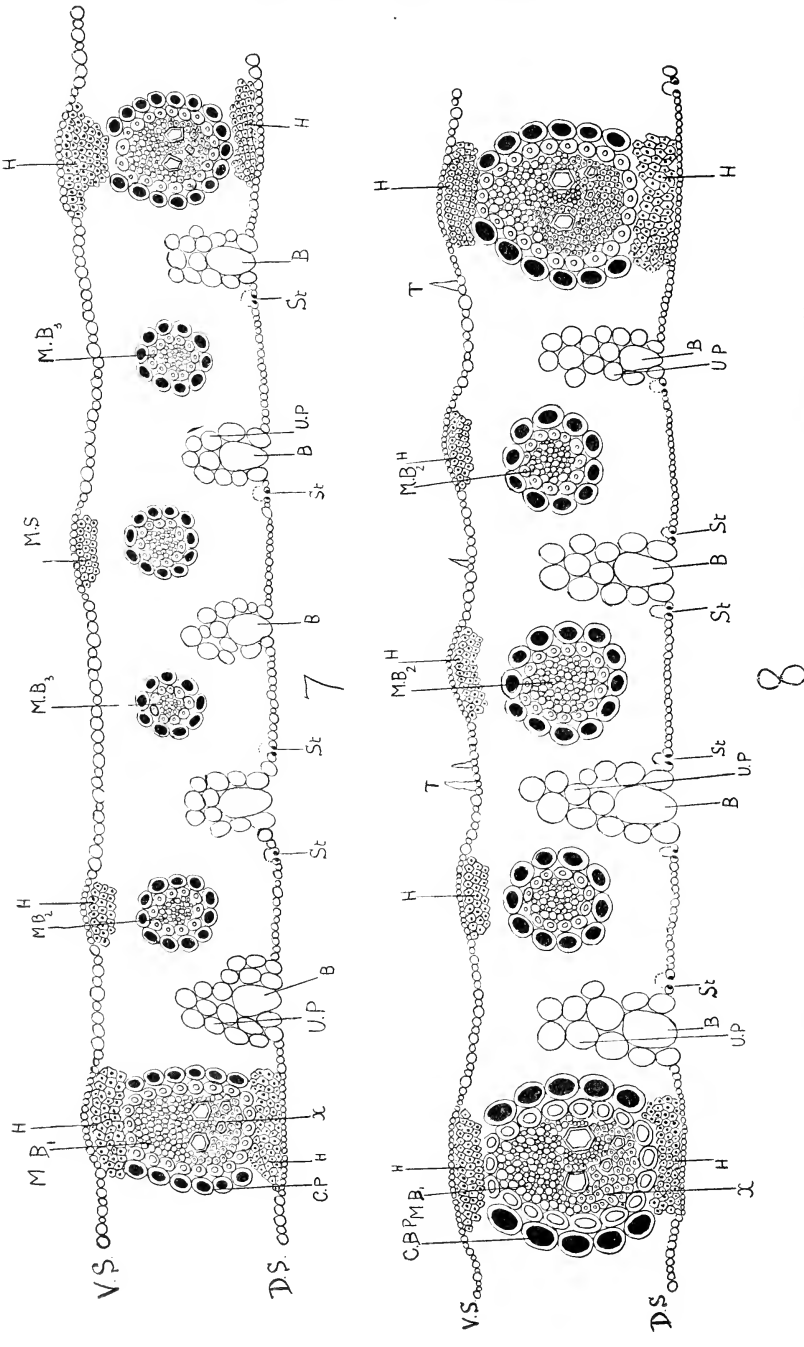


Fig.7.—*Panicum decompositum* R.Br.

Fig.8.—*Chloris acicularis* Lindl.

Chloris acicularis Lindl.

Hab.—Throughout Australia, except Tasmania. Very cosmopolitan, as regards its situation in this State.

Growth-form.—Tufted, somewhat rosette-shaped, bases of stems not bulbous, adventitious roots strongly developed, leaves fairly rigid and pungent.

Leaf-anatomy (Fig.8).—The stomata (St.) are confined to the dorsal surface, and are arranged on the edges of groups of three well developed bulliform cells (B.). The bundles are either primary ($M.B_1$), or a special form of secondary ($M.B_2$). They are large, with well developed xylem-elements. The hypoderma is very well developed. Bands of colourless parenchyma-cells extend between the bundles for about three-quarters of the distance between the two surfaces.

Conclusion.—This grass presents typical xerophytic features in the development of hypoderma, in the bands of colourless parenchyma-cells, in the position of the stomata, and in the bulliform cells.

Panicum leucophæum H.B.K.

Hab.—Throughout Australia, particularly in the interior. Also in tropical Africa and America. It is very partial to shady situations.

Growth-form.—Tufted, bases of stems bulbous and hairy. Leaves narrow and rather flaccid.

Leaf-anatomy (Fig 9).—The epidermal cells on the ventral surface are interrupted by stomata, and trichomes (T.) are numerous. On the dorsal surface, bulliform cells, in groups of five, occur between the bundles; and stomata, as a rule, occur on one side of these groups of cells. Trichomes are numerous on this surface also.

The bundles are of three types, viz., primary ($M.B_1$), secondary ($M.B_3$), and a special form of secondary ($M.B_2$). The secondary bundles, with no hypoderma, are most numerous.

Conclusion.—This is the least xerophytic of all the Panic-grasses examined. The hypoderma is comparatively weakly developed, the bundles are small, and the bulliform cells are not

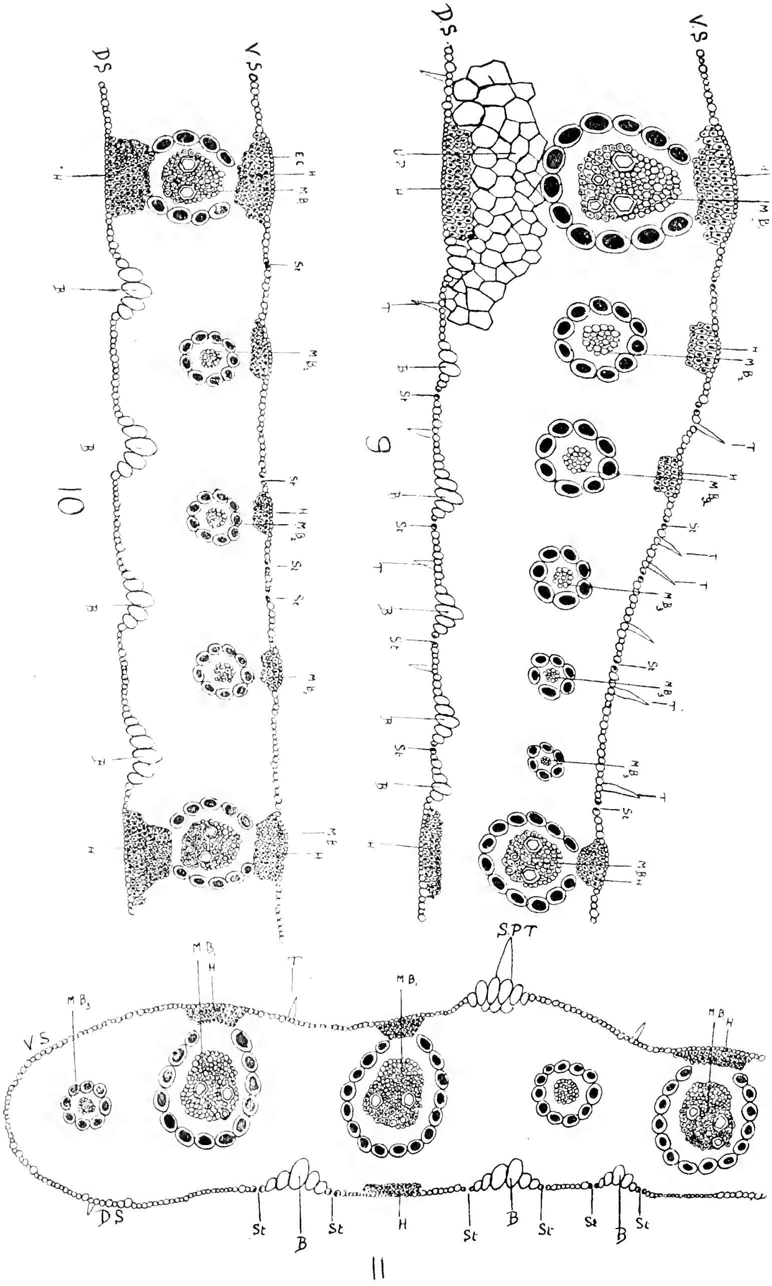


Fig.9.—*Panicum leucophaeum* H.B.K. Fig.10.—*P. Benthami* Domin. Fig.11.—*Eragrostis lacunaria* F.v.M.

so distinctly fan-shaped as in the others. My experience of the grass in the field is that, while its rootstock is extremely permanent and drought-resisting, the foliage quickly withers under drought-conditions.

PANICUM BENTHAMI Domin.

Hab.—Interior and northern tablelands of the State. The grass occurs principally on the black or alluvial soils.

Growth-form.—Tufted, extreme stem-development, bases of stems hairy but not bulbous, leaves fairly coarse and rigid.

Leaf-anatomy (Fig. 10).—Stomata were seen only on the ventral surface. On the dorsal surface, the bulliform cells (B.), arranged in groups of five or six between the bundles, are large, and form slight depressions.

The bundles are of two kinds, viz., primary ($M.B_1$), and a special form of secondary ($M.B_2$). Hypoderma is developed under all the bundles.

Conclusion.—The order of xerophytism of the Panic-grasses according to their leaf-structure, is thus as follows:—(1) *Panicum flavidum*, (2) *P. decompositum*, (3) *P. Benthami*, and (4) *P. leucophæum*. This corresponds, in my experience, to their behaviour in the field.

ERAGROSTIS LACUNARIA F.v.M.

Hab.—In the interior of all the States, except Tasmania and Western Australia. In the interior of this State, it is very common on the red soils.

Growth-form.—A small, tufted grass, bases of stems not bulbous, leaves rigid and rather coarse.

Leaf-anatomy (Figs. 11-12).—The epidermal cells on the ventral surface are irregular in size. Trichomes are numerous. A striking feature of some of these trichomes is their large size. The latter are arranged on groups of four or five, large, epidermal cells, somewhat fan-shaped in character; the whole structure may be called a sub-papillose protuberance (S.p.P.).

On the dorsal surface, groups of six bulliform cells occur between the bundles; they are situated in depressions, and have stomata (St.) on their edges.

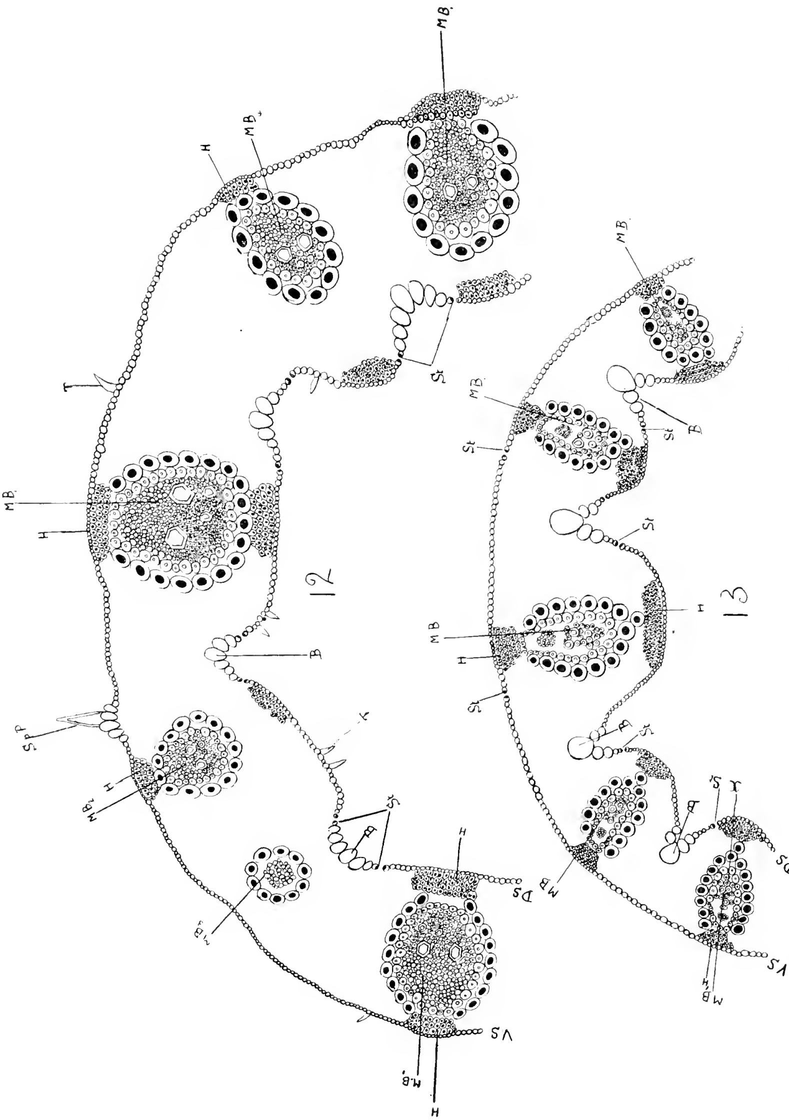


Fig. 12. —*Eragrostis lacunaria* F. v. M., (midrib). Fig. 13. —*E. curvula* var. *valida* (Stapf).

The bundles are of four kinds, viz., primary ($M.B_1$), secondary ($M.B_3$), and a special form of secondary ($M.B_2$), and those of an intermediate type ($M.B_4$). They are about equal in numbers.

The xylem in the bundles consists, for the most part, of small vessels.

Conclusion.—The xerophytism of this grass is shown by its trichomes, bulliform cells, and well developed hypoderma.

ERAGROSTIS CURVULA var. VALIDA Stapf.

Hab.—South Africa, and probably the United States of America. It occurs only under cultivation in this State.

Growth-form.—Tussocky, stems hard and woody, adventitious roots long and tough. Leaves long, coarse, but rather flaccid.

Leaf-anatomy (Fig.13). Stomata occur on both surfaces. Trichomes are absent. The bulliform cells are characteristic; they occur in distinct depressions, and the middle one is very large.

All the bundles ($M.B_1$) are primary, and contain large xylem-elements. Hypoderma is very well developed.

Conclusion.—This grass, an introduced one, is under review for the purpose of comparing it with *E. lacunaria.* Both are growing side by side at Nyngan Demonstration Farm, and both are showing well marked xerophytism. It will be noticed that the leaves of *E. curvula* var. *valida*, which are very long, have much better developed hypoderma and xylem-elements than *E. lacunaria*: this is probably for the purpose of maintaining the rigidity of the leaf.

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AUSTRALIAN NEUROPTERA. Part ii.

By Esben-Petersen, Silkeborg.

(Plates vi.-xiii.: and two text-figs.)

(Communicated by W. W. Froggatt, F.L.S.)

In the following notes, which may be looked upon as preliminary ones only, I hope to give a contribution to the knowledge of the Australian fauna of Myrmeleonidæ. Unfortunately, I have not been able to work out the two large genera *Myrmeleon* and *Formicaleon*, so that lack of material necessitates the postponement of this work until more material is at hand.

My best thanks are due to the Government Entomologist, Mr. W. W. Froggatt, and to my friend, Mr. R. J. Tillyard, for loans and gifts of material.

Table of Genera of Australian *Myrmeleonidæ*.

1. In the hindwing, only one crossvein (rarely two) before the origin of the radial sector .... 2.
   In the hindwing, three or more crossveins before the origin of the radial sector .... 12.
2. No spurs .... 3.
   Spurs present .... 5.
3. In the forewing, 1A runs directly into the hindmargin. M and Cu_1 unite before tip of wing .... *Chrysoleon* Bks.
   In the forewing, Cu_2 and 1A unite before margin. M and Cu_1 run separately into the margin of the wing .... 4.
4. Legs rather stout. In the forewing, C forks at the origin of radial sector .... *Gymnocnemia* Schn.
   Legs long and slender. In the forewing, C forks much beyond origin of radial sector, always at origin of first branch of radial sector .... *Froggattisca* mihi.
5. Basal joint of tarsi longer than apical one. In the forewing, Cu_2 runs parallel to Cu_1 for some distance .... 6.
   Basal joint of tarsi shorter than apical one. In the forewing, Cu_2 does not run parallel to Cu_1 .... 7.
6. Some of the crossveins in the costal area of the forewing united (two series of cells); the bent branches of radial sector in forewing form, or tend to form, a straight line through the apical part of wing. In hindwing, several rows of cells between Cu_1 and hind margin........ *Protoplectron* Gerst.

In the forewing, the crossveins in the costal area are simple, the branches of radial sector not forming any straight line. In hindwing, two rows of cells betweed Cu_1 and hind margin.................. ....*Pseudoformicaleo* Weele.

7. Spurs as long as, or longer than, first four tarsal joints together................... *Distoleon* Bks.

Spurs shorter than first four tarsal joints together...................... 8.

8. Hind margin of the wings excavated; wings with lustrous markings............... *Periclystus* Gerst.

Hind margin of the wings not excavated; wings without lustrous markings.. 9.

9. Legs short, stout and strongly haired. Spurs strongly curved, and as long as the first three tarsal joints together.........*Formicaleon* Bks.

Legs rather long and slender, not strongly haired. Spurs shorter than the first three tarsal joints together.................................... 10.

10. Abdomen long and slender, especially in ♂. In forewing, Cu forks before origin of radial sector.........................*Macronemurus* Costa.

Abdomen of usual size. In forewing, Cu forks beyond the origin of radial sector.. 11.

11. Wings long and narrow. Legs very slender. Each of second, third, and fourth tarsal joints longer than broad. Spurs nearly as long as first and second joints united...............................*Dendroleon* Br.

Wings broad or rather broad. Legs rather stout (when slender, the wings are very broad). Second, third, and fourth tarsal joints not longer than broad. Spurs a little longer than first joint........................... *Glenoleon* Bks.

12. Legs stout, short, and strongly haired. The bent branches of radial sector form a straight line through the middle of the apical part of wings...*Acanthaclisis* Rbr.

Legs rather slender, haired. No straight line through the middle of the apical part of wings .... 13.

13. In both wings, M and Cu_1 unite long before tip of wings............................. *Callistoleon* Bks.

M and Cu_1 do not unite ....*Myrmeleon* L.

The Malayan genus *Episalus* Gerst., is not included in this Table.

Acanthaclisis.

Rambur, Hist. Nat. Ins. Névr., p.378(1842).

The Australian species of this genus differ from the European-African ones in regard to the shape of the spurs. In *Acanthaclisis occitanica*, *A. bœtica*, and *A. distincta*, the basal part of the spurs is broad, nearly straight; and forms, together with the pointed apical part, almost a right angle. In the Australian species, *A. subtendens*, *A. fundata*, *A. fulva*, *A. subfasciata*, *A. maclachlani*, and *A. annulata*, the spurs have no broad basal part, and they are more or less gradually curved, not angular. *A. subtendens*, *A. fundata*, *A. fulva*, and partly also *A. subfasciata*, agree with the *A. occitanica*-group as to the shape and neuration of wings, the strongly haired and short legs, the length of tarsal joints, and the habitual appearance. *A. maclachlani* and *A. annulata*, however, differ with regard to their longer and narrower wings, their shorter spurs, and their relatively longer tibiæ and tarsal joints. In the neuration of wings, there are also differences. Navás has founded a new genus, *Cosina*, including *C. maclachlani* and *C. neozelandica* (the latter unknown to me); but it seems to me, that the generic characters mentioned by him are not satisfactory. I think, for the present, that it will be preferable to retain the Australian species in *Acanthaclisis*, and place them in two groups: the *A. fundata*-group, and the *A. maclachlani*-group.

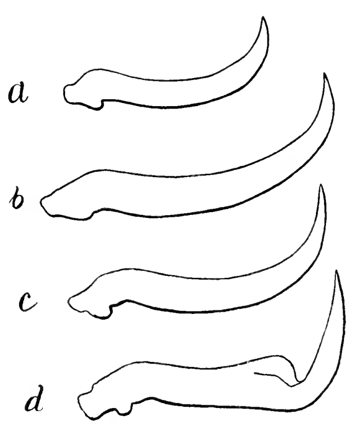


Fig. 1.—Internal spur of left tibia, seen from inner side, in: *a*, *A. annulata*; *b*, *A. subtendens*; *c*, *A. fundata*; *d*, *A. bœtica*.

Below, I give a Table of the Australian species known to me.

1. In the hindwing, 6-8 crossveins before origin of radial sector. Cu_2 runs into hind margin of hindwing opposite to, or behind, origin of radial sector (*A. fundata*-group).......... .... 2.

In the hindwing, 11-16 crossveins before origin of radial sector. Cu_2 runs into the hind margin much before origin of radial sector (*A. maclachlani*-group).. 5.

2. Forewing with four rather indistinct transverse bands...*subfasciata* Bks.

No transverse bands on forewing.. 3.

3. Length of forewing at least 70 mm; nervature yellowish-red and black ....*fulva* Esb-Pet.

Length of forewing not 50 mm.; nervature yellowish-white and black 4.

4. Cubital area in the forewing (the space between the stem of C_1, the Cu_2, and the first anal vein) with only one row of cellules (exceptionally, two rows are indicated). Cu_1 and Cu_2 proportionately wide apart. The line formed by bent branches from Cu_1 rather indistinct.................... *fundata* Walk.

Cubital area in the forewing with two rows of cellules in its middle. Cu_1 and Cu_2 not wide apart. The line formed by bent branches from Cu_1 distinct and straight........................ *subtendens* Walk.

5. Thorax above with only two small yellowish spots on mesoscutellum. Abdomen with narrow, yellowish, transverse bands................................ *maclachlani* Weele.

Thorax above with large yellowish spots. Abdomen with broad, yellowish, transverse bands...................................... *annulata*, n.sp.

ACANTHACLISIS ANNULATA, sp.nov. (Plates vi., fig.1; vii., fig.9.)

Face and labrum yellowish; labial and maxillary palpi yellowish; apical joint of labial palpi brown exteriorly; above the antennæ, (which are lost) a transverse blackish-brown streak. Vertex blackish-brown, touching the transverse streak in its middle, and with some indistinct pale spots; above the transverse streak and close to each of the eyes, a yellowish triangular spot. Vertex rather raised. Prothorax hardly as long as broad, trapezoid, brownish-black, with four yellowish spots along the front margin; four triangular, transversely placed, spots in the middle; hind margin yellowish, abrupted in the middle. Along the side margins, long white and black hairs. Mesothorax brownish-black, with four large yellowish spots, and some small and indistinct ones, along the front and lateral margins. Metathorax brownish-black, with five yellowish spots. Meso- and metathorax whitish-haired. First abdominal segment above, black; second black, with narrow yellowish front margin and broader hind margin; third to sixth black, with broad yellow front, and hind margin; seventh and eighth black, with yellow posterior half; ninth brownish-black, with yellowish forceps, which are nearly as long as seventh and eighth segments united. Forceps provided with long blackish hairs exteriorly, and with strong, blackish, basally directed bristles interiorly.

Wings long and narrow, with acute tips. Longitudinal nervures yellowish white or yellowish-red, blackish-banded. Crossveins mostly blackish, broadly blackish-shaded. In the hindwings, 11 crossveins before origin of radial sector. Cubital area in the forewing with two rows of cellules in its middle.

Length of forewing, 45-50; of hindwing, 43-46 mm.

Southern Cross, W. Australia; one male (type), 1912, W. W. Froggatt (Coll. Froggatt)—Broken Hill, N.S.W.; one male (Coll. Tillyard).

ACANTHACLISIS MACLACHLANI.

v.d. Weele, Notes Leyd. Mus., xiv., p.210(1904).

I have seen two males of this species, one from Bernier Is., N. W. Australia,(W. W. Froggatt leg.) and one from Port Darwin (Dodd leg.). In one specimen, the membrane of the wings is almost quite hyaline, and the veins indistinctly shaded with brown; in the other specimen, the membrane of the forewings gets a brownish-black aspect from the broadly marginated veins. Thorax and abdomen are blackish-brown. Mesoscutellum with two small, but distinct yellowish spots Abdominal segments above with narrowly yellowish hind margin. In the hindwing, 16-17 crossveins before origin of radial sector. Cubital area in forewing with two rows of cellules in its middle part.

Type in Mus. Leyden.

ACANTHACLISIS SUBFASCIATA. (Plate xiii., fig.27.)

Banks, Proc. Ent. Soc. Wash., xv., p.141(1913).

This species is easily recognised by its banded forewings. The intercubital area in forewings acutely angulated basally; the cubital area narrow and long, with one row of cellules.

I have seen one specimen from North Queensland (Dodd leg.).

ACANTHACLISIS FULVA.

Esben-Petersen, Ent. Mitt., i., p.269(1912).

No doubt this species is the largest in the genus, the forewing measuring 72 mm., and the hindwing 69 mm.

Nervures reddish-yellow, and black-banded. Eight to eleven crossveins at the base of costal area of forewing, simple. In hindwing, 8 crossveins before origin of radial sector. Cubital area in forewing with two irregular rows of cellules. Cu_1 and Cu_2 wide apart.

Type from North Queensland (Coll. Esb.-Petersen).

ACANTHACLISIS FUNDATA. (Plate vii., fig.8.)

Myrmeleon fundatus Walker, Cat. Neur. Ins. Brit. Mus., p.320 (1853).

The habitual structure of this species similar to that of *A. occitanica*; the main difference is found in the shape of the spurs. The broad, black, median streak on thorax hardly divided by any pale longitudinal line. Abdomen blackish. The cubital area in the forewing with two rows of cellules in its middle. Cu_1 and Cu_2 not wide apart, *i.e.*, the intercubital area acutely angulated basally. The line formed by bent branches from Cu_1 straight and distinct. R and Cu_1 with broad black bands.

I have seen specimens only from New South Wales, W. W. Froggatt leg.(Coll. Froggatt); and from Broken Hill (Coll. Esb.-Petersen).

ACANTHACLISIS SUBTENDENS. (Plate vii., fig.7.)

Myrmeleon subtendens Walk., Cat. Neur. Ins. Brit. Mus., p.321 (1853).

Acanthaclisis conspurcata Gerstaecker, Mitt. naturw. Ver. f. Neuvorp. u. Rügen, p.5(1885).

The broad median streak on thorax divided by a narrow pale line. Abdomen more or less brownish above, with a blackish median streak. The line formed by bent branches from Cu_1 indistinct. In strongly marked specimens, a row of rectangular dark spots in the subcostal area in both pairs of wings; a row of oblong spots in the median area (the space between M and Cu_1) of the forewing; and sometimes, also, a spot where Cu_2 runs into the hindmargin. In the hindwing, the apical crossvein between M and Cu_1 is often dark-shaded.

I have seen two females from Cape York; 20 x. 1908; W. W. Froggatt leg. (Coll. Froggatt); and one male, North Queensland (Coll. Petersen).

I have not seen the types of Walker's above-mentioned species; the specimens before me have been determined from the descriptions only; and, on that account, it is possible that my identification may be wrong. I am quite sure, however, that we have two closely allied but distinct species.

I regard *A. conspurcata* Gerst., as a synonym of this species, although v.d. Weele, who has seen Gerstaecker's type, refers it to *A. fundata* (Notes Leyd. Mus., xx., p.60, 1908). Probably v.d.Weele regards *A. fundata* and *A. subtendens* as one species.

Callistoleon.

Banks, Ann. Ent. Soc. Amer., p.42(1910).

Wings hyaline, with brownish-black spots. In forewing, 1A ends before origin of first branch of radial sector; in hindwing, before origin of radial sector. About seven crossveins before origin of radial sector in forewing, four or five in hindwing. Crossveins in costal area simple. No straight line formed by bent branches of radial sector in apical part of wings. M and Cu_1 unite before the tip of the wings. Legs short, and rather stout; first tarsal joint a little longer than second; second, third, and fourth of about the same length; fifth twice the length of first; spurs as long as first and second joints united. Front part of vertex much raised.

Type : *Myrmeleon erythrocephalum* Leach,(*M. guttatus* Rbr.).

The two Australian species known to me may be separated as follows :—

Wings rather broad, with large spots along front margin of forewing. Head entirely reddish-yellow.................. *erythrocephalum* Leach.

Wings slender, smaller spots along front of forewing in its apical part. Vertex blackish-brown.................. *illustre* Gerst. (Pl. viii., fig. 10.)

Myrmeleon.

Linné, Syst. Nat., xii., p.913(1767).

Myrmeleon diminutus, sp.nov. (Plates vi., fig.2; viii., fig.11.)

Head yellow. Tip and inner margin of mandibles brown. Palpi yellow. Apical joint of labial palpi fusiform, brown on exterior side. Above antennæ, a brown crossband; between the antennæ, a narrow brown line. Vertex with several brown spots. Antennæ rather short and stout, yellowish, a little darker towards apex; the extreme tip brown; apex of the two basal joints broadly brown, of the following joints narrowly brown below. Prothorax yellowish, a little broader than long, with a brown median stripe, and two shorter lateral ones; meso- and metathorax with several greyish-brown dots and streaks [abdomen lost]. Legs yellowish, blackish-brown haired; tarsal joints blackish at the tips. Spurs hardly as long as basal joint. Wings hyaline. Veins yellowish, brownish-banded except costa and radius. Most crossveins brown on their front half. Pterostigma greyish-yellow. In forewing, seven crossveins before origin of radial sector; in hindwing, five or six.

Length of forewing, 18 mm.; of hindwing, 16·5 mm.

Broken Hill, N.S.W.; two specimens; type in Coll. Tillyard, cotype in Coll. Esb.-Petersen.

GYMNOCNEMIA.

Schneider, Ent. Zeit. Stettin, vi., p.343(1845).

No spurs. Legs rather short, strongly haired; tarsi almost as long as tibiæ. Fifth tarsal joint the longest; first as long as second and third united; fourth the shortest. Wings very long and narrow; forewing rather longer than hindwing. In hindwing, one crossvein before origin of radial sector; in forewing, three or four. Branches from radial sector and from Cu_1 bent, so that they form straight lines.

Species known from Australia: *G. tipularia* Gerst.; *G. pentagramma* Gerst., *G. interrupta*, n.sp., and *G. bipunctata*, n.sp.

In the two species here described, is a very small rudiment of a single spur on each leg, but it is only visible by large magnifying.

GYMNOCNEMIA BIPUNCTATA, sp.nov. (Plates vi., fig.3; ix., fig.13.)

Face yellowish. Palpi yellowish, apical joint dark brown. A broad blackish-brown interantennal spot enclosing the insertion of antennæ; above this band, a reddish-yellow band, and then a blackish band, both in front of the much elevated vertex. On the top of the vertex, several reddish-yellow and blackish spots. Antennæ rather long, blackish-brown, with yellowish-brown annulations at the joints. Prothorax longer than broad, narrowed in front, with rounded front angles, and with three interrupted yellowish-red streaks, which continue on the blackish meso- and metathorax. Abdomen dorsally blackish, with short whitish hairs, ventrally testaceous. Legs testaceous; hind tibiæ with blackish apex; fore and intermediate tibiæ with blackish tip, and two narrow blackish bands on the exterior side; tarsal joints testaceous, with blackish tip. Wings long and slender, with acutely rounded tips. Longitudinal nervures whitish, broadly blackish-brown banded. Some of the crossveins brownish-black shaded. In the hindwing, a large brown spot at the end of M and Cu_1. Two rows of cellules in the cubital area of forewing.

Length of forewing, 21 mm.; of hindwing, 17 mm.

Narromine, N.S.W.; two specimens, 14.x.1905 (W. W. Froggatt leg.); Broken Hill, N.S.W.; one specimen.

Type in Coll. Froggatt; cotype in Coll. Tillyard.

GYMNOCNEMIA INTERRUPTA, sp.nov. (Plates vi., fig 4; viii., fig. 12.)

Face yellowish; palpi brownish with pale joints. A broad black transverse band between the eyes, enclosing the insertion of the antennæ. The raised vertex yellowish-red, with blackish streaks and spots [antennæ wanting]. Prothorax greyish-black, with an indistinct pale median streak, and two very distinct yellowish-red streaks at each side. Meso- and metathorax greyish-black, with some yellowish-red spots. Abdomen black. Legs testaceous, with long black and white hairs. Hind tibiæ with a blackish band at tip and base; fore and intermediate tibiæ with a blackish band at the tip and base, and with two in their middle; tarsi blackish. Wings long and slender, with somewhat acute tips. Longitudinal veins whitish, mostly broadly blackish-brown banded. Crossveins whitish, mostly with one or two very small blackish-brown dots. In forewing, an abrupted longitudinal brownish-black streak along Cu_1, terminating at the tip of the wings; in the hindwing, a blackish-brown streak at the end of M and Cu_1. In the forewing, two rows of cellules in the middle of the cubital area.

Length of forewing, 18 mm.; of hindwing, 15 mm.

Coolebah, N.S.W.; one specimen, 16.ii.1907 (W. W. Froggatt leg.). Type in Coll. Froggatt.

FROGGATTISCA, gen.nov.

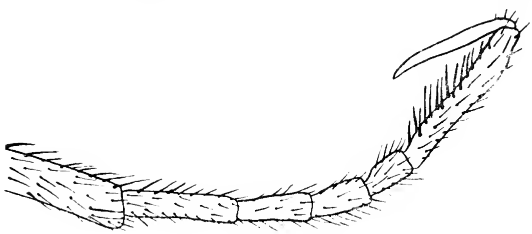
Antennæ long and slender. Prothorax and abdomen long and slender. Legs very long and slender. Femur and tibia of the same length. Fore-tarsus one-half the length of fore-tibia, hind-tarsus hardly half the length of hind-tibia. No spurs. Wings long and slender, strongly marked; tip of hindwing somewhat falcate. Three crossveins before radial sector in forewing, one in hindwing. Origin of first branch from radial sector opposite to fork of Cu in both pairs of wings; 1A runs nearly parallel to the hind margin.

This genus is nearly allied to *Dendroleon* Brauer, but the absence of spurs, and its slender and strongly marked wings separate it from that genus.

Type: *Froggattisca pulchella*, sp.nov.

FROGGATTISCA PULCHELLA, sp.nov. (Plate ix., fig.14.)

Face and palpi yellowish; above the antennæ, a blackish-brown transverse band proceeding between the antennæ as a V-shaped spot. Above the transverse blackish streak, a narrow yellowish one. Vertex somewhat raised, bronze-brown. Eyes greenish, metallic, shining. Antennæ blackish-brown, the club blackish; two joints before the club very pale, nearly white. Prothorax reddish-brown, longer than broad, narrowed in front, and with rounded front angles. One-third from the front margin, a transverse impression. Meso- and metathorax greyish-brown, with



Text-fig.2.--Left foretarsus of *Froggattisca pulchella*.

narrow, whitish, hind margins. Abdomen reddish-brown, becoming blackish-brown towards àpex. Fore and intermediate legs blackish-brown, hind femur brown, with a broad blackish band in its middle, and a narrower one at the tip; hind tibiæ brown, with a blackish band near base and at tip; hind tarsus blackish, first joint brown at base. All the claws yellowish. Body and legs with soft pilosity. Wings hyaline, with brownish tinge in the disc, and sooty-brown markings. Longitudinal nervures mostly yellowish; the greatest number of crossveins in the forewings strongly sooty-brown shaded.

Length of forewing, 35 mm.; of hindwing, 35 mm.

Colo Vale, N.S.W.; one female; 20.iv.1900; W. W. Froggatt leg.(Coll. Froggatt).

PROTOPLECTRON.

Gerstaecker, Mitt. naturw. Ver. f. Neuvorp. u. Rügen, p.15(1884).

Banks, Ann. Ent. Soc. Am., iii., p.40(1910).

Type: *P. venustum* Gerst.

Tibia short and stout, two-thirds the length of the stout and short femur; tarsus long and slender, longer than tibia. Basal joint of tarsus the longest, longer than second-fourth united, which, united, are of the same length as fifth. Spurs as long as first joint.

In the forewing, Cu_2 and 1A run parallel to Cu_1 for some distance. Some of the crossveins in the costal area of forewing united (two series of cells): the bent branches of radial sector in forewing form, or tend to form, a straight line through the middle of the apical part of the wing. In the hindwing, several rows of cells between Cu_1 and hind margin.

Table of Species.

All nervures yellowish .... *pallidum* Bks.
The nervures more or less marked with black.......... *venustum* Gerst.

PROTOPLECTRON VENUSTUM. (Plate ix., fig.15.)

Gerstaecker, Mitt. naturw. Ver. f. Neuvorp. u. Rügen, p.16(1884).

Face below yellowish; palpi more or less brownish. A blackish cross-band below the eyes; vertex blackish-brown, with ill-defined pale brown markings. Prothorax longer than broad, reddish-brown, with an indistinct pale median line, and a pale longitudinal streak at each side, lateral margins blackish. Abdomen blackish-brown. Femora and tibiæ brown and long-haired; hind tibiæ yellowish, with black apex, and a narrow blackish band near base. Tarsi blackish. Wings with whitish membrane, pale, blackish-banded nervures, and many more or less brownish-shaded crossveins.

Length of forewing, 26 mm.; of hindwing, 25 mm.

New South Wales; one specimen; 14.x.1905; W. W. Froggatt leg.(Coll. Froggatt).

Pseudoformicaleo.

v.d.Weele, Notes Leyd. Mus., xxxi., p.25(1909).

Tahulus Navás, Revue Russe d'Ent., xii., p.112(1912).

Tibiæ short and stout, two-thirds the length of the stout and short femur; tarsus long and slender, longer than tibia. Basal joint of tarsus the longest, longer than second, third, and fourth united, which, together, are of the same length as fifth Spurs as long as first joint. In forewing, Cu_2 and 1A run parallel to Cu_1 for some distance. Crossveins in the costal area of forewing simple. Branches of radial sector not forming any straight line. In hindwing, two rows of cells between Cu_1 and hind margin.

Pseudoformicaleo nubecula. (Plate x., fig.16.)

Creagris nubecula Gerstaecker, Mitt. naturw. Ver. f. Neuvorp. u. Rügen, p.18(1885).

Pseudoformicaleo jacobsoni Weele, Notes Leyd. Mus., xxi., p.25 (1909).

Protoplectron costatus Banks, Ann. Ent. Soc. Am., iii., p.41(1910).

Tahulus caligatus Navás, Revue Russe d'Ent., xii., p.113(1912).

I have seen one specimen from Australia, which undoubtedly belongs to the species of Gerstaecker; and, as far as I can see, it also agrees with the description of *P. costatus* given by Banks.

I have, in my collection, specimens of *Pseudoformicaleo jacobsoni* from Java, and *Tahulus caligatus* from Formosa; and I am undoubtedly right in regarding them as synonyms.

Periclystus.

Gerstaecker, Mitt. naturw. Ver. f. Neuvorp. u. Rügen, p.103 (1887).

Front part of vertex much raised. Wings hyaline, with brownish-black or golden shining spots or bands. Hind margin of wing with two excavations, the apical one the deeper. Costal area rather narrow, with simple crossveins, from the pterostigma broader, and with forked crossveins. Five or six crossveins before origin of radial sector in the forewing, one in the hindwing. The somewhat bent branches of radial sector tend to form a straight line through the middle of the apical part of the wings. Legs slender; first tarsal joint about twice the length of second, and about one-half the length of fifth; second, third, and fourth of almost the same length. Spurs slender, and as long as first and second tarsal joints united.

Type: *Periclystus laceratus* Gerst.

The two Australian species known to me may be separated as follows:—

Forewing with a nearly complete median crossband, and an irregular one before pterostigma; hindwing with a broad crossband before pterostigma .... *circuiter* Walk.

No complete crossbands .... *laceratus* Gerst.

PERICLYSTUS CIRCUITER. (Plate x., fig.17.)

Myrmeleon circuiter Walker, Cat. Neur. Ins. Brit. Mus., p.400 (1853).

Periclystus callipeplus Gerstaecker, Mitt. naturw. f. Neuvorp. u. Rügen, p.107(1887).

Of this species, I have an old specimen in my collection, from Cairns, Queensland. It agrees very well with the description of *P. callipeplus*, and also with that of *M. circuiter*. I have sent a photo. of the specimen to the British Museum, and Dr. Meade-Waldo states that it agrees very well with the type-series of Walker. On that account, I place the name of the species of Gerstaecker as a synonym of that of Walker.

PERICLYSTUS LACERATUS. (Plate x., fig.18.)

Gerstaecker, Mitt. naturw. Ver. f. Neuvorp. u. Rügen, p.105 (1887).

Cape York, Queensland; one male; 20.x.1908(W. W. Froggatt leg.), Coll. Froggatt; Queensland; one female, Coll. Petersen.

The male is more slender, and has narrower wings, than the female; the excavations of the hind margin of the wings of the male are hardly so deep as in the female.

DISTOLEON.

Banks, Ann. Ent. Soc. Amer., p.42(1910).

Wings long and narrow, hindwing as long as forewing. Seven or eight crossveins before origin of radial sector in forewing, one in the hindwing. In forewing, the bent branches of the radial sector and Cu_1 tend to form straight lines through the apical part of the wings. Spurs as long as first four tarsal joints, fifth much longer than first.

Type : *D. verticalis* Bks.

Distoleon bistrigatus.

Myrmeleon bistrigatus Ramb., Hist. Nat. Ins. Névr., p.391 (1842). *M. striola* Walk., Cat. Neur. Ins. Brit. Mus., p.340 (1853); *M. perjurus* Walk., *ibid.*, p.340; *M. torvus* Walk., *ibid.*, p.341; *M. violentus* Walk., *ibid.*, p.348.

Of this wide-spread Australian species, I have seen one specimen from Queensland, in Coll. Froggatt; and several specimens from Oahu. I have seen also a very fine undescribed species from Australia.

Formicaleon.

Banks, Ann. Ent. Soc. Amer., p.16(1911).

The genotype is *F. tetragrammicus* Fabr., in which the bent branches of the radial sector form a straight line through the middle of the apical part of the wing.

I call attention to the fact, that this line is wanting in some of the Australian species hitherto placed in this genus. These species may be placed in a new genus, and I propose the name *Alloformicaleon*, with *F. australis* Esb.-Pet., as genotype; but I will postpone giving a more complete description of the genus until more material is at hand.

Formicaleon australis, sp.nov. (Plates vi., fig.6; xi., fig.19.)

Face and palpi yellowish. Below the antennæ, a blackish-brown streak. The vertex reddish-brown, raised, and with a slight median impression; on the hind part of the elevated vertex, two blackish indistinct spots. Round each eye, a narrow yellowish circle. Antennæ as long as head and thorax united, brown, with yellowish annulations at the joints; club blackish-brown at tip. Prothorax broader than long, reddish-brown, with three longitudinal yellowish streaks. Meso- and metathorax reddish-brown, with narrow yellowish hind margins. First segment yellowish above, with a dark brown median spot; second segment entirely dark brown; front half of third segment yellowish, with a dark brown median spot; hind part with a narrow yellowish hind border; fourth, fifth, and sixth segments yellowish above, with a broad dark brown transverse band in their hind part; seventh and eighth dark brown, with yellowish hind border; ninth yellow. Venter of abdomen brown, with yellowish annulations at the joints. Legs yellowish, strongly blackish-haired; fore and intermediate tibiæ anteriorly with some blackish spots; tarsi yellowish, the points with blackish tips. Spurs reddish, and nearly as long as first to third joints united. Wings long and narrow. Longitudinal nervures yellowish-white, blackish-banded. Several crossveins blackish and faintly blackish-brown shaded.

Fore- and hindwings, 30 mm. in length.

Sydney; two specimens; W. W. Froggatt leg. Type in Coll. Froggatt; cotype in Coll. Petersen.

Dendroleon.

Brauer, Novara-Expedition, Neuroptera, p.42(1866).

Antennæ long and slender. Legs long and slender. Tarsus two-thirds the length of tibia. First tarsal joint longer than second, or third, or fourth, shorter than fifth; second, third, and fourth of the same length, each of them twice longer than broad. Spurs slender, nearly as long as first and second joints united. Wings long and rather narrow; costal crossveins simple, a few forked before pterostigma. Cu forks much beyond origin of radial sector; 1A and Cu_2 united before the margin. The bent branches of radial sector form a straight line through the middle of the apical part of the wing. Three or four crossveins before origin of radial sector in forewing, one in hindwing.

Dendroleon longipennis, sp.nov. (Plate xi., fig.20.)

Face yellowish. Maxillary palpi yellowish; fifth and base of third joint brownish. A broad blackish-brown streak between the eyes, enclosing the insertion of the antennæ. Vertex raised, reddish-brown, with two brownish-black, irregular, transverse streaks abrupted in the middle. Prothorax longer than broad, greyish-brown, blackish-haired; front angles rounded, and with yellowish border; two irregular pale longitudinal streaks, not reaching the front border, and a slight indication of a pale and narrow median line. Meso- and metathorax dark greyish-brown, with a narrow yellow hind border. Abdomen pale greyish-brown. Legs testaceous, dark brown-haired; femora with a blackish band at tip, and with a long dark streak on the ventral side; tibiæ with a narrow blackish band at tip and base, and the foremost with a long dark streak on the upper side; tarsi blackish: spurs yellowish-red, and nearly as long as the two basal joints. Wings long and slender, with acute tips, whitish, black-banded, longitudinal nervures; crossveins mostly blackish, several of them brownish-shaded. Wings with some blackish-brown markings.

Length of forewing, 26 mm; of hindwing, 25 mm.

New South Wales; one specimen; W. W. Froggatt leg. (Coll. Froggatt).

GLENOLEON.

Banks, Trans. Amer. Ent. Soc., xxxix., p.223(1913).

Cu forks beyond origin of radial sector. Three or four cross-veins before radial sector in forewing, one in hindwing. In forewing, 1A and Cu_2 unite before the margin. In the middle of the apical part of the wing, the bent branches of the radial sector form a straight line.

Type: *Myrmeleon pulchellus* Ramb.

Banks proposed this genus for the Australian species of *Glenurus* Hag., but the species placed in the genus, as it is restricted at present, form a rather heterogeneous group as to the form of the wings, and the length and slenderness of the legs and tarsal joints. In *G. indecisum* and *G. annulicorne*, we have very broad wings, with broadly rounded tips, slender and rather long legs and tarsal joints; in *G. pulchellum* and *G. dissolutum*, the wings are broad, with somewhat acute tips, and the legs and tarsal joints of usual size; in *G. falsum* and *G. meteoricum*, the wings are slender and narrow, and the legs and tarsal joints relatively stout, short, and strongly haired. With regard to the form of the wings, these two species are closely allied to the species of the genus *Dendroleon*, in which, however, the species have slender and relatively long legs, and tarsal joints as in the *G. indecisum*-group

I think that it will be necessary, when more material comes under consideration, to make a new arrangement of the species, which at present are placed in the two genera *Glenoleon* and *Dendroleon.*

The species known to me may be tabulated as follows :—

1. Hindwings with distinct black spots.. 2.
   Hindwings without distinct black spots, only minute dots.............. 6.
2. Hindwings with two complete crossbands in their apical part..............
   .... *pulchellum* Rbr.
   Not two complete bands.. 3.
3. In hindwings, four crossveins below radius are marked with black; a large spot at the pterostigma, and another opposite to it on the hind margin...................................... *radiale* Bks.(Plate xii., fig.24).
   No marks along radius on hindwing.. 4
4. A lunate crossband in the hindwing, from pterostigma to hind margin; its inner margin convex. Vertex black...............*falsum* Walk.
   No such band. Vertex reddish-yellow, with black spots and streaks...5.
5. Before pterostigma, in fore- and hindwings, a large black spot.............
   .... *dissolutum* Gerst.
   Only a minute spot.. *meteoricum* Gerst.
6. Antennæ with a broad yellow band at base, and near the club. Cu_2, in forewing, straight.................................... *annulicorne* Esb.-Pet.
   Antennæ without any broad band. Cu_2, in forewing, somewhat curved.
   .... *indecisum* Bks.

I do not know *G. stigmatum* Bks.,(Ann. Ent. Soc. Amer., p.40, 1910) from Kuranda, but, judging from the description, it is closely allied to *G. dissolutum.*

Glenoleon annulicorne, sp.nov. (Plates vi., fig.5; xiii., fig.26.)

Face and palpi pale yellow; a broad, blackish, transverse band between the eyes, enclosing the insertion of the antennæ. Vertex reddish-yellow, with a few blackish spots. Antennæ blackish-brown, with pale annulations at the base; third joint as long as first and second united, pale yellow; three joints before the club pale yellow. Thorax dull black, with pale yellow streaks and spots, mostly on prothorax. Legs slender, brownish, with long dark bristles. Coxæ with one or two dark streaks exteriorly. Femora with a dark band at apex, and a yellowish-white one just before that. Fore and intermediate tibiæ with a dark band at apex, one in the middle, and one near base; hind tibiæ with a dark band at apex. Second, third, and fourth tarsal joints blackish. Abdomen black, yellowish-spotted. Wings rather narrow, hind margin of apical part slightly incurved. Longitudinal nervures dark brown, with some whitish bands; crossveins mostly blackish-brown Along radius and cubitus in forewings, brown dots. A brown dot where 1A joins Cu_2. Two or three crossveins at the end of M and Cu_2 brownish-margined. Pterostigma indistinct; in the forewing, with a small brown spot before it.

Length of forewing, 22-23 mm.; of hindwing, 21-22 mm.

Victoria; one specimen (Coll. Esben-Petersen), the other not labelled. Type in Coll. West Australian Museum, Perth; cotype in Coll. Esben-Petersen.

This species has great likeness to *G. indecisum* Bks., from which it differs by the narrower wings, the more spotted abdomen, and the straight Cu_2 in the forewings. In *G. indecisum*, Cu_2, in the forewing, is somewhat curved, and wide apart from Cu_1.

GLENOLEON INDECISUM. (Plate xiii., fig.25.)

Banks, Trans. Amer. Ent. Soc., xxxix., p.225(1913).

Mackay, Queensland; one specimen, 1905; R. Turner leg.(Coll. Froggatt).

GLENOLEON DISSOLUTUM. (Plate xii., fig.23.)

Gerstaecker, Mitt. naturw. Ver. f. Neuvorp. u. Rügen, xvi., p.26 (1884).

Prince of Wales Island; one specimen; H. Elgner leg. (Coll. Froggatt).

GLENOLEON FALSUM. (Plate xi., fig.21.)

Walker, Cat. Neur. Ins. Brit. Mus., p.303(1853).

Blue Mountains, N.S.W.; one specimen; 20.viii.1901; W. W. Froggatt leg. (Coll. Froggatt).

GLENOLEON METEORICUM. (Plate xii., fig.22.)

Gerstaecker, Mitt. naturw. Ver. f. Neuvorp. u. Rügen, xvi., p.25 (1884).

Sydney; one specimen; W. W. Froggatt leg.(Coll. Froggatt).

EXPLANATION OF PLATES VI.-XIII.

Plate vi.

Fig. 1.—*Acanthaclisis annulata*, n.sp.
Fig. 2.—*Myrmeleon diminutus*, n.sp.
Fig. 3.—*Gymnocnemia bipunctata*, n.sp.
Fig. 4.—*Gymnocnemia interrupta*, n.sp.
Fig. 5.—*Glenoleon annulicorne*, n.sp.
Fig. 6.—*Formicaleon australis*, n.sp.

Plate vii.

Fig. 7.—*Acanthaclisis subtendens* Walk.
Fig. 8.—*Acanthaclisis fundata* Walk.
Fig. 9.—*Acanthaclisis annulata*, n.sp.

Plate viii.

Fig. 10.—*Callistoleon illustre* Gerst.
Fig. 11.—*Myrmeleon diminutus*, n.sp.
Fig. 12.—*Gymnocnemia interrupta*, n.sp.

Plate ix.

Fig. 13.—*Gymnocnemia bipunctata*, n.sp.
Fig. 14.—*Froggattisca pulchella*, n.sp.
Fig. 15.—*Protoplectron venustum* Gerst.

Plate x.

Fig. 16.—*Pseudoformicaleo nubecula* Gerst.
Fig. 17.—*Periclystus circuiter* Walk.
Fig. 18.—*Periclystus laceratus* Gerst.

Plate xi.

Fig. 19.—*Formicaleon australis*, n.sp.
Fig. 20.—*Dendroleon longipennis*, n.sp.
Fig. 21.—*Glenoleon falsum* Walk.

Plate xii.

Fig-22.—*Glenoleon meteoricum* Gerst.
Fig. 23.—*Glenoleon dissolutum* Gerst.
Fig. 24.—*Glenoleon radiale* Banks.

Plate xiii.

Fig. 25.—*Glenoleon indecisum* Banks.
Fig. 26.—*Glenoleon annulicorne*, n.sp.
Fig. 27.—*Acanthaclisis subfasciata* Banks.

ORDINARY MONTHLY MEETING.

April 28th, 1915.

Mr. A. G. Hamilton, President, in the Chair.

Miss Constance E. M. Le Plastrier, Lindfield; and Mr. Harry Stephens, B.Sc.Agr., Biological Branch, Department of Agriculture, Sydney, were elected Ordinary Members of the Society.

The President announced that the Council had elected Messrs. A. H. Lucas, M.A., B.Sc., C. Hedley, F.L.S., W. W. Froggatt, F.L.S., and W. S. Dun, to be Vice-Presidents; Mr. J. H. Campbell, [Royal Mint, Macquarie Street] to be Hon. Treasurer; and Mr. A. F. Basset Hull to be a Member of the Council [to fill an extraordinary vacancy, occasioned by the decease of Mr. J. R. Garland], for the current Session.

The President referred to the recent news of the award, for 1915, of the Linnean Gold Medal, by the Linnean Society of London, to Mr. J. H. Maiden, F L.S.; and it was resolved that the hearty congratulations of the Society should be tendered to the recipient.

The President, in addressing some valedictory remarks to Mr. Gilbert Goldfinch, a Member present, who expected to leave shortly with the Third Contingent of troops, gave expression to the good wishes of Members for his welfare, and for his safe return.

The Donations and Exchanges received since the previous Monthly Meeting (31st March, 1915), amounting to 5 Vols., 40 Parts or Nos., 7 Bulletins, 2 Reports, and 10 Pamphlets, received from 36 Societies, etc., were laid upon the table.

DESCRIPTIONS OF SIX NEW SPECIES OF *BUPRESTIDÆ.*

By H. J. Carter, B.A., F.E.S.

The residence of a keen collector, like Mr. H. W. Brown, at Cue, West Australia, has resulted in the capture of many interesting Coleoptera in this little explored region. Besides a number of new Tenebrionidæ, the following six species of Buprestidæ are undescribed, five of which are from the Cue district.

Chalcotænia violacea, n.sp.

♂. Upper surface dark violet, with coppery depressions more or less filled with yellow flocculence. Head with base, mouthparts, under margin of eye, and two basal joints of antennæ coppery, the rest of antennæ piceous red, raised part of forehead violet, central excavation flavo-pulvulose, pronotum and elytra violet on the raised, coppery or flavo-pulvulose on the depressed parts; scutellum blue, underside, femora (except the apex) coppery, albivillose, or floccose, apex of femora, tibiæ, and tarsi blue.

Head with a large scutiform excavation on front, having an interrupted carinate margin, an interrupted medial sulcus, basal part closely, subconfluently punctate, antennæ extending almost to base of prothorax, two basal joints with large punctures, 3rd cylindric, 4-11 serrate and successively shorter. *Prothorax* 5 x 6·5 mm., subquadrate, subsinuate at base and apex, all angles produced and acute, posteriorly more sharply so and subdentate, sides feebly rounded, converging anteriorly, and faintly sinuately widening behind; disc with wide medial, and two wider lateral sulci, the latter oblique, not at extreme sides, diverging apically to the angles, and narrowly continued on basal line to meet medial sulcus; space between sulci and extreme sides rugosely and irregularly punctate, the sulci finely punctate, the ridges wide and smooth except for a few large punctures. *Scutellum* transverse, smooth. *Elytra* wider than prothorax at base, and thrice and one-half as long, posterior sides very finely crenate or obsoletely dentate, apex finely rounded; irregularly 5-costate (including the suture), with three intervening sulci, besides a lateral sulcus, and three spots more markedly pulvulose than the rest; these placed, one at base, the second before the middle, at the interruption of the 3rd costa, the third postmedial at the widening of the 3rd sulcus; all costæ wide, rounded and nearly smooth, the first sutural, the second parallel to first, diverging at scutellum, and not quite meeting the sutural costa at apex, the third starting behind the basal spot, interrupted by a wide antemedial depression, and joining the 2nd costa on the apical declivity, the fourth abbreviated, starting from the humeral swelling, narrowed and terminated before the postmedial spot, the fifth starting behind humeral region, terminated on apical border, all sulci and depressions closely and finely punctate, costæ with a few irregular larger punctures. Prosternum sulcate in middle, the sulcus with a coppery carinate margin, the three apical segments of abdomen with a slightly raised smooth carina, last segment triangularly excised.

♀. With lower surface less pulvulose, showing a more coppery and pilose surface, with a smooth spot on the sides of abdominal segments, the apex not excised; head less coppery, basal joints of antennæ blue.

Dimensions: ♂.24·5 × 8; ♀.25 × 8½ mm.

Hab.—Cue, West Australia (H. W. Brown).

The facies and sculpture of the upper surface are very like those of *Chalcophorella Beltanæ* Blackb., or *C. exilis* Blackb.; but it is a much larger and more varicolored insect than these, while the distinct abdominal costa (wanting in *Chalcophorella*), and the somewhat longer antennæ point decidedly to *Chalcotænia* as its place. A marked character in this species is the almost total absence of the usual posterior denticulation of the elytra. Only by a close examination, can the very slight apology for this be observed. Type in author's Collection.

BUPRESTIS MŒSTA, n.sp.(?)

Oval, nitid; head and pronotum dark violet, front of the former sometimes interspersed with copper, elytra entirely blue-black, underside blue or dark green, legs and antennæ violet or blue.

Head coarsely dentate, with a short carina between eyes, and a triangular impression on epistoma. *Prothorax* as in *B. 10-notata* L. & G., widest at base, sides nearly straight, slightly converging to apex, front angles depressed and obtuse (from above), posterior acute, disc with a wide medial sulcus, and two large basal foveæ, irregularly punctate. *Scutellum* small, transverse. *Elytra* as wide as prothorax, and thrice and one-half as long, widened behind middle, apex trispinose, outside and sutural spines short and sharp, the middle blunt and rounded; striate-punctate, the striæ forming deep sulci at apex and sides, showing the punctures more than in *B. decemnotata*, intervals convex and punctate underside very lightly and shortly villose, and finely punctate. *Dimensions:* 13·5-15 x 4·5-6 mm.

Hab.—Dorrigo, New South Wales (W. Heron).

I have received five specimens of this, which may very well be only a melanic variety of the well known *B. decemnotata* L. & G., (= *B. aurantiopicta* L. & G ?). I have, moreover, a specimen from Queensland (Mr. R. Illidge), which is similar to the above except in showing a small indication of a red mark on the 7th interval behind the middle; but the apex of the elytra differs from that in six specimens of *B. decemnotata* before me [which agree with Saunders' figure in being bispinose, not truncate, as in his description (Trans. Ent. Soc., 1868, p.7)]. In the ♂, the apex of abdomen is truncate; in the ♀, oval. Types in the author's Collection.

Note.—In one of my six specimens of *B. 10-notata*, the two postmedial spots are confluent, forming a short fascia, as in the figure of *B. aurantiopicta* given by Laporte & Gory, and oddly enough also in that of *B. 10-notata*.

Bubastes formosa, n.sp.

Cylindric, nitid, and glabrous; head (on forehead only), pronotum, and elytra a *rich blue* (in one example, the elytra somewhat greenish); epistoma, mouth, antennæ, and a triangular patch on apex of forehead, sides of prothorax, sides and apex of elytra, together with the underside and legs, *brassy*; (the sides of elytra less nitid than the rest, and, towards the apex, rather red than brassy). *Scutellum* green.

Head coarsely and closely punctate, a sulcus between eyes, widening into an elongate smooth space. *Prothorax* 4 x 5 mm., bisinuate at apex and base (more feebly so at apex), widest near base, sides feebly rounded and converging anteriorly, nearly straight posteriorly, front angles obtuse and declivous, posterior angles (seen from above) rectangular; disc coarsely punctate as on head, becoming coarser, with a tendency to latitudinal confluence towards base, a smooth medial line terminating in a fovea near base, lateral carina short, not visible from above. *Scutellum* circular, with a depressed area behind it. *Elytra* of same width as prothorax, and more than thrice as long, rather deeply striate near suture, less deeply at sides, punctures coarser than in *B. inconsistans* Thoms., two or more rows of punctures crowded in the striæ, and sometimes overflowing on the raised intervals; anterior portion of elytra slightly rugulose, apex obliquely bispinose, sutural spine longest, sides crenate near apex; underside very coarsely punctate on prosternum, less coarse on meso- and metasternum and legs, on abdomen becoming finer towards apex, last segment rugose, metasternum sulcate. *Dimensions :* 16-18 x 5·6 mm.

Hab.—Cue, West Australia (H. W. Brown).

I am indebted to Mr. Brown for two male specimens of this most beautiful species of the genus. It differs widely in colour alone from all described species. Type in the author's Collection.

BUBASTES SUTURALIS, n.sp.

Cylindric, brilliantly nitid, glabrous above, shortly albispilose beneath. Head green or coppery, prothorax brassy on disc, green at sides, elytra gold or coppery shading off to green laterally, with the sutural interval blue or violet, basal margin blue or green, underside and legs bright green, antennæ and tarsi coppery-red, scutellum blue.

Head concave and sharply striate between the eyes, coarsely punctate, more sparsely so than in *B. formosa*, and not at all rugose. *Prothorax* (in ♀, 3·5 x 5·5 mm.) more narrowly convex than usual, apex feebly, base strongly bisinuate, sides feebly widened, arcuately converging anteriorly, front angles rounded, posterior angles acute (as seen from above); punctures on centre and apex much smaller than on head, becoming coarser at base, and transversely rugose at sides, the punctures more sparse than in *B. formosa*, without definite medial line, except that indicated by a deep elongate fovea near base. *Scutellum* circular, depressed and concave; punctate. *Elytra* of same width as prothorax at base, and more than thrice as long, each elytron bispinose at apex, in ♂ the spines of nearly equal length, the excision between them semicircular, in ♀ the apical spines obsolete or blunt; striate, with about three rows of punctures crowded between the intervals, the punctures larger than in *B inconsistans* Thoms., and smaller than in *B. formosa*, the intervals little raised, nitid and almost impunctate, becoming obsolescent at apex; underside coarsely punctate, the punctures becoming gradually finer from sternum to apex of abdomen. *Dimensions*: ♂, 12 × 4; ♀, 17 × 6 mm.

Hab.—Drysdale River (H. Giles), Cue (H. W. Brown).

Three specimens examined. *B. splendens* Blackb., seems near it, but is described as green, with base of head and antennæ violet. *B. aureocincta* Blackb., while differing in colour, has evidently a very differently shaped prothorax. Type in the author's Collection.

NEOCURIS BROWNII, n.sp.

Ovate, nitid, head and prothorax of ♂ blue, the latter with base and sides greenish, of ♀ brilliant brassy-green; in both sexes the scutellum green, elytra yellow, with basal margin green, the suture and sides narrowly dark violet, underside, legs, and antennæ metallic green.

Head wide, not deeply received into prothorax, concave between eyes, finely and closely punctate. *Prothorax* widest at base, gently and roundly converging from base to apex; truncate at apex, bisinuate at base, anterior angles obtuse, posterior acute (both viewed from above); closely punctate as on head, without medial line, a shallow oblique impression on each side extending from apex outwards, and a transverse triangular basal fovea near hind angles. *Scutellum* small, transversely oval, smooth. *Elytra* not covering apex of abdomen, of same width as prothorax at base, separately rounded behind, obscurely impressed near shoulder; finely punctate-striate; underside closely punctate. *Dimensions:* 6-7 × $2\frac{1}{4}$-$2\frac{1}{2}$ mm.

Hab.—Cue, West Australia (H. W. Brown).

A pair, the sexes, form another of Mr. Brown's interesting captures in this district. The species is very near *N. discoflava* Fairm., but the head and pronotum are bright metallic, without the coppery margin, the elytra with much narrower dark edging, the yellow extending almost to apex, the head is more tumid and less enclosed in the prothorax than in Fairmaire's species, with the underside different. Type in the author's Collection.

STIGMODERA IMMACULATA, n.sp.

Oblong-ovate; head, antennæ, prothorax, scutellum, underside, and legs, of ♂, bright metallic green; of ♀, rich golden-coppery, elytra (in both sexes) pale yellow; underside sparsely clothed with short white hair.

Head finely punctate, with a shallow excavation between eyes. *Prothorax* narrow, apex truncate, base bisinuate, sides straightly converging from base to apex, anterior angles unseen from above, deflexed and embracing the head, posterior angles subacute; disc finely and closely punctate in front, more coarsely so at base, medial line impressed only near base, two small basal foveæ. *Elytra* of same width as prothorax at base, and about twice and one-half as long, with moderate posthumeral and postmedial enlargements, rounded at apex, with a small circular excision bounded externally by two short sharp black spines, sides near apex entire; striate-punctate, intervals convex and finely punctate, apex of abdomen truncate in ♂, rounded in ♀; underside finely punctate, prosternum, especially the sides, more coarsely punctate. *Dimensions:* 8 × 3·5 mm.

Hab.—Cue, West Australia (H. W. Brown).

Of the *S. sexguttata* Macl., (*S. puella* Saund.), and *S. dispar* Blackb., type, but larger and wider than Macleay's species, and the elytra without any markings. Two specimens, the sexes, received from Mr. Brown, who states that the sexual coloration is constant. The shape of the prothorax is unusual, narrow and subconic, with its anterior part of the same width as the head. *S. dispar* Blackb., (from Queensland) has a very differently shaped prothorax, *inter alia*. Type in the author's Collection.

Stigmodera.—I have unfortunately used two preoccupied names in describing my species, and would, therefore, note the following alterations.

S. caudata Cart., = *S. Hackeri* Cart.

Kerremans has utilised the name *caudata* (Soc. Ent. Belg., 1900, p.316).

S. gracilis Cart., = *S. gracilior* Cart.

The name *gracilis* was used previously by Castelnau and Gory for a Brazilian species, since transferred to *Conognatha*.

Nascio.—When describing two new species (These Proceedings, 1912, pp.482-3), I had not then read Mons. Kerremans' work in the Genera Insectorum, and hence did not note his division of the genus, a division entirely satisfactory, and, indeed, necessary. In accordance with this, *Nascio Tillyardi* Carter, belongs to the new genus, and should be known as *Nascioides Tillyardi* Cart. The learned author has inadvertently omitted *Nascio chydœa* Oll., *Nascioides munda* Oll., and *N. multesima* Oll., from that work.

NORTHERN TERRITORY *TERMITIDÆ*. Part i.

By Gerald F. Hill, F.E.S., Government Entomologist, Northern Territory.

(Plates xiv.-xxiii.)

The following contribution to a knowledge of the Australian *Termitidæ* has been prepared from part of a large collection of Termites, and many field-notes compiled during the past two years, in what may be termed the coastal region of the Northern Territory.

Fifteen species are dealt with in this paper, eight of which are described as new. One new species is recorded from Melville Island; the remainder are from localities situated within 70 miles of Darwin, and within 20 miles of the Darwin-Pine Creek Railway. The Departmental collection contains about 27 species from the latter area, but it is probable that the number will be brought up to 30 or more when the whole collection has been worked out.

In the absence of the winged forms, it has been found impossible to determine accurately several common species of the genus *Eutermes*. These, and a few species of the genus *Termes*, which are represented in the collection by one or two examples only, have been held over until more material is available for study.

I desire to express my thanks to Mr. W. W. Froggatt, Government Entomologist of New South Wales, for his courteous assistance in determining many species submitted to him, and to acknowledge the help I have derived from a perusal of his works on Australian Termites.

Heterotermes validus, sp.nov.

Winged form.—General colour ochreous, legs and antennæ paler; wings pale fuscous tinged with ochreous, nervures fuscous;

clypeus pale yellow; labrum pale ferruginous. Length to tip of body $4\frac{1}{2}$ mm.; to tip of wings 10 mm. Head large, longer than broad, rounded behind; forehead prominent, flattened, divided from the posterior part of the head by a wide, curved suture passing in front of the eyes and extending back to a point in line with the posterior margin of the eyes, a small circular excrescence in the centre of the head in line with the posterior margin of the eyes; clypeus large, arcuate behind, slightly rounded on the sides, truncate in front, a deep suture dividing it into two lobes, the posterior one convex and divided in the middle line by an indistinct suture; labrum long, convex, widest at the base, sloping in to the truncate apex, not reaching the tip of the jaws; eyes small, circular, coarsely faceted, projecting, placed on the sides of the head, equidistant from the apex of the labrum and the hind margin of the head; ocelli wanting. Antennæ very short, 16-jointed, springing from a circular cleft in front of the eyes, 1st joint longest; 2nd half the length, slender; 3rd very small; 3rd-10th coalesced; 11th-13th moniliform; 14th-16th hairy. Thorax covered with scattered hairs; prothorax moderately large, not as wide as head, not as long as broad, rugose on the summit, depressed at the sides, front margin turned up, notched in the centre, sides and hind margin rounded, with a slight indentation behind. Wings long (forewings 9 mm., hindwings $8\frac{1}{2}$ mm.), narrow (2 mm.), fragile, rounded at the tips. Forewing: costal nervure slender, paler than the rest; subcostal nervure stout, running close to the costal and merging into it before the middle; median stout at the base but rapidly becoming slender, curving downwards near the base below the middle line of the wing, then rising above the middle, two simple, slender, oblique nervures branching from it, the first about the middle, and both joining the hind margin well round from the apex, bifurcating at about two-thirds of its length from the base, the lower branch joining the hind margin well round from the apex, the upper branch again forked near the apex, the anterior branch joining the costal margin, the posterior the hind margin at points equidistant from the apex; submedian nervure stout at the base, slender towards the extremity, running through the lower part of the wing at the base but rising to near the middle at a point nearly abreast of the first fork in the median nervure, joining the hind margin about three-quarters of the length of the wing from its base, with seven oblique nervures, the first four stout, simple, increasing in length; the 5th stout, with two branches; 6th and 7th slender, simple. Hindwing: costal and subcostal nervures similar to forewing; median nervure differs in that the upper branch at the apex is wanting; submedian similar to forewing excepting that there are eight oblique nervures, and that the 1st to 6th are all stout and simple, the 7th divides into three long, slender branches, the 8th long, slender, forked near its extremity. Scapular shield angular, showing four branches, cross-suture convex. Legs stout, femora with scattered hairs; tibia and tarsi covered with hairs; tibial spines long; claws long; plantula wanting. Abdomen short, swollen towards the extremity; cerci and anal appendices long, slender, hairy.

Soldier.—Head, antennæ, base of jaws and labrum bright golden; jaws dark castaneous; the rest creamy-white Length, $5\frac{1}{2}$ mm. (head, 2 mm.; jaws, 1 mm.; thorax and abdomen, $2\frac{1}{2}$ mm.). Head long, slender, cylindrical, rounded behind, straight on the sides to the antennal cleft; forehead slightly raised on the summit, then sloping sharply to the base of the powerful jaws; a small, obscure, circular cleft in the forehead behind the raised summit. Antennæ moderately long, 17-jointed, springing from a circular cleft at the side of the head; 1st joint longest, slightly turbinate; 2nd one-half the length, cylindrical; 3rd and 4th swollen towards the apex; 5th-17th oval; 3rd-17th hairy. Clypeus moderately large, straight on the sides, flat, truncate in front. Labrum large, long, convex, widest at the base, rounded on the sides to the spade-shaped apex, which bears two long and several short, slender hairs. Jaws long, stout, flattened, slightly curved upwards and inwards (the under surface from the hind margin of the head to the tip of the jaws forming an uninterrupted curve), at the base of the left jaw a stout, blunt fang, separated by a deep cleft from a flat, irregular tooth; at the base of the right jaw a single-pointed, broad tooth opposed to the larger tooth on the left. Prothorax heart-shaped, a little wider than long, a deep indentation in the front margin, slightly turned up in front and on the sides, the middle convex, the hind margin truncate. Abdomen short, widest at the tip, covered with stout hairs; cerci and anal appendices long, hairy. Legs strong; tibia covered with hairs; claws and tibial spines long.

Worker.—Head pale yellow, legs and antennæ paler; abdomen whitish. Length $3\frac{1}{2}$ mm. Head large, orbiculate, arcuate behind the clypeus. Antennæ 17-jointed, moderately long. Clypeus large, convex, lobed, truncate in front, a ferruginous spot at either end. Labrum large, apical two-thirds convex, spade-shaped, basal one-third narrower, with two depressions, one on either side of a median ridge, the hind margin produced at either side into a projection directed backwards. Jaws hidden by the labrum. Prothorax small, rugose, saddle-shaped; front margin rounded and turned up, with a deep median indentation; a deep indentation on either side behind the upturned front margin, sides rounded to the truncate hind margin. Abdomen elongate-oval. Cerci long, slender, hairy. Legs stout; tibia covered with bristles.

Observations on this species have been confined to a small community (1 winged insect, 12 workers, and 10 soldiers) taken in the stem of a Papaw, which had been hollowed out and filled with earthy material; and to a still smaller community found under a log at East Point, near Darwin.

Hab.—Darwin, Northern Territory (G. F. Hill, 17/12/13). Types (No.95) in the Entomologist's Office, Department of Agriculture, N.T.

Termes nana, sp.nov.

Winged form not known.

Soldier.—Head pale ferruginous, darkest towards the forehead; labrum pale ferruginous: basal joint of antennæ paler than labrum, rest of antennæ ochreous; jaws dark reddish-brown; thorax, legs, and abdomen whitish. Length, 3 mm. Head long, moderately slender, rounded behind, nearly straight on the sides, rounded in front to the base of the jaws; forehead raised on the summit, sloping down to the clypeus. Clypeus large, arcuate behind, truncate in front, with a dark spot at either end. Labrum large, straight on the sides for one-half its length, then sloping to the bluntly pointed apex. Jaws long, slender, falcate, basal three-fourths of the cutting edge finely serrated. Antennæ 13-jointed, springing from circular clefts on the side of the head; 1st joint long, stout, slightly curved, swollen towards the apex; 2nd less than half the length, globose; 4th-11th moniliform; 12th longer; 13th elongate-oval; first three joints with few hairs, the rest moderately hairy. Prothorax small, not as wide as head, wider than long, anterior half bent upwards, front margin arcuate and slightly indented in the middle, sides convex and sloping to the deeply indented hind margin. Abdomen small, not as large as head; cerci small, cone-shaped, hairy; femora moderately stout; tibia slender, flattened; claws and spines small; fourth tarsal joint hairy towards the apex.

Worker.—Head pale ochreous; antennæ, thorax, and legs paler; rest of insect whitish. Length, 3 mm. Head moderately large, longer than broad, broadest behind the jaws, rounded behind, convex on the summit, forehead divided from posterior two thirds of the head by an indistinct suture (most noticeable in young specimens), arcuate behind the clypeus. Clypeus large, convex, apical one-fourth separated by a deep suture, basal three-fourths with few hairs, divided in the middle line by a suture, a large ferruginous spot at each end. Labrum large, broad behind, sloping to the truncate apex. Antennæ 13-jointed. Prothorax small, wider than long, similar to soldier. Abdomen long, slender, tapered at either end. Cerci small, cone-shaped. Legs as in soldier.

The type and cotype specimens were taken under a coconut lying on the ground, and in tunnels leading to it. Another small colony was found building a covered passage up the outside of a concrete house-pile in an endeavour to reach the floor-joists.

Hab.—Darwin, Northern Territory, (G. F. Hill, 28/1/14). Types (No.100) in the Entomologist's Office, Department of Agriculture, N.T.

Termes germana, sp.nov.

Winged form not known.

Soldier.—Head dark ochreous, jaws darker; thorax and legs pale yellow; rest of body yellowish-white. Length, 4 mm. Head large, longer than broad, rounded behind, curved on the sides to the base of the jaws, widest across the middle, convex on the summit. Forehead hairy, slightly flattened and rugose, sloping down to the base of the clypeus. Clypeus large, flat, lobed in front, divided in the middle line by a deep suture; a small ferruginous spot at either end. Labrum long, convex, sloping on the sides to the rounded apex, reaching half way to the barb on either mandible, a few bristles on the apical half. Jaws large, curved, on either side about the middle a large, angular barb or fang directed backwards. Palpi long and slender, as long as jaws. Antennæ long, slender, 15-jointed, springing from circular protuberances on the sides of the head; 1st joint long, slightly swollen towards the apex, without hairs; 2nd one-half the length, slender, without hairs; 3rd one-half the length of 2nd; 4th and 5th moniliform; 6th to 14th oval, increasing in length; 15th elongate-oval; each joint from the 5th stalked and banded with white. Prothorax with a few long hairs, small, nearly as long as wide, divided across the middle by a deep suture, anterior half rounded and bent upwards, posterior half slightly convex, sloping on the sides to the rounded hind margin. Abdomen small, tapered to the extremity, hairy; cerci slender. Legs stout, 4th tarsal joint long, slender; claws slender; tibia armed with numerous spines in addition to the three apical spines.

Worker.—Head pale yellow; antennæ, legs and thorax lighter; rest of body white. Length, 3 mm. Head orbiculate. Forehead slightly concave, arcuate behind the clypeus. Clypeus large, convex, truncate in front, with a brown spot at either end. Labrum large, broad behind, sloping on the sides to the truncate apex, barely hiding a large tooth near the tip of the left jaw. Antennæ 14-jointed. Prothorax small, similar to soldier. Abdomen moderately large, tapered rapidly to the extremity; cerci slender. Legs slender; tibial spines and claws small.

Only one small colony has come under the writer's notice. This was situated under a piece of wood lying upon the ground. The termites are believed to feed upon decaying grass-leaves.

Hab.—Fannie Bay, near Darwin, Northern Territory (G. F. Hill, 30/12/13). Types (No.119) in Entomologist's Office, Department of Agriculture, N.T.

TERMES RUBRICEPS Froggatt.

Proc. Linn. Soc. N. S. Wales, 1897, xxii., p.730.

Winged form [description incomplete].—General colour brown above, ochreous below. Head very dark brown. Ocelli pale yellow; base of clypeus light brown; antennæ lighter, and banded with whitish; thorax and apex of each dorsal plate of abdomen brown; rest of insect dark ochreous. Head large, rounded, slightly longer than wide. Forehead concave, with a deep circular cleft in the centre, a distinct suture from the cleft to the posterior margin of the head, arcuate behind the clypeus, summit without hairs. Eyes large, finely faceted, projecting. Ocelli large, circular, in line with the front margin of the eyes, from which they are widely separated. Between the ocelli and clypeus, a large light brown spot. Antennæ 18-jointed, springing from a circular cleft in front of, and close to, the eye; 1st joint moderately long, cylindrical, apex whitish and fringed with hairs; 3rd and 4th very small, coalesced; 5th to 7th moniliform; 8th to 17th stalked, straight on the sides; 18th elongate; 5th to 18th covered with fine short hairs, and a few long ones. Clypeus large, convex, divided by a suture, apex lobed. Labrum large, convex, widest across the middle, sloping to the blunt apex. Prothorax saddle-shaped, not as wide as head, wider than long, truncate in front, rounded on the sides and hind margin, front margin bent up in the middle and crossed by a suture; behind the suture, the summit is concave. Scapular shield showing the base of five nervures; cross-suture transverse. Abdomen nearly cylindrical, bluntly rounded at the end. Cerci very small. Abdomen and thorax covered with short hairs. Legs long, stout, hairy; tibial spines strong; claws long and slender. [Wings damaged].

The foregoing description refers to a single damaged specimen taken in an underground passage (11/1/14) in which were found numerous soldiers and workers. A portion of two wings only remained. Considering the proximity of these insects to the writer's house, the fact that lights were burning nightly only a few yards distant, and that occupied passages were examined frequently throughout the wet season, it is remarkable that numbers of winged insects were not secured.

Termes rubriceps is not known to build termitaria, although the insects are frequently taken in the walls of termitaria built by *Coptotermes acinaciformis*, at the base of termitaria built by *Eutermes triodiæ*, and in abandoned nests of doubtful identity. In such situations, the colonies are small, and consist of workers and soldiers, which live upon the food stored by their hosts or upon rejectamenta.

Their real homes are in rambling, underground galleries and chambers, situated on well-drained, pebbly or stony country. They are largely grass-feeders, and, as such, can hardly be regarded as pests. Small grassless or thinly grassed patches are generally characteristic of the land tunnelled by these termites. One may see, in such places, hundreds of workers and soldiers streaming out of small openings, measuring about 6 mm. by 3 mm., and dividing into parties or scattering. In a few minutes, the workers begin to return, each with a short piece of grass (green or dry), a grass-seed, a piece of Eucalypt-leaf or other vegetable matter; and, before long, there is a constant stream backward and forward. In this work, the soldiers direct operations, and defend the workers from predaceous ants. When sufficient food has been collected, or when disturbed, all return, and the openings, from which they came, are quickly sealed up with saliva-moistened earth. As a rule, operations are carried on simultaneously from several openings, sometimes as many as twelve, over an area of 20 to 30 feet or more. Some of the openings are provided with projecting lips, but, as a rule, they are flush with the ground, faced with cemented particles of earth, and sealed just below the level of the ground.

Although generally nocturnal in their habits, they are very often found gathering their food in the full glare of sunlight. Stores are collected at frequent intervals throughout the year.

Just below the surface, and opening off the tunnel used as an exit, there is an elongate, oval chamber which, like similar ones deeper down, will be found, after harvesting operations, to be full of short lengths of grass, etc. The lower chambers are generally larger than those near the surface, but all are very irregular in size and shape, varying, in the lower ones, from 6 to 10 mm., from floor to roof, and from 30 to 60 mm. across. The passages connecting them are greatly constricted for a short distance, and neither the passages nor the chambers are coated with alimentary rejectamenta, such as is to be found in the tunnels of *Mastotermes*. Certain chambers, either near the surface or deeper down, are used for the reception of waste-products, and such portions of the dead as are not used for food. Most of the chambers are from 1½ to 6 inches below the surface, rarely are they deeper than 12 inches. There appears to be no regular "nursery." The eggs are carried by the workers to any of the large flat chambers, and there deposited in little heaps. Larvæ and nymphs are found in all the passages and galleries.

The eggs are yellowish-white, semitransparent, convex on one side, concave on the other, and bluntly rounded at the ends. They measure 0·03 in length by 0·01 mm. in width, and have been taken in December, January, and February.

Loc.—Darwin, Stapleton, Brock's Creek, N.T.

TERMES TURNERI, Froggatt.

Froggatt, *op. cit.*, 1897, p.736.

This would appear to be an uncommon species in the northern portion of the Territory, since only two small communities have come under the writer's notice.

The first was taken at Stapleton (31/12/12) in a few small galleries in the basal portion of the wall of a termitarium of *Coptotermes acinaciformis*, and comprised a few soldiers, workers, and winged forms. The queen was probably destroyed or lost in the fall of earth. The second community was taken a few days later, in the same locality, in portion of a deserted termitarium of *Termes* sp., near *ferox*. In both cases, the winged forms greatly outnumbered the workers and soldiers.

Coptotermes acinaciformis Froggatt. (Plates xiv.-xviii.)

Termes acinaciformis Froggatt, *op. cit.*, 1897, p.740.

This is, probably, the commonest species in the northern part of the Territory, where they are responsible for most of the damage to growing forest-trees. Hollow Ironwood-trees (*Pithecolobium moniliferum*) and Eucalypts are almost invariably infested with them, but they are rarely found in fence-posts or in buildings constructed of indigenous or imported timbers.

The large, dome-shaped termitaria (Plate xiv.), typical of the species, are usually found on well-drained, open forest country at the base of a tree, or enveloping a stump (Plate xv.). They are rarely found on wet lands or on hill-sides. Few attain a height of more than four or five feet, but occasionally one sees a straight column, six to eight feet high, surmounting one of these dome-shaped mounds. These columns are formed as the tree-trunks are gradually converted into food, and finally replaced by a column of earth and triturated wood. In most cases, trees appear to be attacked from below ground, and hollowed out to a considerable height before any external evidence of the presence of termites can be detected. Sometimes destruction is not carried beyond this stage, and excellent fencing timber is obtained from such trees, especially from *Eucalyptus miniata*, a timber that possesses considerable termite-resisting properties when used for fences, stock-yards, etc. More often, however, destruction continues, and the characteristic termitaria are built, and gradually extended, until the weakened trunk is blown over or consumed. Isolated mounds are common, and, if opened, will be found to contain, as a rule, some portion of a tree or stump (Plate xvi.). What occurs, when this portion is consumed, is not known, but there is evidence, in the shrivelled condition of the queens' abdomina, in the small number of soldiers and workers often observed, and in the number of abandoned and ruined termitaria, to suggest that the community dies out gradually as the food-supply diminishes.

The walls of the termitaria are constructed of fine particles of earth and sand, gathered on the surface of the ground, and firmly cemented together into an intensely hard mass. The foundations rest upon the surface, and are often used as the homes of other termites (*T. rubriceps*, *T. Turneri*, and *Eutermes* spp.), and of true ants (*Opisthopsis respiciens*, *Camponotus Novæ-Hollandiæ*, and *Iridomyrmex detectus*). The thickness of the walls varies, even in the same termitarium, from two inches near the summit, to twelve inches near the ground, or on the sides. A few irregular, winding passages traverse the walls, and, in them, may be found a few soldiers and workers. The interior is composed of triturated wood moulded into curious forms. The upper portion is open and easily broken, but lower down it is more solid, lumpy, and folded. Near the ground, towards the middle of the nest, this papiermaché-like material is in thin layers, forming more or less horizontal chambers. This is the "nursery." It contains the queen, eggs, larvæ, nymphæ, and a few soldiers and workers. The queen is generally found about three inches from the ground, and about the middle of the nest, in a low domed cell with more or less level floor, from which she cannot escape. The eggs are removed by the workers, as soon as they are laid, to surrounding cells, and the young are reared still further from the queen.

The interior is generally separated from the walls by a space varying from ¼ inch to 3 inches, and is connected, in certain parts, by threads or a network of finely drawn out composition. In termitaria having no portion of a stump or tree within their walls, the woody interior rests upon a concave surface of earthy material, pierced by a few small passages. The lower portion of the interior is fairly dry, but the summit is moist and viscous.

In the Stapleton district, where the predominant termitaria are those of *Eutermes triodiæ*, there are many abandoned mounds, apparently of that species, on the heavy grey-soil flats at the foot of the hills. In breaking these down, one occasionally finds large nests of *Coptotermes acinaciformis* built within them, and resting on a foundation of solid earthy material, twenty to thirty inches thick, penetrated by a few passages into the surrounding soil (Plates xvii.-xviii.).

The occurrence of a male in the queen's cell is very rare indeed. Complementary queens have not been found by the writer, but it is probable that they are used, since several termitaria, from which queens were removed, were immediately repaired, and have since been increased to their original size.

A fully-developed gravid queen measures about 18 mm. in length, by 6 mm. in width at the widest part of the abdomen.

Winged swarms leave the termitaria in December and January, but a few winged insects may be found in them months later.

When disturbed, the soldiers eject a small quantity of milky secretion from a circular opening above the jaws, a habit that at once distinguishes them from other local species.

This species is not infrequently met with in company with *Rhinotermes reticulatus*, but, unlike Rhinotermes, they are rarely found in buildings, and never (to the writer's knowledge) in cultivated plants.

Loc. - Darwin, Stapleton, Melville Island, Bathurst Island.

COPRITERMES MELVILLENSIS, sp.nov.

Winged form not known.

Soldier.—Head yellow, thorax, antennæ, and legs paler, the apex of each antennal segment banded with white; jaws dark castaneous; rest of insect whitish. Length, $3\frac{1}{2}$ mm. exclusive of jaws; jaws $1\frac{1}{4}$ mm. Head long, slender, cylindrical, bluntly rounded behind, straight on the sides to near the truncate front. Forehead produced into a cone-shaped projection, which is directed slightly upwards, and extends as far forward as the apex of the labrum, bearing a wart-like protuberance on either side between the base and the antennal cleft. Clypeus small, rounded in front. Labrum long, nearly straight on the sides, truncate at the apex, with either side produced into a slender point, anterior half with a patch of ochreous and scattered hairs, the rest white. Antennæ long, stout, hairy, 14-jointed, springing from a circular protuberance situated within a deep angular depression in front of the head; 1st joint long, stout, cylindrical; 2nd one-half the diameter and length; 3rd and 4th smallest, moniliform; 5th to 13th increasing in length, turbinate; 14th elongate. Jaws very long, longer than head, similar to *Copritermes Froggatti*, and *C. Taylori*. Prothorax small, not as wide as head, divided across the middle by a deep depression, the apical half rounded in front, and turned up like a collar, the sides curving round to the hind margin, which is slightly indented. Abdomen elongate-oval, round in section; cerci large, hairy, pale ferruginous in colour, and conspicuous against the whitish body. Claws and tibial spines stout.

Worker.—Head pale yellow; thorax, legs, and antennæ lighter; the rest of the insect whitish. Length, $3\frac{1}{3}$ mm. Head large, round. Clypeus large, convex, lobed, a dark spot at each end. Labrum large, widest in the middle, contracted towards the truncate apex. Prothorax narrow, divided by a deep depression, apical half rounded, and turned up like a collar, hind margin rounded. Abdomen elongate-oval. Legs stout; claws and spines small; cerci large.

The type and cotype specimens were taken from a small termitarium composed of a blackish-coloured composition of triturated wood and earth, built against the trunk of a living Eucalypt-tree.

In common with allied species, both the soldiers and workers are timid, and make no effort to defend themselves when disturbed. The soldiers produce a sharp, snapping sound with the jaws, which are normally carried horizontally, and meet only at the tips. In dead specimens, the jaws are almost invariably depressed, and crossed at the base.

Excepting in the paler colour of the head (soldier), this species does not differ from a mainland-form taken in company with a smaller termite (*T. nana*) in a blackish-coloured mass of triturated wood and earth, within a cluster of bamboos growing in the Botanic Gardens, Darwin.

Hab.—Fort Dundas, Melville Island, Northern Territory (G. F. Hill, 12/4/14). Type (No.115) in the Entomologist's Office, Department of Agriculture, N.T.

COPRITERMES TAYLORI, sp.nov.

Winged form not known.

Neoteinic queen.—Head, thorax, and chitinous plates of abdomen light yellow; legs and antennæ paler; rest of body creamy-white. Length, 5 mm. Head rounded behind; forehead concave; eyes circular, projecting from the sides of the head, finely faceted; ocelli round, in line with the front margin of the eyes; clypeus large, convex, arcuate behind, rounded on the side, divided longitudinally by a suture which extends across the concave forehead, front margin rounded, depressed, divided from the posterior portion by a deep lateral suture. Labrum large, projecting beyond the jaws, broadest behind, narrowing to the bluntly pointed apex. Antennæ hairy, 15-jointed, short, slender, springing from a circular cleft in front of the eyes; 1st joint long, slightly turbinate; 2nd one-half the length of first, cylindrical; 3rd very small; 4th to 10th larger, coalesced; 11th, 12th, 13th increasing in size; 14th longer, nearly cylindrical; 15th elongate-oval, slightly stalked, longer than 14th. Prothorax long, narrower than head, saddle-shaped, truncate and rigid in front, sides and hind margin rounded; wing-pads rudimentary. Tarsi slender, claws small. Cerci small, cone-shaped. Entire head, thorax, abdomen, and legs covered with fine pale hairs.

Male (king).—General colour dark brown above; head castaneous; antennæ dark brown, with the base and apex of each segment whitish; legs and chitinous plates of ventral surface light brown. Length, $3\frac{1}{2}$ mm. Head rounded behind, flattened on the summit, sloping down to the prominent clypeus, with a curious keyhole-like whitish mark in the depressed centre in line with the middle of the eyes. Eyes large, prominent, projecting well beyond the genæ. Ocelli large, reniform, adjacent to the inner margin of the eyes. Antennæ hairy, 15-jointed, springing from circular clefts in front of the eyes; 1st joint long, stout, cylindrical; 2nd one-half as long; 3rd very small; 4th-10th moniliform; 11th-14th increasing in length; 13th and 14th nearly cylindrical; 15th largest, elongate-oval. Clypeus paler than head, large, convex, arcuate behind, rounded on the sides; apex whitish, rounded in front, divided from the basal two-thirds by a deep transverse suture. Labrum large, covering the jaws, narrow at the base, swelling out at the sides beyond the middle, and contracting again to the rounded apex. Prothorax long, rugose, narrower than head, truncate and slightly bent in front;

sides and posterior margin rounded. Scapular shield angular; cross-suture transverse. Thighs stout, flattened; tibia slender; apical spines and claws large. Cerci small, cone-shaped.

Soldier.—Head pale yellow, antennæ with the base and apex of each segment white-banded; jaws dark castaneous; rest of insect dull white. Length, $2\frac{2}{3}$ mm., exclusive of jaws; jaws 1 mm. Head long, slender, cylindrical, rounded behind, sides straight to near the antennal clefts, truncate in front, with the forehead produced into a long cone-shaped projection directed slightly upwards, and extending as far forward as the apex of the labrum. Clypeus small, rounded in front, whitish in colour. Labrum long, very slightly contracted towards the apex, which is produced into a sharp point at either side and bears a few long hairs. Antennæ long, slender, hairy, 14-jointed, springing from circular clefts within angular depressions on the side of the head; 1st joint long, stout, nearly cylindrical; 2nd one-half the length of the 1st, slender; 3rd and 4th small, moniliform; 5th 13th increasing in length, slightly turbinate; 14th longer than 13th, elongate-oval. Jaws very long, longer than head, curved, slender, springing from the centre of the head, curved downwards to near the tips, which are straighter and flattened on one side. At the base of the left jaw, there is a large blunt fang opposed to a bluntened projection on the right. Prothorax small, not as wide as head, the apical half rounded in front, and turned up nearly at right angles, the sides sloping back to the hind margin, which is slightly indented in the middle. Abdomen elongate-oval, rounded in section. Femora flattened. Tibia long, slender, with small apical spines and large claws. Cerci small, hairy.

Worker.—Head and antennæ paler than soldier, with ferruginous spots on either end of the clypeus. Head large, rounded, more hairy than that of the soldier. Clypeus large, convex, rounded behind, lobed. Labrum large, rounded in front. Antennæ 14-jointed, hairy, 3rd and 4th joints smallest. Legs stout; tibial spines small; claws large. Cerci small, hairy. The posterior opening always appears to be distended, as in the soldiers. Length, 3 mm.

Eggs.—Pale yellow, curved, bluntly rounded at the ends, $\frac{1}{2}$ mm. in length.

This species appears to be a rare one, only one community having come under the writer's notice up to the present time. This colony consisted of a gravid neoteinic queen, king, two complementary queens, about 15 soldiers, about 100 workers, numerous nymphæ and eggs. The nest was a rounded mass, about 3 inches in diameter, composed of triturated wood and earth, situated just below the surface of the ground at the base of a fencepost-strutt. The royal pair were found in a small gallery, not differentiated from other galleries, with a few soldiers and workers. The eggs were stored in similar galleries close by. One of the complementary queens occupied a small passage about one inch distant, and by her were numerous eggs, and a few soldiers and workers. The species is of little economic importance.

I have pleasure in naming the species after Mr. Frank H. Taylor, Entomologist to the Australian Institute of Tropical Medicine, Queensland.

Hab.—Koolpinyah, near Darwin, Northern Territory (G. F. Hill, 21/11/13). Types(No.89) in Entomologist's Office, Department of Agriculture, N.T.

COPRITERMES FROGGATTI, sp.nov.

Winged form not known.

Queen.—Head and marking on scapular shield ferruginous; clypeus, antennæ, thorax, legs, and chitinous plates of abdomen paler; rest of body whitish. Length, 10 mm. Head hairy like prothorax, rounded behind, flattened on summit, a keyhole-like mark in the centre, in line with the centre of the eyes. Eyes large, projecting well beyond the sides of the head; ocelli large, reniform. Antennæ hairy, base and apex of each segment white, 13-jointed, springing from a circular cleft in front of the eyes; 1st joint long and fairly stout; 2nd much shorter; 3rd smallest, circular; 4th and 5th moniliform; 6th-12th increasing in length, slightly turbinate; 13th same length as 12th. Clypeus large, arcuate behind, divided in the middle line by an indistinct suture, apex depressed, divided from the basal three-fourths by a deep cross-suture, sides sloping to the truncate front margin.

Labrum large, convex, broad at the base, spade-shaped at the apex, not reaching the tip of the stout jaws. Prothorax saddle-shaped, truncate and slightly raised in front, rounded behind, divided in the middle line by a narrow suture; on the summit, an irregular raised area one-half the width of the prothorax, with depressed centre. Scapular shield hairy, showing the base of four main nervures very distinctly; cross-suture nearly transverse. Abdomen long, cylindrical, bluntly rounded at the end; chitinous plates hairy; cerci indistinct.

Soldier.—Head dark ochreous; antennæ ochreous, with the base and apex of each segment white; jaws dark castaneous; rest of insect whitish. Length, $3\frac{1}{4}$ mm., exclusive of jaws; jaws 1 mm. Head a little longer than broad, bluntly rounded behind, sides straight to the base of a sharp projection from an irregular, roughened protuberance below the antennal cleft, truncate in front, with the forehead produced into a long, hairy, cone-shaped projection bearing a smaller projection on either side at the base, directed slightly upwards, and extending as far forward as the apex of the labrum. Clypeus indistinct. Labrum long, with the nearly straight sides produced into a point at either side, the front margin between the points slightly convex, scattered reddish hairs on the upper anterior portion. [In one of the co-types the labrum is slightly contracted on the sides, and truncate in front.] Antennæ hairy, 14-jointed, springing from slightly raised tubercles in front of the head, and below the two smaller projections of the forehead; first joint long, stout, nearly cylindrical; 2nd less than one-half the length, slender; 3rd and 4th smallest; 5th-13th long, slightly turbinate; 14th longer than than 13th, elongate-oval. Jaws very long, longer than head, slender, curved, springing from the centre of the head, tips flattened on one side and sharply curved downwards, with a large blunt fang at the base of the left jaw, opposed to an irregular bluntened projection on the right. Prothorax small, about one-half the width of the head, divided in the middle line by an indistinct suture, the middle of the apical half turned up nearly at right angles like a collar, front margin rounded, notched in the middle, hind margin rounded. Abdomen elongate-oval, round in section; cerci small; claws strong; tibial spines larger than in *H. Taylori*.

Worker.—Head pale yellow; thorax and antennæ lighter; rest of insect whitish. Length, 3¼ mm. Head small, rounded behind and on the sides, with an obscure keyhole-like mark in the centre of the slightly flattened forehead. Clypeus large, convex, rounded, divided in the middle line by an obscure suture, front margin truncate, apex divided from hind portion by a deep suture, a brown spot at either end of the clypeus in line with the antennal clefts. Labrum large, hairy, not covering jaws, broad at the base, sloping in to the truncate apex. Antennæ short, 14-jointed, arising from small protuberances; 1st joint long, slender; 2nd one-half the length; 3rd and 4th small, coalesced; 5th larger; 6th to 13th moniliform; 14th long. Prothorax small, hairy, rounded behind, apical half turned up nearly at right angles Legs small, slender. Abdomen elongate-oval; cerci very small.

This appears to be a rare species, only one small colony having been taken. The queen, with three soldiers and about fifty workers and nymphæ, were taken at ground-level in an abandoned termitarium of *Eutermes hastilis*. It is a very distinct species, easily distinguished from others of this group.

I have much pleasure in dedicating this species to Mr. W. W. Froggatt, Government Entomologist of New South Wales, who has kindly identified many termites for me, and whose works on the Termitidæ I have freely consulted.

Hab.—Thirty-four miles east of Darwin, Northern Territory (G. F. Hill, 14/1/13). Types (No.34) in Entomologist's Office, Department of Agriculture, N.T.

EUTERMES PASTINATOR, sp.nov. (Plates xix.)

Winged form.—Head nearly black, antennæ, clypeus, labrum, palpi, legs, and underparts dull ochreous; thorax, chitinous plates of dorsum of abdomen, and a spot at either end of plates 2-6 of ventral surface, dark brown. Length, to tip of wings, 20·5 mm.; to tip of body, 10 mm. Head very hairy, round behind, a narrow cleft in the depressed centre of the flattened summit, arcuate behind the clypeus; eyes large, round, projecting; ocelli large, oval. Antennæ 16-jointed, hairy, springing from a circular cleft in front of the eyes; 1st joint long, stout, cylindrical; 2nd and 3rd smaller, slightly turbinate, with few hairs; 4th short, hairy; 5th to 15th longer, turbinate, becoming more slender and stalked towards the tip; 16th slender, elongate-oval. Clypeus large, broad, convex, with an indistinct median suture, lobed in front. Labrum narrow at the base, swelling out on the sides, rounded in front. Palpi stout, hairy. Jaws large, stout; right mandible with two, sharp, angular, stout teeth at apex, followed by a much shorter and blunter one, and a large serrated basal tooth; left mandible with two, sharp apical teeth, the hindermost connected with a third and smaller pointed one by a long cutting edge; at the base of the mandible there is a large, irregular, blunt tooth opposed to the serrated tooth on the right. Prothorax hairy, wider than long, narrower than head, with median suture, straight along the front margin, rounded on the sides and hind margin, front margin slightly bent up in the centre. Scapular shields hairy, rugose; cross-suture transverse. Wings large (forewing $15\frac{1}{3}$ mm. long, by $4\frac{1}{2}$ mm. in width; hindwing $14\frac{2}{3}$ mm. long, by $4\frac{1}{2}$ mm. in width), rounded at the tips, base of the costal and below subcostal nervures yellow, rest of wings smoky. Forewing, costal and subcostal nervures stout, running close together and nearly parallel to the tip of the wing; median nervure running through upper half of the wing for two-thirds of its length, with three simple nervelets, the first two of which are long and slender; submedian nervure slender, parallel to the median to a little beyond the first branch in the latter, then curving downwards to the hind margin, with eleven simple, oblique nervures, the first five of which are very stout. Hindwing similar to forewing, excepting that there is usually one less oblique nervure from the submedian. Legs strong, hairy; claws and tibial spines long and slender. Abdomen large, elongate-oval, bluntly rounded at the tip, covered with fine hairs; cerci short, cone-shaped, hairy.

Queen.—General colour creamy-white; chitinous plates dark brown, fringed on the hind margin with fine hairs; connecting membrane glabrous. Total length, 25 mm.; diameter of abdomen, 8 mm.

Soldier.—Head rusty-brown, base of snout darker, back of head distinctly lighter, rest of insect ochreous-yellow. Length, 3⅓ mm. Head round behind, tapered to the base of the snout, a cluster of fine hairs and bristles on tip of snout; scattered, long, slender, reddish bristles on rest of head. Palpi long, slender, very hairy, reaching tip of snout. Antennæ 14-jointed, very long and slender, the base of segments 2-6 whitish; 1st segment long, moderately stout, nearly cylindrical, without hairs; 2nd and 3rd less than one-half the length, slender; 4th to 10th increasing in length, slightly swollen towards the apex; 11th to 14th decreasing in length. Prothorax small, not as wide as head, much wider than long, rounded in front and behind, anterior half bent up in the middle, and fringed with a few long hairs. Hind margin of pro-, meso-, and metathorax fringed similarly. Legs very long; femora cylindrical, sharply contracted at the base, with a few fine hairs; tibia long, hairy; spines small; claws long and slender. Abdomen small, covered with scattered hairs; cerci long, slender, with a few long hairs at apex.

Worker.—Head pale ferruginous above; clypeus, thorax, and legs very pale ochreous; rest of insect whitish. Length, 5½ mm. Head rounded behind, broadest across the middle, arcuate behind the clypeus, a pale median suture joining another which crosses the head well behind the clypeus, a dark ferruginous spot at either end of the clypeus. Clypeus large, convex, divided by a median suture, lobed in front, apex bluntly pointed. Labrum large, narrowest at the base, swelling out on the sides, rounded in front. Jaws short, not as stout as, but otherwise similar to, those of winged forms. Antennæ 16-jointed. Legs moderately short and stout; tibial spines small; claws moderately long and slender. Abdomen large, covered with fine scattered hairs; cerci large, hairy.

The termitaria of *E. pastinator* are enveloped in an intensely hard exterior wall, composed of fine particles of earth, sand, and short lengths of grass firmly cemented together. Few exceed 2 ft. in height, by 2 ft. 9 in. in diameter at the base, the average being about 1 ft. 6 in. in height, by about 2 ft. in diameter. In shape, they are flattened domes, with or without irregular projections of the sides and summit, but all are sufficiently alike to distinguish them from the nests of other local species (Plate xix.).

The interior is composed of similar material, and is not separable from the walls. A labyrinth of passages traverses it in all directions, those near the base being larger and more flattened than the others. There is no well-defined "nursery," and the position of the queen-cell varies greatly in individual nests. Sometimes it is situated near the side, and about one inch below the level of the surrounding surface-soil; at others, it is well down below ground-level, and beneath the middle of the superstructure. The cell measures about 3 inches in diameter, by $\frac{1}{2}$ inch in height; with irregular floor, and the sides pierced by three or four holes large enough to admit the soldiers and workers.

The exterior walls rest upon the natural surface of the soil, and are largely, if not entirely, constructed of material mined from below, with a small admixture of short lengths of grass to bind the particles. Below the superstructure, there is an area, roughly corresponding to the size of the dome, which is traversed by innumerable passages. These passages contain a quantity of grass cut into lengths of about $\frac{1}{3}$ of an inch, but the greater part of the underground space is occupied by the young and adults. The main store of grass, upon which they live, is stored in the superstructure. Foraging tunnels pass out beneath the walls into the surrounding soil, and, from them, the workers and soldiers reach the surface to gather food.

The termitaria are found on high, well-drained situations, either on light gravelly loam, or on stony hill-sides. In the latter situations, the underground portions of the nests are restricted or rambling, as a matter of course, according to the nature and quantity of stone underlying the superstructure. Accretions to the outer walls (Pl. xix., fig.7) are made during the dry season. In two nests kept under close observation at Koolpinyah, in May, this work was carried on during alternate nights, between the hours of 8 p.m. and 8 a.m. Supplementary queens are unknown.

Termitophilous insects, other than *Mastotermes darwiniensis*, have not been recorded from these nests, nor are the latter invaded by predaceous ants.

Hab.—Thirty-four-mile Siding, Northern Territory Railway (G. F. Hill, 14/11/13); Darwin, Koolpinyah, Stapleton. Types (No.28) in Entomologist's Office, Department of Agriculture, N.T.

EUTERMES LONGIPENNIS, nov.sp.

Winged form.—Upper surface of head castaneous; mouth-parts ochreous; antennæ dark ochreous, the apex of each segment paler; thorax and scapular shields ferruginous; dorsal plates of abdomen dark brown, ventral plates with a light brown spot at each end; the rest of insect ochreous. Length, to tip of wings, 20 mm.; to tip of body, 10 mm. Head very hairy, rounded behind, broadest across the eyes, sloping in to the base of the clypeus, flattened on the summit, and divided by an obscure median suture, which merges into a forked cleft in line with the centre of the eyes; eyes moderately large, projecting, finely faceted; ocelli oval, adjacent to the inner margin of the eyes. Antennæ 16-jointed, stout, hairy, springing from a circular cleft in front of the eyes; 1st joint long, slightly turbinate; 2nd less than one-half the length, and slightly swollen at the apex; 3rd about the same length as the 2nd, stalked; 4th very short, more rounded; 5th-7th larger, rounded; 8th-15th elongate, stalked, swollen towards the apex; 16th shorter, elongate-oval. Clypeus moderately large, hairy, slightly arcuate behind, lobed in front, apex paler in colour, and bluntly pointed. Labrum narrow at the base, swelling out on the sides, rounded in front, covering the tips of the jaws. Jaws large, right mandible with two, sharp, stout, angular teeth at the apex, followed by a much shorter and blunted one, and a large, serrated basal tooth; left mandible with two, sharp, apical teeth, the hindermost connected with a third and smaller one by a long cutting edge; at the base of the jaw, a large, irregular, blunt tooth opposed to the serrated tooth on the right. Prothorax hairy, broad, not as wide as head, middle of front margin bent-up, sides sloping round to the hind margin, which is nearly straight, a deep depression behind the bent-up front margin on either side of the median line. Scapular shields hairy, small; cross-suture transverse. Wings very large (forewing 27 mm. in length, by 4½ mm. in width; hindwing 16¼ mm. in length, by 5 mm. in width), below the base of the costal and the entire length of the subcostal nervures deep yellow, giving the front margin of the wing a conspicuous tinge of colour; oblique nervures dark brown, the rest of wing dull ochreous. Forewing: costal and subcostal nervures stout, running nearly parallel to the apex; median nervure running through the upper half of the wing, slender, number and position of nervelets very variable, and rarely alike in the same pair of wings; submedian nervure slender, running through the middle of the wing for about one-half its length, number of oblique nervures variable (9 to 12), most or all of which are very stout, simple or bifurcated, rarely alike in the same pair of wings. Hindwing: costal and subcostal nervures similar to forewing, median nervure stouter than in forewing, with several short, oblique nervelets running towards the subcostal, the number, form, and position of the main branches very variable, and usually differing in the same pair of wings; submedian nervure as stout as median, oblique nervures very stout and variable as to number and form, and often differing greatly in the same pair of wings. Legs strong, hairy, inner margin of tibiæ fringed with numerous bristles; tibial spines and claws long. Abdomen nearly cylindrical, broadly rounded at the tip, covered with fine golden pubescence; cerci short, hairy.

Soldier.—Head reddish-brown; thorax and antennæ brownish-yellow, base and apex of each antennal segment, from the second to seventh, white-banded; legs and rest of insect stramineous. Length, 3½ mm. Head large, rounded behind and on the sides, sloping abruptly to the base of the snout (head wider, and more rounded than in *E. pastinator*), a few fine hairs on tip of the snout, and long, scattered bristles on the rest of the head. Antennæ 14-jointed, moderately long; 1st joint moderately long, stout, nearly cylindrical, with a few hairs; 2nd less than one-half the length and width, nearly cylindrical, with a few short hairs; 3rd shorter than 2nd, more hirsute; 4th to 6th about the same length as 2nd, hairy, swollen towards the apices; 7th-13th longer, hairy, stalked; 14th shorter, elongate-oval. Prothorax small, not as wide as head, much wider than long, rounded in front and behind, anterior half bent-up in the middle, and fringed with a few, long, reddish hairs; hind margin of pro-, meso-, and metathorax similarly fringed. Abdomen small, covered with stout, red hairs; cerci long, slender, hairy. Legs short, moderately stout, with a few hairs; tibial spines small; claws very small.

Worker.—Head brown above; rest of head and thorax pale ochreous; legs much paler; abdomen whitish. Length, 4 mm. Head slightly longer than wide, rounded behind, arcuate behind the clypeus, a pale median suture dividing the head, and joining another irregular one, which crosses the forehead well behind the clypeus. Clypeus very large, broadly lobed, divided by a median suture, a dark spot at either end, posterior lobe convex, anterior lobe whitish, with a yellow mark on either side of the middle, front margin slightly arcuate. Labrum large, convex, narrow at the base, spreading out in the middle, rounded in front. Jaws short, not as stout as in the winged form, but otherwise similar. Antennæ 15-jointed. Abdomen large; cerci slender, with a few hairs. Legs short, stout, with scattered reddish hairs; tibial spines small; claws long.

Further research will probably prove this to be a fairly common species in the locality from which the types and cotypes were taken. Termitaria similar to those described below were not infrequently noticed, but they were taken to be those of an undetermined species of *Eutermes*. That there were two species in the same locality, building outwardly similar termitaria, was not discovered until recently.

The termitarium from which the types were taken, measured 24 inches in height, by 16 inches in diameter at the base, with sides tapered evenly to the bluntly pointed apex. The walls were built of the same material as the interior, *i.e.*, a composition of triturated wood and fine particles of earth, and were not separable from the inner portion. The outer part of the mass was dense and nearly solid, but, towards the centre, it was traversed by many passages and flattened galleries (the latter mostly near the base, and evidently forming the "nursery"). The base rested partly on the sandy surface of the soil, and partly on a dead stump (*Eugenia*), now eaten away to the ground-level. The nest contained a great number of matured winged forms and many soldiers, but few workers and eggs. Unfortunately, owing to the lateness of the hour, and the fact that the species was not recognised as being distinct from others previously investigated, no special effort was made to secure the queen. A second and similar termitarium was found over the remnant of a Eucalypt-tree (at Koolpinyah, 30/5/13). In this case, the interior contained a quantity of larval excrement of the Cetonid beetle, *Hemipharis insularis*, the pellets being either loose or cemented together in masses in the lower galleries. Numerous *Hemipharis* larvæ and pupæ were found near the remaining underground portion of the stump.

Hab.—Koolpinyah, Northern Territory (G. F. Hill, 21/11/13). Types (No.87) in Entomologist's Office, Department of Agriculture, N.T.

EUTERMES TRIODIÆ Froggatt. (Plates xx.-xxiii.)

Froggatt, *op. cit.*, 1897, p.745.

Travellers on the Darwin-Pine Creek Railway are familiar with the great termitaria of the Spinifex Termite, and many writers have referred to them in past years.

The mounds, or termitaria, are found on almost all kinds of soils, and in various situations, but rarely, in the Territory at any rate, on black peaty soils or on rocky hill-sides. They are commonly found on sour, stiff, grey soil or sandy flats, on timbered or treeless land, on dry gravelly or scrubby country, and in the little gullies amongst the low sandstone ridges (Plates xx.-xxiii.).

The starting-point of a termitarium is invariably a tussock of coarse grass, never a stump, tree, or log. They vary considerably in size, shape, and relative density, but all are constructed entirely of fine particles of earth and sand, cemented together with proctodæal and salivary products. The interior is a maze of irregular chambers and passages, which are, in most cases, tightly packed with short lengths of grass. In small, recently constructed mounds, the outer walls and interior partitions are very thin and easily broken, but, in the older and larger ones, only the recently-added buttresses are fragile. The interior and older buttresses are so strengthened, and the passages so cemented up, that it is difficult to make any impression upon them, even with a sharp pick. The writer has not made an investigation of the interior of these giant mounds, but many of the smaller ones, up to eight or nine feet in height, have been examined. In every case, the interior was not sheathed in an enveloping wall, such as exists in the termitaria of *Coptotermes*, but the structure and composition was similar throughout.

The food consists of dry grass only, the principal stores of which are found towards the outer walls from the ground to the summit. Many of the galleries and passages, especially in the upper middle portion, are frequently entirely filled with earthy material and rejectamenta cemented into a solid mass. The queen-cell is situated in the middle, and about six inches from the ground Above and below the queen-cell, the structure is more open and laminated, and contains the eggs and larvæ. Adult males have not been found with the queens, nor have complementary queens been discovered.

The whole structure rests upon the natural surface of the ground, and a number of tunnels pass out under the walls into the surrounding soil. These tunnels are flattened (averaging about 5 mm., by 20-50 mm.) and lie obliquely to the surface, presumably to facilitate the carrying of comparatively long pieces of grass along them to the termitarium. When stores of grass are to be gathered, openings are cut through the intervening soil to the surface, and the soldiers and workers pour out in all directions. The tunnels lie a few inches under the surface, and extend outward from the mound for some considerable distance (44 feet in one instance). The food is gathered quickly by the workers, carried to the openings, and thence underground to the termitarium. The tunnels are kept in repair, and are occupied throughout the year. Harvesting is done in the dry season, and at night or early in the morning.

The soldiers are very numerous and pugnacious. If a portion of the mound is damaged, they quickly cluster about the breach to protect the workers while repairs are being effected. The mouth-parts are not adapted for biting, but, from the tip of the snout, they eject a clear, honey-like fluid, which appears to possess caustic properties, besides impeding the actions of attacking predaceous ants. This secretion does not appear on the snout as a drop, but leaves it in a fine jet, which has the appearance of a silken thread waving from the tip. In defence, the Eutermes are more formidable than any of the apparently better-armed Termes. Even powerful ants, such as *Odontomachus ruficeps*, are sometimes driven off by the little Eutermes.

There is no evidence to support the assertion that the termitaria are abandoned during the dry season. On the contrary, the dry season is a period of great activity, and it is the season when most, if not all, the food-supply is gathered. Moreover, it would be a physical impossibility for a gravid queen to leave a termitarium; and it is hardly conceivable that the workers and soldiers would abandon her and the thousands of eggs and young larvæ, upon which the welfare of the community depends, to seek shelter in the few tunnels outside the mound, even were these roomy enough to accommodate them.

It is also erroneously stated by popular writers and others, that these great structures are built of earth mined from below. Doubtless, the small quantity of earth removed in making foraging tunnels is used in constructing the termitaria, but when we consider how few and small these tunnels are, it is obvious that the quantity of building-material obtained from them must be very limited. With the exception of one species of *Eutermes*, which builds a very small mound, all the termites found in the Territory collect the great bulk of the earth and sand used in their termitaria, upon the surface.

RHINOTERMES RETICULATUS Froggatt.

Froggatt, *op. cit.*, 1896, p.540.

This a common and very destructive species often found in dead trees, fence-posts, stacks of timber, and in boxes, benches, jute and cotton goods, harness, etc., stored in outhouses.

As a rule, they work under cover of an enveloping crust of earthy material, and their detection is easy; but, sometimes, considerable damage is done before they make their appearance on exposed surfaces. Regular termitaria or mounds are rarely, if ever, constructed in the northern part of the Territory, nor are the young reared in trees, logs, etc., either on or above the surface of the ground. It is a rule that the workers and soldiers make their way in tunnels from distant underground nests, coming up under the box or log, as the case may be, covering it with a thin earthy crust, and rapidly reducing it to a mere shell. Occasionally, one finds large nymphæ with rudimentary wings, or, late in the wet season, fully developed winged insects in such positions, but the young larvæ, nymphs, and eggs are not found in these feeding-places. Although frequent attempts have been made to follow these tunnels back to the nests, the writer has never met with success, either owing to the fact that they were lost under buildings, or in ground where it was impossible to keep their course.

One termitarium, possibly proving the exception to the rule that *Rhinotermes* do not build mounds, was found at Batchelor. This was a black, cone-shaped mass of earth and triturated wood, 18 inches high, by 12 inches in diameter at the base, built at the side of a stump, which itself was enveloped in a crust of similar composition. Both the stump and the termitarium swarmed with termites, but the latter contained no queen or young. The structure resembled others in the vicinity, which were occupied by *Eutermes*, excepting that it differed somewhat in the amount of wood in its composition.

Winged swarms appear in Darwin about the beginning of March.

Lepisma sp., and the small Tenebrionid beetle, *Aphitobius piceus* Oll., are frequently associated with these termites.

The larvæ of a Tachinid fly destroy Rhinotermes under natural conditions, but they are too rare to constitute an effective natural control (two examples only have been taken by the writer). The parasites were taken in termite-galleries under a log, at Batchelor, on 10th July. Each was surrounded by about eighty dead termites, which they had sucked dry. In captivity, they destroyed, in two days, 25 and 28 Rhinotermes, then pupated after resting two days. One fly emerged on 26th; the other pupa failed to mature.

RHINOTERMES INTERMEDIUS Brauer.

Brauer, Reise Novara, Zool. Th., Neuroptera, p.49.

This species is not so common as *R. reticulatus* in the neighbourhood of Darwin.

Winged forms, soldiers (major and minor types), and workers were taken under a stack of wood in Darwin, on 29th November; and a month later, numbers of winged insects were taken at a lamp in the vicinity. The nest was situated, apparently, under the floor of an outhouse, up to which point a number of tunnels were traced.

The habits of the two species of this genus appear to be similar. Swarming takes place at night, when large numbers are attracted by lights, and find their way into houses.

The individuals of a swarm, after a short flight, settle on the ground, spread their wings, and move backwards until these are broken off at the cross-sutures. The males are generally the first to shed the wings, the females sometimes retaining one or more until after mating. Immediately the wings are dropped, the males follow the females until a crevice is found under a piece of wood, bark, or tussock of grass, where mating takes place. Couples placed in breeding-jars partly filled with loam, mated under chips of wood, then burrowed down into the soil, where they lived only five or six days.

Loc.—Darwin.

CALOTERMES IRREGULARIS Froggatt.

Froggatt, *op. cit.*, 1896, p.525.

This genus appears to be represented in the Territory by the above species only. It is a rare termite, only one colony having been found by the writer.

While investigating the cause of a gummy exudation from the fork of a small, unidentified, exotic tree in the Botanic Gardens, Darwin, on 22nd July, many larvæ of a large fruit-fly (*Dacus* sp.)

were found in the trunk, about three feet from the ground, crawling in a mass of comminuted wood saturated with gum and offensive-smelling fluid. On splitting the trunk downwards, the termites were found in irregular vertical passages through the green wood to a depth of about twelve inches from the fork. The passages were partly filled with comminuted wood, gum, and fluid, and were inhabited by the termites and fruit-fly larvæ. The extremities of the passages were drier, and were occupied chiefly by termites of the worker-caste. The individuals comprised about 100 soldiers, about 400 adult workers, one male (the king), a number of larvæ and nymphæ (measuring up to 4 mm. in length), and about 50 eggs. The queen was evidently shaken out, and lost in the long grass, which surrounded the trunk. The majority of these were secured as specimens, and the remainder, about 12 soldiers, 50 adult workers, and numerous nymphæ, were removed, with several fruit-fly larvæ, in portion of the stump to a breeding-jar.

The remaining portion of the stump was examined, and found to be intact for a height of 2 feet from the ground. There was no trace of an external coverway up the outer side, or a passage up the interior from the ground, such as are always found when trees are attacked by other species of termites known to the writer. In this case, the tree was attacked at the fork, about three feet from the ground, and hollowed out to within about one-eighth of an inch of the bark.

The fruit-fly larvæ pupated between 8th and 15th August, and the flies emerged between 1st and 9th September.

Up to 5th August, none of the nymphæ showed developing wing-pads, nor could any of them be differentiated as destined to become soldiers or complementary queens. On 1st September, three, young, complementary queens were found amongst the nymphæ, one of which was preserved, while the remaining two were kept alive for observation, On 22nd September, many of the nymphæ could be separated, by the development which had taken place in the meso- and metanota since 5th August, as destined to become winged-forms. The little colony was now well established, and should have provided a good deal of interesting data, had it not died out from want of attention during the writer's absence.

This species is too rare to be regarded as an economic pest of importance.

EXPLANATION OF PLATES XIV.-XXIII.

Plate xiv.

Fig.1.—Termitarium of *Coptotermes acinaciformis* Froggatt; Koolpinyah, N.T.

Plate xv.

Fig.2.—Termitarium of *C. acinaciformis*; Stapleton, N.T.

Plate xvi.

Fig.3.—Section of termitarium of *C. acinaciformis*; Batchelor, N.T.

Plate xvii.

Fig.4.—Termitarium of *C. acinaciformis* in termitarium of *Eutermes triodiæ*; Stapleton, N.T.

Plate xviii.

Fig.5.—Termitarium of *C. acinaciformis* in termitarium of *Eutermes triodiæ*; Stapleton, N.T.

Plate xix.

Fig.6.—Termitarium of *Eutermes pastinator*, showing recently added portion; Stapleton, N.T.

Fig.7.—Termitarium of *Eutermes pastinator*; recently added portion broken away, to show numerous holes in wall of older portion; Stapleton, N.T.

Plate xx.

Fig.8.—Typical termitaria of *Eutermes triodiæ*; 34-Mile Siding, N.T. Railway.

Plate xxi.

Fig.9.—Large termitarium of *Eutermes triodiæ*; 34-Mile Siding, N.T. Railway.

Plate xxii.

Fig.10.—An unusual form of termitarium of *Eutermes triodiæ*; 34-Mile Siding, N.T. Railway.

Plate xxiii.

Fig.11.—Termitarium of *Eutermes triodiæ*; Batchelor, N.T.

FEEDING-TRACKS OF *LIMAX MAXIMUS* LINN.

By Thomas Steel, F.L.S.

(Plate xxiv.)

In Proc. Linn. Soc. London, October, 1913, p.70, Mrs. Jane Longstaff, F.L.S., describes and figures the feeding-tracks of this slug. Some eighteen years ago, I noticed an individual of the same species feeding on the film of green conferva which had grown inside a white enamel bowl used for holding water for a dog. The tracks are very plainly shown by the removal of the green conferva from the white surface. There is no trace visible of the twin scratches at the apex of the individual tracks, seen by Mrs. Longstaff, and given in her illustration.

Mrs. Longstaff figures only a single row of the tracks, and does not give the scale; and as my specimen shows the sequence of a large number of rows, and also various irregular and return-tracks, it will be of interest. The illustration is from a photograph by my son, Mr. W. A. Steel, and is natural size.

I have deposited the specimen in the Australian Museum, Sydney.

EXPLANATION OF PLATE XXIV.

Feeding-tracks of *Limax maximns* Linn. (nat. size).

NOTES AND EXHIBITS.

Mr. Fred Turner exhibited, from his herbarium, a series of remarkably fine specimens, collected over a great part of New South Wales, comprising the typical species, var. *tenuior*, and the various forms of *Panicum flavidum* Retz., including one that Dr. Domin has recently described as a new species, under the name of *Panicum globoideum.* Bentham and Mueller, Flora Austr., Vol. vii., p.474, included this form under *P. flavidum*; Mr. F. M. Bailey, C.M.G., F.L.S., Government Botanist, Queensland, does not regard it as specifically distinct, and the exhibitor has long held the same opinion. Mr. Turner also showed his original figures (Plates xi. and xii.) of the typical *P. flavidum*, and its variety *tenuior*, which were published in the Government "Agricultural Gazette" (Vol. iv., Part 3, 1893). The form that Dr. Domin regards as a new species has the same robust habit as the typical *P. flavidum*, except when growing in damp situations, when it is a little taller, identically dilated leaf-sheaths and acute leaves, which are glabrous, glaucous, and striate, a short ciliate ligula, a panicle of several short, somewhat distinct branches, and a slightly dilated flexuous rhachis, sometimes ending in a distinctly aristate point. The distinctly but shortly pedicellate spikelets, to which Dr. Domin refers, are also a characteristic of very many of the specimens the exhibitor has examined of the typical *P. flavidum* growing in New South Wales (*vide* the dissectional drawings in Pl. xi. referred to). In some of the more robust forms, many of the spikelets are a little larger and more or less globose than those in the typical species, and have an additional nerve or two on each of the lower glumes, but there are the same number of glumes, and a single, large, broad palea in each spikelet. In order to avoid confusion in the identification of this grass in the future, it might be recorded as *P. flavidum* var. *globoideum.* Mr. Turner's first record of this grass in New South Wales was made in the Official Catalogue (p.441), Indian and Colonial Exhibition, London, 1886. It is also recorded in his botanical surveys of New England, The Darling, and South-West and North-West New South Wales.* As

* These Proceedings, 1903-4-5.

regards the economic value of all these forms, the description on p.31 of Turner's "Grasses of New South Wales," published by the Government of this State in 1890, of the typical species, is applicable to them all, and has since been amply verified by pastoralists and stockmen all over the State. Some graziers call these grasses "shot grass," and distinguish between the extreme forms as "small shot grass" and "big shot grass." It is worth putting on record that the plain-turkey is fond of the grain of these grasses.

Mr. Basset Hull exhibited a skin of the Yellow-webbed or Wilson's Storm Petrel (*Oceanites oceanicus exasperatus* Mathews), caught by Mr. E. I. Bickford, on board the s.s. Cooma, between Brisbane and Sydney on a recent voyage. This species was found breeding in Adelie Land by the Australian Antarctic Expedition.—Also a section of a stem of *Callicoma serratifolia*, from Manly, cut through by a wood-boring beetle.

Dr. E. W. Ferguson exhibited, by the permission of the Principal Microbiologist, a collection of foreign biting-flies recently received by the Department of Public Health, from the Imperial Bureau of Entomology, London. The species sent were chiefly African, but a few Asiatic species are included. The collection comprised *Simuliidæ* (3 spp.), *Tabanidæ* (67 spp.), *Muscidæ* (13 spp.), and *Hippoboscidæ* (3 spp.). Attention was drawn to particular species, such as *Glossina palpalis* and *G. morsitans*, which were of interest as proved transmitters of disease. The collection is now housed at the Microbiological Laboratory, Department of Public Health, and will be made available to workers for reference.

Dr. J. B. Cleland exhibited specimens of the rootlets of Eucalyptus, each several inches long, dependent from the roof of a tunnel, driven at a depth of 50 ft. from the surface, at Wellington Caves. Portion of the cave-area is at present being exploited for rock-phosphates. The rootlets in question, which were present in masses, had grown to the length shown since the tunnel had been cut two months before. The rootlets show many lateral branches, and probably represent the effort to replace roots destroyed in making the tunnel. White Box (*E. albens*) grew immediately above the tunnel. To this the rootlets probably belong, though a Kurrajong grew some further distance away. The depth to which the rootlets descended was probably due to their following clefts in the rock, which had been filled with débris, and in which the phosphatic masses had developed.

Mr. E. Cheel exhibited leaves of the common cultivated Grape-vine (*Vitis vinifera* L.) affected with a disease known as Erinosis, caused by mites (*Phytoptus vitis*) which pierce and suck the young cellular tissue and cause the so-called Erineum—hairlike developments of the epidermal cells. The specimens affected are from Canley Vale and Campbelltown. He showed also the following interesting series of Australian plants similarly affected with mites, probably of the same genus or possibly *Tetranychus* or some other closely allied mites. *Eucalyptus saligna* Sm ; Moona Plains; A. R. Crawford; December, 1904. *E.* sp.; Jellore Creek, viâ Mittagong; E. Cheel; April, 1912. *Dryandra nivea* R.Br.; S. Perth, W.A.; A. G. Hamilton, 1902: Midland Junction, W.A.; R. Helms; August, 1899: Swan Hill, Lowden, W.A.; Max Koch; December, 1910. *Dryandra obtusa* R.Br.; Hopetown, W.A.; J. H. Maiden; November, 1909. *Banksia* sp., probably *B. repens*; West Australia; J. Staer; March, 1911.

Mr. A. A. Hamilton showed, on behalf of Mr. J. H. Maiden, F.L.S., Government Botanist, tubers of *Mirabilis longiflora* L.; and flowering-specimens of *Eucalyptus torquata* Luehmann. Both plants are growing in the Botanic Gardens, Sydney. Mr. Hamilton showed also specimens of, and communicated notes on, various plants from the National Herbarium, comprising *Plantago lanceolata* L., showing basal prolification of the inflorescence. Examples collected by Mr. E. Cheel at Colo (January, 1912) exhibit, in the earlier stage, arrested growth of the primary spike, with resultant crowding of the flowers at its base. This condition becomes accentuated as the growth increases, and lateral spikes are seen to be in course of formation at the base of the primary one. In a series of specimens from Hornsby (Coll. W. F. Blakely) similar conditions obtain, but are carried a stage further, the formation of the lateral spikes at the base of the primary having, in some cases, been effected, Specimens exhibited by Mr. Ewen Mackinnon at the Meeting of this Society, in November, 1913, show several distinct basal spikes in addition to the primary one, which has become narrowed and elongated. A further series (Coll. W. M. Carne; Beecroft; November, 1914) exhibits the final stage, viz., multiplication of spikes. The primary spike is reduced in length, and is thickly studded with whorls of abbreviated spikes, in extreme cases almost to the apex.—*Rosa* Hort. var., showing frondiferous diaphysis. In an example communicated by Mr. T. Steel (Pennant Hills; January, 1915) the axis of the shoot is prolonged through the flower, the calyx-lobes have assumed the form and functions of ordinary pinnate leaves, and the reproductive organs remain undeveloped. In a second example (Coll. L. MacDonald; Mosman; December, 1914) only two of the calyx-lobes have shown frondescence, the other lobes remaining normal.—*Pelargonium* (*Geranium*) Hort. var. (Miss Carne; Beecroft; March, 1915), showing lateral, foliar prolification of the inflorescence. A tuft of leaves is noted intermixed with sessile flower-buds at the base of the inflorescence, the whole surrounded by a normal involucre. The unilateral inflorescence, consisting of but two flowers, indicates arrested growth.—*Isopogon anemonifolius* R.Br., (A. A. Hamilton; Newnes Junction; September, 1914); showing the xerophytic characters of reduced, sclerophyllous leaves, and generally stunted growth. Two examples were exhibited. The environment of these two examples was widely dissimilar, one growing on an elevated, barren ridge; and the other in a swamp. According to Schimper ("Plant-Geography," pp.2-8), the presence of humous acids in the peaty soil of a bog creates a physiologically dry condition for the swamp-vegetation. As a consequence, the plant living in the swamp has been compelled to resort to the same devices for avoiding excessive transpiration as its congener on the dry ridge, hence the morphological similarity of the two examples.—*Callitris Muelleri* Benth. & Hook. f., showing dimorphic foliage. The juvenile leaves are still *in situ*, though the plant has reached the fruiting stage. This species is described in the Fl. Austr. (vi.,

237) as a tree attaining 20-30 feet, and Mr. J. H. Maiden (Forest Flora of N. S. Wales, ii., 53) says:—"I have seen it up to perhaps 40 ft. in height with a trunk of 12 in." On the dry ridges in the higher parts of the Blue Mountains, it seldom reaches a height of more than 6-8 feet, the example exhibited having matured its fruit when only 1 foot high.—*Panax sambucifolius* Sieb., showing leaf-variation. The leaves are from 2 inches to above 1 foot long, simply pinnate, bipinnate to pinnatisect, with 3, 5, 7, 9, 11, 13, 15, 17, or more leaflets. The leaflets are linear, lanceolate, oval, elliptical to rotundate; sessile, or with petioles varying from 1 line to 1 inch long; their apices obtuse, acute, or acuminate, and their margins entire, shortly toothed, deeply toothed, serrate, or lobed. Measurements: $4\frac{1}{2}$ inches $\times 2\frac{1}{2}$, $3 \times 1\frac{1}{2}$, 3×1, $3 \times \frac{1}{8}$, $2 \times \frac{1}{8}$, $1\frac{1}{2} \times 1\frac{1}{4}$, $1\frac{1}{2} \times 1$, 1×1 line, $\frac{7}{8} \times \frac{5}{8}$ inch, $\frac{7}{8} \times \frac{1}{4}$ inch.

Dr. H. G. Chapman showed three sections of the small intestine, demonstrating the internal marginal layer of the circular muscle fibres; (1) a section of the ileum of the cat, (2) a section of the jejunum of the cat, and (3) a section of the jejunum of man. He had also observed this layer in the intestine of the Echidna. He showed also a section of the fundus of the dog's stomach, demonstrating the resistance of the oxyntic cells to digestive action by the gastric ferments.

Dr. J. R. Dixon exhibited, under the microscope, transverse sections of the decalcified lower jaw-bone of a dog, prepared by the pyridin-silver-nitrate method. By this method, an elective staining of the sheath, which lines the canaliculi, resulted. This staining showed that the sheath lined also the lacunar spaces and the Haversian canals. The slide further demonstrated not only the free communication, by means of the canaliculi, between the elements of any one Haversian system, but that equally free communication existed between adjacent Haversian systems.

ORDINARY MONTHLY MEETING.

May 26th, 1915.

Mr. A. G. Hamilton, President, in the Chair.

Mr. Percy G. Gilder, Department of Agriculture, Sydney; and Mr. Arthur W. Williams, Byron, N.S.W., were elected Ordinary Members of the Society.

A letter from Mr. J. H. Maiden, F.L.S., returning thanks for the Society's congratulations on the award, for 1915, of the Linnean Gold Medal, was communicated.

The President, upon requisition, convened a Special General Meeting to be held after the next Monthly Meeting on 30th June. *Business:* The Hon. Treasurer to move—"That the Annual Subscriptions of all Ordinary Members of the Society serving with the Australian Expeditionary Forces be remitted during their term of service."

The President made regretful reference to the decease of Mr. William Allan, of Wingham, and Mr. Charles W. de Vis, of Brisbane. The former was the oldest Member of the Society in point of years, elected in 1886. He settled on the Manning River in his younger days, and spent the rest of his life there. He deceased on 26th April, in his ninety-fifth year. Mr. C. W. de Vis, for many years Curator of the Queensland Museum, had been a Corresponding Member for more than thirty years.

The Donations and Exchanges received since the previous Monthly Meeting (28th April, 1915), amounting to 12 Vols., 93 Parts or Nos., 36 Bulletins, and 1 Pamphlet, received from 40 Societies, etc., were laid upon the table.

THE GEOLOGY AND PETROLOGY OF THE GREAT SERPENTINE-BELT OF NEW SOUTH WALES.

Part iv. The Dolerites, Spilites, and Keratophyres of the Nundle District.

By W. N. Benson, B.Sc., B.A., F.G.S., Linnean Macleay Fellow of the Society in Geology.

(Plates xxv.-xxvii., and six text-figs.)

Introduction.—The first three Parts of this series recently issued(**1**) contain some of the results of field-observations made during the years 1909-1911, and of petrological observations made in Cambridge, whither the writer proceeded, having been awarded a Research Scholarship, by the Royal Commissioners of the Exhibition of 1851. Attention was devoted in the field chiefly to the occurrence of serpentine, and the intricate relationships of the dolerites and spilites were less studied, for the peculiar interest attaching to them was then unknown. A perusal of Messrs. Dewey and Flett's paper on British Pillow Lavas(**2**) showed the importance of these rocks, but the material that had been collected was not sufficient to allow of a detailed discussion, and a re-examination of the field-evidence was necessary. The following is the result of six weeks' further work in the Nundle district, and the study of about one hundred and seventy thin slices of the rocks collected.

In the previous papers it was recognised that the coarse-grained dolerites were intrusive sill-like bodies, and it was believed that the fine-grained, or aphanitic, and frequently amygdaloidal spilitic rocks were lava-flows. At the same time it was remarked that many passage-rocks existed, and that it was frequently found difficult to refer an amygdaloidal dolerite of medium grainsize either to the one group or to the other. The same doubt as to the distinction of flow from sill has arisen in most localities in which these rocks occur. A second difficulty exists in the nomenclature. It was pointed out that the term "spilite" by original definition and present-day usage covered only such rocks as had undergone a considerable amount of alteration, with the formation of abundant secondary minerals. This has not always been the case among our rocks in New South Wales, unless we are to consider the acid felspar as a secondary mineral (a point which is discussed below), though in all essential features, chemical composition, structural characteristics, and geological association, they agree entirely with the rocks to which Dr. Flett has applied the term "spilite." To indicate this similarity in essential features, it seemed best to extend the use of the term to cover the apparently unaltered rocks in New South Wales, and the name "spilite" will be employed in the sequel in the same sense as before. The distinction adopted to separate the dolerites and spilites, is one of texture and grainsize: the former have a coarse or medium grainsize, with an ophitic, granular, or intersertal texture; the latter are fine-grained, or partially glassy, with a more or less variolitic texture. All gradations may be found between them. Mineralogically, they differ from normal dolerites and basalts chiefly in the strongly sodic nature of their felspars.

Geological Occurrence.—The general sequence of sedimentation in the Nundle district has been already discussed in Part ii. of this series. Briefly, the Devonian formation consists of a lower portion, the Woolomin Series, comprising phyllites, tuffs, and radiolarian jasper; a middle portion, the Bowling Alley or Tamworth Series, consisting of radiolarian cherts and claystones, volcanic tuffs and breccias, and coral limestones; and an upper portion, the Nundle or Barraba Series, made up of mudstones, containing *Lepidodendron australe* and radiolaria, with numerous bands of tuff and breccia. Spilites and dolerites occur in some amount in the Woolomin Series, are abundant in the Bowling Alley Series, but are absent from the Nundle Series In Carboniferous times, the formation was strongly folded, and slightly overturned towards the west, and a great mass of peridotite was injected into the plane separating the Woolomin Series from the main bulk of the Bowling Alley Series. A large amount of strike-faulting took place, which has greatly disturbed the stratigraphical succession, and this revision of the area makes it appear probable that some modification will have to be made in the detailed succession previously announced. It is hoped to discuss this in a later communication, after comparative work has been done in less complex areas. The consideration of the tuffs and breccias (which, doubtless, are cognate with the dolerites and spilites) is also reserved for future study.

Detailed examination of the lines of contact between the igneous and sedimentary rocks, shows that the extent of true lava-flows has been overestimated. In nearly every instance, the igneous rock is intrusive into the sedimentary rock, whether it be a coarse-grained dolerite or a fine-grained spilite: indeed, there has only one instance been observed where doubt can exist on this point. An interesting fact brought to light in this revision, is the frequent occurrence of the pillow or ellipsoidal structure, which is so common a feature of British and German spilite-lavas. But, though it has been held by some writers that this structure is characteristic of lavas that have flowed over the surface of the sea-bottom, it does not appear to be confined to these. Pillow-structure is well developed in the Nundle district in rocks which show intrusive contacts with the surrounding sediments (radiolarian claystones), and the alternative view held by other writers, *e.g.*, Teall(**3**) and Geikie(**4**)* that pillow-structure may also be produced in lavas intrusive into loosely compacted clays on the sea-floor, is the one most applicable to the features seen in the Nundle district. The various explanations that have been offered for the explanation of pillow-structure have been discussed by Clements(**5**), Daly(**6**), Sundius(**7**), Van Hise and Leith(**37**), whose papers give extensive bibliographies of the subject.† Tempest Anderson describes the formation of pillow-structure in recent

* "Basic lavas flowing into water or watery silt."

† Since the above was written, Wilson's discussion of the origin of pillow-structure in the Archæan rocks of North-western Ontario has come to hand (The Geology of the Kewagama Lake Map-Area, Quebec. Geol. Survey of Canada. Memoir 39, p.50). He cites, though he disputes, Lawson's statement that the ellipsoidal rocks of California are intrusive (Mining and Scientific Press, No.119, Vol. iv., 1912, p.199).

lavas in Savaii as follows(**8**):—"An ovoid mass of lava still in communication with the source of supply, and having its surface, though still red-hot, reduced to a pasty condition, would be seen to swell or crack into a sort of bud with a narrow neck like a prickly pear on a cactus, and this would rapidly increase in heat, mobility, and size, till it either became a lobe as large as a sack or pillow, like the others, or perhaps stopped short at the size of an Indian club or large Florence flask. Sometimes the neck supplying the new lobe would be several feet long and as thick as a man's arm before it would expand into a full-sized lobe; more commonly it would be short, so that the fresh-formed lobes were heaped together." Sundius accepts this as the process by which the pillow-lavas were made in the pre-Cambrian rocks of Lappland, but suggests that the pressure of the moving lava may break off and separate the pillows from one another: this would account for the rarity of connecting tubes between the pillows in the lavas he describes. Daly, in his recent work(**9**), compares the production of these lava-ellipsoids to the formation of the "spheroidal state" in water. Sundius notes that the effect must depend on the possession by the magma of a definite degree of viscosity, and finds in this the explanation of the association of pillowy and non-pillowy lavas. Mr. Harker has pointed out(**10**) that there is only a slight difference between the conditions of injection of lava into the loose muds of sea-floor, and an outflow of lava over the sea-floor, which is but the injection of magma between the soft muds and the overlying water.* The difference is naturally to be found in the slower cooling of the lava in the former case owing to the blanketing action of the muds. It seems quite probable that a flow with typically pillowy surface may show an intrusive contact with the mud-surface on which it rests, and such may be the case in parts of the Nundle district. While, in many instances, pillow-structure is a feature of deep-sea marine flows, as is shown by the fine-grained nature of the sediments with which they are associated, it is clear, from Tempest Anderson's observations, that it cannot be confined to such situa-

* Compare F. von Wolff. Der Vulkanismus (Stuttgart, 1913), pp.252 and 255.

tions; and, moreover, pillow-lavas have been found associated with lacustrine deposits(36). Jukes-Brown has argued for the shallow-water origin of the radiolarian rocks associated with the pillow-lavas of Ballantrae in Ayrshire(11), and Professor David and Mr. Pittman have declared that the Tamworth radiolarian claystones etc., which are continuous with those associated with the pillow-lavas of the Nundle district, were developed in comparatively shallow water(12).

The mode of occurrence of special masses may now be described. No doubt can exist as to the intrusive character of any of the large patches of dolerite marked on the geological map of the district given in Part ii. They all represent areas of dolerite of coarse or medium grainsize, and almost free from vesicles. Not infrequently there occur in them veins of very coarse-grained dolerite-pegmatite. Their intrusive contacts with the surrounding sediments are clearly observable. Often they have themselves been invaded by later masses of dolerite, which have a strongly marked, fine-grained, chilled, marginal zone against the invaded rock. Such contact-zones may be seen in several places in the lower part of Munro's Creek.

The areas marked as spilite-flows require more detailed consideration. The most important is that crossing the Peel River two miles south of Bowling Alley Point, and extending thence towards Hanging Rock. In the cutting on the main road, it consists of a group of stratiform masses, which may be seen to have intrusive contacts with the radiolarian claystones on either side. The same features are to be seen where this zone crosses Madden's, Moonlight, and Daylight Creeks, south of this point. The individual sills have a medium to fine grainsize, and are often amygdaloidal. In microscopical texture, they vary between ophitic dolerites and variolitic spilites: this variation may be seen on either side of a sill, and is due to marginal cooling; frequently, however, the sill is of uniform texture throughout. Multiple sills occur here and there, with chilled edges between the component parts. The vesicles are filled with calcite, epidote, and chlorite, and along the northern slope of Tom Tiger, axinite is frequently present in the vesicles, while axinite- and quartz-veins occur in the vicinity. Owing to the abundance of porphyry dykes in the vicinity, it was thought probable that the boric acid may have been derived from an underlying mass of granite which approached the surface in this region, though none of the porphyries contain tourmaline. There is, however, the possibility that the axinite may proceed from the dolerite-magma itself: axinitic contact-rocks are occasionally observed about diabases in Germany and New Jersey(**13**).

On Tom Tiger, the prominent peak north of the junction of Swamp Creek and the Peel River, pillow-structure is to be seen in the crags about the summit. The pillows are sometimes more than a yard in diameter, and their marginal zones of chilling are narrow and not well marked. They are separated by narrow bands of epidote, calcite and quartz. No exposures of the contact-line between the sediments and the igneous rock can be seen on Tom Tiger itself, but in Swamp Creek, half a mile to the south, a strongly intrusive junction is exposed. The bared rocks in the creek-bottom show that a considerable thickness, about ten yards, of fairly coarse-grained spilite is full of irregular, twisted fragments of chert of all sizes. The whole appearance suggests that the igneous rock invaded partially consolidated sediments. Pillow-structure is also observable here. Following the zone further southwards, pillow-structure is again met with on the ridge separating Swamp Creek and Happy Valley, and from this was obtained the specimen of spilite, of which an analysis was given in Part iii. The map in Part ii. shows a break in the spilite-zone south of this point, but it has now been proved to extend uninterruptedly to beyond Oakenville Creek, and the contacts with the sedimentary rocks, wherever visible, show the intrusive nature of the igneous rock.

A thickness of over four hundred feet of pillow-lava is exposed in the bed of Happy Valley. The pillows vary from a few inches to over six feet in diameter; the inner portion is porphyritic, with a subvariolitic base; the outer and rapidly chilled portions are aphanitic, and have frequently a variolitic structure. Vesicles are not abundant, nor are they concentrically arranged; they tend to concentrate towards the centres of the pillows. The individual masses are separated, as usual, by narrow bands of epidote, etc., and quite large crystals of quartz or epidote may occur in the cuspate cavities between several pillows; no radiolarian chert has been observed in such a situation, though it occurs in this manner in several British localities. Occasionally, the pillow-lavas are invaded by massive non-pillowy dolerite, which sometimes has chilled marginal zones.

Pillow-structure may also be observed on the cuttings on the Hanging Rock road, though greatly obscured by spheroidal weathering. The spilites are here intersected by a dyke of hornblende-lamprophyre. The exposures on Oakenville Creek, just to the south of the road, are almost entirely covered with drift; one exposure, however, shows a most intimate mixture of spilite and chert. Fig. 1 was traced from a flat-ground surface of a

Text-fig. 1.—Spilite intrusive into radiolarian clay. (Nat. size).

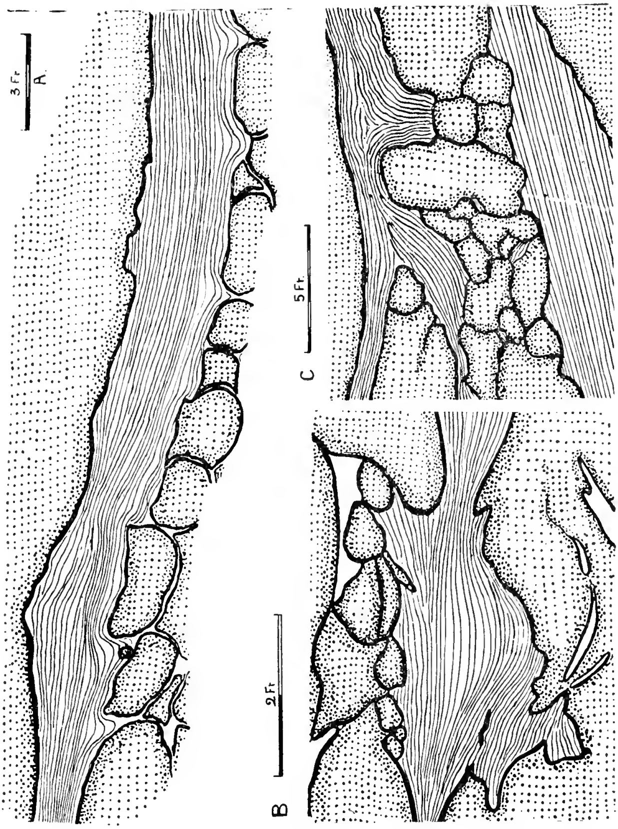
specimen obtained from here. The microscopical character of the entangled chert suggests that, in this case, it is largely, if not entirely, the product of infiltrations subsequent to the consolidation of the igneous rock. Such is believed by Messrs. Reynolds and Gardiner* to be the origin of the strings and patches of chert in the spilites of Kilbride Peninsula, County Mayo, Ireland.

Another important mass of pillowy rock commences nearly a mile further up Swamp Creek than the point where the first zone crossed, and continues thence up the gorge to the falls. It

* Quart. Journ. Geol. Soc., 1912, pp. 80-81.

may be a repetition of the first zone, though this does not seem probable at present. Near the entrance to the gorge is exposed the mass of chert and spilite shown in Fig.2A. This is the only instance in which doubt may exist as to the intrusive nature of the pillowy rock. The manner in which the banding in the chert bends in and out sympathetically with the boundaries of the lava-pillows, may indicate that they were deposited on a pillowy surface. On the other hand, the upper mass of lava has transgressive boundaries against the chert. It is not pillowy where it is in contact with the chert, but the structure becomes observable about thirty feet above the chert. The upper mass may be a surface-flow which has broken up the lines of bedding of the clays over which it flowed, but the section does not preclude the possibility that both the upper and lower masses of igneous rock were intrusive into soft clays, crumpling, or breaking through their lines of bedding as they went. Exposures of chert and spilite observed higher up the gorge clearly exemplify the second alternative. Indeed, there does not seem any other explanation possible for the features illustrated in Figs.2B and 2C. These narrow bands of chert lie in a great thickness of pillow-lava, probably four or five hundred feet (screes and tangling brushwood prevent more exact measurement). The pillows may be as much as eight feet in diameter, and are just like those occurring in Happy Valley. Not infrequently they are quite free from vesicles. In between the pillows is often a very fine-grained rock which looks like chert, but which the microscope proves to be made up of quartz, epidote and a little actinolite; the same minerals, less finely crystallised, form the usual bands separating the pillows. As in Happy Valley, there is no radiolarian chert between the pillows, nor do they show the strongly marked radial contraction-cracks that are sometimes seen in similar rocks in other parts of the world. There are associated massive intrusive dolerites quite indistinguishable, in hand-specimen, from the rock in the centre of the pillows (though under the microscope they may appear less variolitic), and it is often difficult to determine whether there is a passage from the pillowy rock into the massive dolerite, or whether there is a definite boundary between them.

No very definite statement is possible with regard to the other masses of spilite mapped, since their boundaries are rarely observable. It seems safest to consider them, also, as intrusive, whether they are vesicular or not, when there is no evidence to the contrary, and particularly when the rock is not pillowy, and



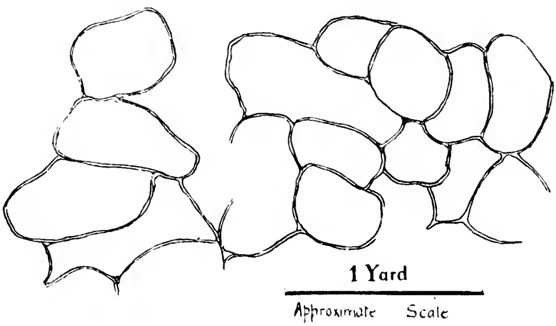
Text-fig.2.—Associations of chert and lava in Swamp Creek Gorge.

the texture is not more than subvariolitic. Even highly variolitic rocks have been proved to be intrusive. On such negative evidence, we may class as intrusive spilites or amygdaloidal dolerites, the bands shown on Moonlight Hill, those on the western side of Tom Tiger, and those forming the White Rocks overlooking Munro's Creek (see Part ii., Plate xxiii.). Confirmation of the intrusive nature of the first-mentioned group of spilites, is afforded by two poorly exposed contacts, and in the last case we find, on tracing the horizon of the igneous from the crags down across the scree-covered slopes into Munro's Creek, the great mass of White Rock is represented by a number of narrow sills, all intrusive into the cherts or claystones. But, though the sills often show transgressive boundaries, the general course of the mass is parallel to the strike of the country.

With regard to the statement made previously, that a lava-flow occurred on Moonlight Hill, swamping the coral-limestone, some modification must be made. A closer examination of the field-occurrence showed that the specimen described was not part of a flow, but of a mass of agglomerate, composed almost entirely of spilite-fragments, and evidently formed adjacent to the point of eruption. As stated, it contains large and small masses and fragments of limestone, some of which contain recognisable fossils of coral. On the western side of Munro's Creek, however, opposite to the Razorback, there is also an association of spilite and limestone, with somewhat analogous characters. The limestone, unfortunately, is so crystalline that no organic remains are preserved. It forms a lens about seventy yards long and ten wide. At its northern extremity, it is most intimately mixed up with lava showing skeleton-crystals and other indications of rapid chilling, and this passes laterally into a solid mass of lava, containing numerous fragments of limestones and calcite-filled vesicles. The igneous rock must here be an intrusive body, formed probably at a small depth below the sea-floor.

The nature of the spilite-occurrences in the Woolomin Series is not clear. Dolerites have been proved to occur, and a special type of spilite as yet not chemically analysed. They are rather crushed, and are less variable in texture than the igneous rocks in the Middle Devonian. Only one instance of pillow-structure (and that a dubious one) has been seen in the spilites of the Woolomin Series in the Nundle district: it occurs in a tributary of Munro's Creek. Generally the rocks are quite massive, and free from vesicles. It may be mentioned here that well marked pillow-structure has been observed in some amygdaloidal spilites occurring in the Woolomin Series in Portion 56, Parish of Loomberah, by the bridge over the Peel River, eleven miles south of Tamworth. These rocks are highly altered, as much so as the majority of the British spilites known to the writer. It cannot be doubted that long strips of Bowling Alley (Middle Devonian) rocks are faulted or folded in among the Woolomin Series, but the spilites of these strips should be usually distinguishable from those belonging to the Woolomin Series. Distinction between the two sets of dolerites is not clear at present.

Other rock-types occur that are cognate with the spilites, though differing from them in varying degree. In Munro's Creek, commencing at the Razorback, and running thence up to the end of



Text-fig.3.—Pavement of Pillow-Lava.

the westernmost branch of it, is a series of pale grey green rocks. This mass was overlooked in the first survey, being thought to have been merely a rather altered tuff. Its eastern side adjacent to the serpentine is a flow-breccia, and traces of the same rock appear on the western side of the mass on the other side of the creek. The main mass is composed partly of a very fine-grained variolite with a most peculiar microscopical structure, partly of a subvariolitic porphyritic rock, and partly of a rock with an almost doleritic texture, intrusive into the finely granular or aphanitic variolitic rock. The porphyritic rock has a well developed pillow-structure, and several pavements of it are exposed in the bed of the creek. Fig.3 illustrates one of these.

The doleritic type is abundant, but does not exhibit pillow-structure. It has not been possible to determine the mode of occurrence of these rocks. They lie in the most disturbed zone in the Bowling Alley rocks, and the steep scree-covered slopes on either side do not expose any lines of contact between the sediments and the igneous rocks. It is almost certain that the series is faulted and folded, probably in a syncline. The occurrence of the breccia on both sides of the creek may be due to this; lines of shearing are to be seen in the rock. It is not clear, also, whether any of the rocks were actual flows. At the southern extremity of the mass there is a band of variolite only a yard thick, lying in a rather wider band of decomposed flow-breccia. The line of contact between this and the sediments is indecisive. There is also no clear evidence as to the relation between the variolitic leucocratic rocks and the strongly magnetitic spilite, described above as intrusive into a limestone. There seems to be almost a passage between the two types. In the creek below, pillowy spilitic boulders are associated with the variolites, and here again passage-rocks seem to occur, but the relation of the two types *in situ* is unfortunately obscured. A passage from a rock free from magnetite into one rich in that mineral is not impossible, as will appear from the consideration of the magnetite-keratophyres. A dyke of odinite traverses the series.

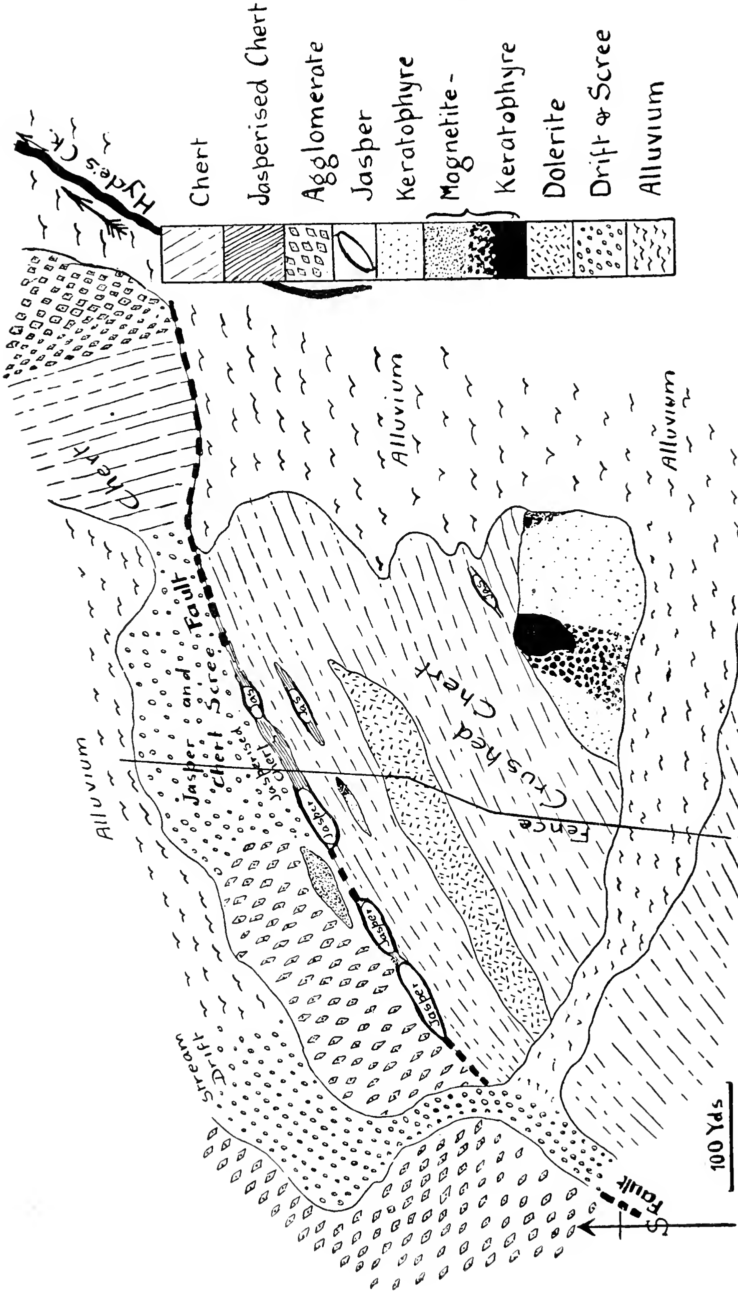
The most remarkable of all the rocks are the keratophyres. Of these are to be distinguished the keratophyres proper, the magnetite-keratophyres, the quartz-magnetite-keratophyres, and the quartz-keratophyres. The simplest occurrence is that of the keratophyre at Hanging Rock, which has been mentioned previously (Part ii., p.586; Part iii., p.666). It is also in a zone of great disturbance, and its relations are obscured. It seems preferable to consider it as a short sill, rather than as a volcanic plug. The rock is made up almost entirely of plagioclase, and analysis shows its extremely sodic character.

The magnetite-keratophyres are linked by passage-rocks both to the spilites and to the keratophyres. In the one sequence, the spilite passes into magnetite-keratophyre by the gradual diminution in the amount of augite present, and the increase in amount and decrease in grainsize of the magnetite; and by the substitution of a very slaggy for an amygdaloidal habit. The change from keratophyre into magnetite-keratophyre is a more complex one, and is discussed at length in the sequel.

North and south of Folly Creek, near the serpentine, there are small masses of spilitic magnetite-keratophyre, which seem to be intrusive into the adjacent sediments. No unusual tectonic features appear in their neighbourhood. Here and there throughout the district are little patches of spilite, richer than usual in magnetite, and showing some approach to the character of magnetite-keratophyres. These, however, are of rare and limited occurrence only.

The main region of development of the purely keratophyric type of rocks lies north-west of Bowling Alley Point in the region between Hyde's and Cope's Creeks. About a mile due west of the small infaulted area of Permo-Carboniferous rocks, is what may be termed the Hyde's Creek Complex. It forms a small ridge, running back from the creek. Fig.4 is a map of the occurrence. The normal strike of the region is that seen to the north-east of the figure, namely, N.N.W.-S.S.E. The strata following this strike are steeply inclined cherts and agglomerates or breccias. The strike warps round from N.N.W. to W.N.W. A fault cuts almost perpendicularly across this, and south of the fault lies an area, the strike of which swings from N.E. to E.N.E. The line of fault is marked by a series of masses of jasper, not of the usual red homogeneous character, but more clearly a secondary vein-like and vesicular rock, with quartz and chalcedony and crystalline hæmatite; the last is present as a finely divided colouring matter, as crystals in druses, and in veinlets through brecciated jasper. Where the jaspers cease, there continue zones of red jasperised radiolarian chert. Microscopical sections of these clearly show the metasomatic effect of ferruginous siliceous solutions.

Intrusions of igneous rock occur both north and south of the fault-line. At the southern end of the hillock is a complex of keratophyre and magnetite-keratophyre as shown. No actual contact with the chert has been seen, but the intrusive nature of

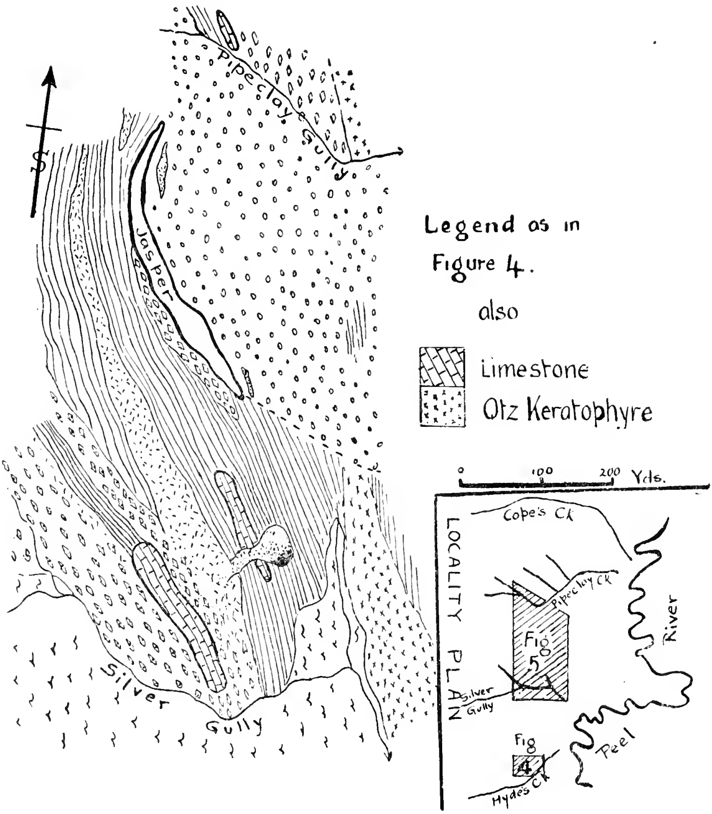


Text-fig.4.—Hyde's Creek Complex.

the igneous rock can scarcely be doubted. The keratophyre, when fresh, has a translucent white colour, and is divided up into small portions, generally about two millimetres in diameter, closely compacted together, and generally without any intervening matrix. A little pyrites is usually present. On weathering, a white kaolinitic rock is produced, or a red or yellow ochreous one. Towards the centre of the mass, and also to the north-east, magnetite-keratophyre is developed. The passage from the one rock into the other is a gradual one through many peculiar intermediate types to be subsequently described. The increasing amount of magnetite may be regularly distributed, giving a uniform grey rock, but more usually it is very irregular, producing breccia-like or nodular rocks. Following these, are almost pure magnetite-keratophyres with but few veinlets of felspathic rock. Finally, in the centre of the ferruginous area, is a black, heavy, and very slaggy magnetite-keratophyre, in which the abundant irregular vesicles are never amygdaloidal, and are nsually filled with calcite. A similar passage from purely felspathic into richly magnetitic rock occurs on the summit of the hillock. Between this and the former mass, is a long intrusion of quartz-dolerite, containing very little augite, and passing, on the margin, into fine-grained, non-porphyritic rock, the composition of which approaches that of an augitic quartz-keratophyre. North of the jasper-band, is a lenticular patch of very vesicular red-brown quartz-magnetite-keratophyre. The vesicles are round or slightly amygdaloidal, and the rock is not at all slaggy.

Along the zone of agglomerate to the north, other small occurrences of quartz-magnetite-keratophyre may be found, and the line of contact between these and the agglomerate is very difficult to define.

At Silver Gully, a mile north of the Hyde's Creek complex, is a second complex, of which a sketch-map is given (Fig.5). This is only very roughly drawn to scale. Beside the agglomerate, is a band of limestone forming a bold outcrop. To the east of this is a narrow band of spilitic agglomerate, beyond which is a long intrusion of dolerite like that in the Hyde's Creek complex. There does not seem to be a clear boundary between the agglomerate and the dolerite, and there is certainly no boundary between the dolerite and an offshoot of spilitic magnetite-keratophyre, which cuts across a second band of limestone, and opens out into a roughly circular area of fine-grained, red-brown and highly



Text-fig.5.—Silver Gully Complex.

vesicular (not slaggy), not very ferruginous magnetite-keratophyre, which passes into a richly magnetitic slaggy rock. The dolerite-sill may be traced for about half a mile to the north, and the agglomerate at its western edge seems to grade into a coarsely granular porphyritic quartz-keratophyre, which, on microscopic examination, proves to be composed entirely of fragmental quartz and albite. Agglomeratic rocks of a rather different nature, composed of fragments of keratophyre, magnetite-keratophyre, and dolerite in a matrix of keratophyre, lie to the west of a great band of jasper, which forms the ridge of the hill between Silver Gully and Pipeclay Creek. This agglomeratic rock appears to be rather of the nature of an intrusive igneous rock, filled with cognate inclusions.

The jasper has the same peculiar feature as that of the Hyde's Creek complex. The scree from the ridge covers the easterly slope, and through it there appear two small areas of vesicular quartz-magnetite-keratophyre like that north of jasper at Hyde's Creek.

Below the limestone on Pipeclay Creek, there is another intimate association of agglomerate and massive igneous rock (in this instance a porphyrite) in which it is difficult to distinguish between an agglomerate, and an igneous intrusion filled with inclusions. This has not been investigated yet. East of this mass, and extending from Silver Gully, across Pipeclay Creek towards Cope's Creek, is a band of very siliceous keratophyre. It is a grey rock, often containing small felspar-phenocrysts, very vesicular, and often amygdaloidal. The long amygdules are filled with calcite, or frequently with quartz or agate, while the microscopic features of the rock show further signs of the action of silicifying solutions. Occasionally the rock is traversed by veins of red jasper. In this case, also, there is no line of contact with the sediments exposed, nor is it obvious that the mass is an intrusion. It is very uniform in character, has a width of from fifty to a hundred yards, and is not associated with any obviously ejectmental deposits.

Petrographical Characters.

In the foregoing, the Devonian igneous rocks were classed into the dolerite-spilite series, the keratophyres, quartz-keratophyres, magnetite-keratophyres, and the variolites of Munro's Creek. They were briefly described in Part iii. of this series, but a more detailed account is now possible, and some modification of the former statements must be made.

1. *The Albite-dolerite and Spilite Group.*

General features.—These rocks are by far the most abundant of the Devonian igneous suite. Mineralogically and chemically, they form a very well marked homogeneous group; and, though the variety of textures developed is very great, they are connected with one another by a complete series of intermediate textures. At the acid extremity of the group there are passage-rocks into the keratophyres. The mineral composition is simple. Throughout the whole group, the predominant mineral is an acid plagioclase. Augite occurs in amount varying from one-fifth to more than one-half of the amount of the felspar. Ilmenite or titaniferous magnetite is next in order of abundance, but varies within wide limits, as does also the amount of apatite. Quartz varies greatly in amount, and in the rôle that it plays: it may occur in isolated grains, in interstitial mosaic, or in micro-pegmatitic intergrowth with felspar. Rarely a small amount of primary, brown hornblende is present. Pyrites is usually present, though only to a small extent. No definite sign of olivine is seen, even among the decomposition-products. Potassic minerals, such as biotite and orthoclase, are absent. The feature which distinguishes the whole group from rocks, similar in chemical composition and geological association in other parts of the world, is the comparative freedom from decomposition. Secondary minerals are present in most of the rocks, calcite, chlorite, or epidote, but usually only in small amount. Complete uralitisation is almost confined to the dynamically altered rocks of the Woolomin Series.

Chemical composition.—The chemical composition of this series is exemplified by the table herewith, and may be contrasted with the average composition of basalts as given by Daly(**9**). The chief feature of our rocks is their richness in soda, and, to a lesser extent, in titanium, (Daly points out that the two often go together) while the alumina, potash, and lime are low. The total iron oxides and magnesia, and the silica of the rocks free from quartz, are about the same as that of the average normal dolerite.

TABLE OF ANALYSES OF ROCKS OF THE NUNDLE DISTRICT.

	117	1002	1021	145	1109	1013	1086	1107	53
SiO_2 ...	48·22	48·35	51·19	54·88	48·61	60·39	56·95	48·04	49·06
Al_2O_3 ..	14·82	14·12	14·40	12·62	18·54	18·40	17·87	14·47	15·70
Fe_2O_3 ...	0·56	4·87	4·43	3·02	0·34	1·03	4·49	0·87	5·38
FeO ...	9·25	10·27	9·04	7·11	6·79	3·50	6·00	11·87	6·37
MgO ...	5·58	4·78	4·51	3·73	7·22	1·27	0·93	5·56	6·17
CaO ...	8·81	6·71	6·05	4·16	10·20	1·53	2·30	9·11	8·95
Na_2O ...	4·95	4·63	4·18	6·01	4·13	8·79	8·80	4·06	3·11
K_2O ..	0·44	0·38	0·78	1·10	0·18	0·46	0·38	0·64	1·52
H_2O+ .	2·54	2·00	1·82	1·76	2·02	1·37	0·71	2·15	} 1·62
H_2O- ...	0·15	0·30	0.24	0·23	0·20	0·20	0·38	0·13	
CO_2 ...	1·40	abs.	abs.	tr.	1·19	1·70	0·91	0·26	—
TiO_2 ...	2·68	2·84	2·69	3·63	0·90	0·80	0·89	1·97	1·36
P_2O_5 ...	0·23	0·35	0·40	0·44	tr.	0·12	tr.	0·08	0·45
FeS_2 ...	0·37	0·22	0·19	0·71	0·04	0·02	0·04	tr.	—
NiO ...	0·03	—	—	0·05	—	—	—	—	—
MnO ...	0·23	0·18	0·21	0·25	0·08	0·08	0·08	0·21	0·31
BaO ..	abs.	0·10	abs.	abs.	—	abs.	—	—	—
	100·26	100·10	100·13	99·70	100·44	99·66	100·73	99·42	100·00

117. Spilite, Frenchman's Spur, Nundle. (See Part iii., p.704, N.T.415).
1002. Dolerite, Munro's Creek, Bowling Alley Point.
1021. Quartz-dolerite, Munro's Creek.
145. Quartz-dolerite, Hanging Rock. (Part iii., p.704, N.T.237).
1109. Variolite, Munro's Creek.
1013. Keratophyre, Hanging Rock, Nundle.
1086. Magnetite-keratophyre, Hyde's Creek.
1107. Dolerite in Serpentine, Chrome Hill, Bowling Alley Point.
53. Average composition of all basalts. (Daly, "Igneous Rocks and their Origin," p.27).

Mineralogical composition.—The high percentage of soda is expressed in the very acid nature of the plagioclase developed. If we calculate the composition of the felspar, assuming that all the orthoclase plays the rôle of albite in the plagioclase, we have the following table:—

No. 117. Felspar Molecules... $Or_4Ab_{80}An_{30}$ or $Ab_{74}An_{26}$
No. 1002. Felspar Molecules... $Or_4Ab_{74}An_{30}$ or $Ab_{72}An_{28}$
No. 1021. Felspar Molecules... $Or_9Ab_{68}An_{32}$ or $Ab_{73}An_{27}$
No. 145. Felspar Molecules... $Or_{12}Ab_{97}An_{15}$ or $Ab_{88}An_{12}$

Thus all the felspars, with the exception of the last, are oligoclase-andesine; the last is albite. Optical tests, however, show that all the felspar in the rocks is albite or acid oligoclase. The excess of anorthite molecule must be present in the pyroxene, which is abundant in the first three, but rarer in the last : the presence of some epidote and chlorite also removes some of the alumina that is reckoned in the calculation as if it formed anorthite. The felspars are often quite clear, and their position in the acid group is nearly always determinable from their positive biaxial character, and their refractive index which is lower than that of Canada balsam. More exact determinations are difficult. The Carlsbad twinning law has not been seen in combination with the albite law; extinction-angles measured on the albite lamellæ perpendicular to (010) give maxima between 8° and 16°, indicating a composition between acid oligoclase and albite. Prof. Becke's methods of investigation in convergent light are rarely applicable(**14**). A measurement made of the angle between the points of emergence of the optic axes of adjacent lamellæ of a pericline twin, indicates a composition of about $Ab_{85}An_{15}$, which again is within the limits expected. Occasionally, the felspars are slightly zoned, albite is at the margin, and oligoclase within. In the earlier account of these rocks, it was stated that andesine predominated among the quartz-dolerites. This is not confirmed by a more extended investigation. Andesine occurs but rarely, and the crystals of which it forms the central parts are strongly zoned. The determination of andesine in some slides remains doubtful owing to the dusty character of the felspar, and in other cases a testing of the Canada balsam shows that it has been insufficiently cooked, and has therefore a refractive index less than that of albite, leading to the above-mentioned error. It was reported, also, that spongy felspar occurred in one instance, though the mineral is usually compact; further search has not brought to light any other instance of spongy felspar than one described. In the porphyritic rocks, no difference can be found between the composition of the microlites and of the phenocrysts. Apart from its unusual composition, there is little to suggest that the acid felspar is not of primary origin. In one rock only has labradorite been found, namely, 1040, the specimen illustrated in Fig.1. The felspar forms clear fresh laths, and is associated with fresh augite, and chloritic decomposition-products of a glassy base.

The pyroxene, also, is generally fresh. Though in many cases there has been a small amount of chlorite, uralite, epidote, and calcite produced from the pyroxene, there is nothing that resembles the highly altered state of pyroxenes in most British spilites. No alkaline pyroxenes have been observed, nor any rhombic pyroxene. Dr. Cox suggests that the quartz-dolerite of the spilitic series in Wales(**15**) may be found to contain augite rich in the rhombic pyroxene molecule. The present series of rocks have been specially searched for this feature, and the optic axial angle of many crystals was measured by the graphical methods of Professor Becke. They proved to be very uniform in character; the value of 2V lay in nearly all cases between 42° and 48°. This is rather less than the normal value for augite, but does not prove the presence of enstatite-augite, in which the angle may diminish to zero. Calculation from the analyses shows, however, that some of the $RSiO_3$ molecule must be joined with diopside molecule in the pyroxene developed. There is no difference between the character of the pyroxene in a quartz-dolerite and that of a dolerite free from quartz. Sahlite-structure is never seen, though twinning is often present. The pyroxene is generally greyish-green in colour when seen in section, and in some of the more finely granular rocks it has a purplish tinge.

The hornblende has the usual reddish-brown colour of hornblende in basic rocks, is rarely present, and in small quantities only.

The ilmenite occurs in plates of very irregular size and shape, and, in more altered rocks, is frequently leucoxenised. The apatite and pyrites are as usual; the mode of occurrence of the quartz will be described below.

The Texture.—The distinction between the dolerites and spilites is one of grainsize only, and is a most indefinite one. There is a wide range of texture between which every gradation can be found. At the holocrystalline end of the series, the most marked type of texture is that of the intersertal quartz-albite-dolerites of Hanging Rock. In these, the crystallisation of the apatite occurred first, that of the ilmenite and augite followed; large prisms of plagioclase then formed, often with quite idiomorphic extremities; their outer portions are clear albite or oligoclase; the inner parts are often dusty and indeterminate; though generally acid, they appear at times to have a core of andesine. The mesostasis between these crystals is very varied in character: sometimes it is merely a quartz-mosaic of minute grains; or it may be a mosaic of minute grains of quartz and an untwinned felspar, which has the same refractive index as that composing the outer zones of the plagioclase crystals; or it may be a micropegmatitic intergrowth of quartz and felspar, radiating from the edges and particularly from the coigns of the large felspar crystals, and these micropegmatitic fringes may be narrow or may stretch across the whole space between the enclosing crystals. Again, the mesostasis may consist of a pericline-twinned mass of felspar, wrapping round the end of the plagioclase prisms that project into the interstitial spaces. Finally, there are instances of the whole interstitial space being occupied by a few large quartz-grains; this last type of mesostasis, though fairly common in the dolerites directly associated with the spilites, is absent from a purely doleritic mass like that of Hanging Rock. Apatite crystals are rarer in the mesostasis than in the main part of the rock; this is the reverse of a feature commonly observed in the quartz-dolerites(**16**).

With decrease in the quantity of quartz, the rock-texture becomes conditioned more entirely by the position of the felspar prismoids. In Munro's Creek, some of the dolerites have a strongly gneissic texture, owing to the parallel position of the felspars. Augite is generally fairly abundant, forming about a third of the rock; it is usually roughly idiomorphic. Ilmenite and apatite vary greatly in amount.

From this stage there is a passage into the ophitic texture, with a decrease in the size of the pyroxene crystals. Rocks with this texture are not so common as the former, and are among the purely doleritic sills, but the structure is most developed in connection with the passage-rocks between the dolerites and spilites (see Plate xxv., fig.2).

The majority of the rocks which we shall term spilites have the texture characteristic of the spilites of Germany, and differ from these only in their greater freshness. They are partially porphyritic or glomeroporphyritic. The glomeroporphyritic types have small ophitic aggregates of augite, felspar, and ilmenite, as well as isolated phenocrysts of the same minerals. The groundmass varies considerably; in some rocks it has a basaltic habit, but differs from basalt in the following peculiarity: the felspar phenocrysts have been enlarged, their outline is no longer sharp and rectilinear, but embayed, each embayment being filled with a grain of augite, on either side of which there project little tongue-like points of felspar (see Plate xxv., fig.3). Somewhat similar characters have been described by Rinne from the diabases of the Harz Mountains(**17**). There is usually no flow-arrangement of the felspars, and, though the rocks are vesicular in places, there is no special alteration in texture noticeable about the vesicles.

Another type of groundmass has much greater distinction between base and phenocryst, and a more marked flow-structure. This is very characteristic of the zone of spilitic rocks that extends north and south from Tom Tiger. The sharply bounded plagioclase phenocrysts have frequently microlitic extensions, giving swallow-tailed, or pronged terminations. The augite phenocrysts are moulded against the felspars, and do not show skeletal forms. Ilmenite and magnetite form long irregular aggregates of small grains. The groundmass consists of felspar, in the form of strips not much shorter than the phenocryst, and varying in size thence down to the finest microlitic dimensions. Its outline is rarely rectilinear; it has skeletal extensions, or is bent and twisted, forming shreds rather than laths. There is sometimes a general flow-arrangement; at other times the felspar is more radially grouped (a subvariolitic texture), or is quite irregular (see Plate xxv., fig.5). Associated with the felspars, are minutely granular augites and ilmenites; not infrequently the augite lies in narrow streaks between the felspar shreds. With decreasing grainsize, this texture becomes more and more confused, and the rock is more readily chloritised. Skeleton-crystals of augite occur, which are like rods made up of very minute grains, and feathered, one might say, with tiny plates of ilmenite. Such minutely granular augite is also frequently around minute laths of plagioclase. In many of these rocks there is more or less brown glass in the base (see Plate xxv., fig.6). The spilites are frequently vesicular, and sometimes, in the holocrystalline spilites, the vesicles are surrounded by hypocrystalline rock. One of the most remarkable types of rock is that in which an ophitic dolerite of medium grainsize has interstitial areas of fine-grained subvariolitic rock (Plate xxv., fig.2).

The amygdaloidal dolerite and holocrystalline spilites described above are characteristic of the non-pillowy masses of spilite and the central portions of the pillowy spilites all along the Frenchman's Spur, and the slopes north of Tom Tiger. The outer portions differ in being hypocrystalline. The phenocrysts and felspar microlites in the groundmass are sharply bounded, take on more distinctly the clustering radiating habit of variolitic rocks and are surrounded by a blackened border, full of skeleton-ilmenite and finely divided augite. In such rocks, there are frequently clear traces of flow-brecciation, the several fragments being sharply bounded in some places; in others they merge into the surrounding rock. These rocks show many structures within a short space, glassy, fragmental, or variolitic, solid or filled with lakelets of chlorite. In all these the felspars remain quite clear, and are acid oligoclase or albite. The extreme outer margin of one pillow in Swamp Creek exhibits a structure of which no parallel is known to the writer. It so closely resembles the plan of a pillow-lava that it may be termed the micro-ellipsoidal structure. It is probably a first stage in the formation of variolitic structure, preserved owing to the sudden quenching. The rock is broken up into small ellipsoidal portions about 0·2 mm. in diameter, consisting of radiating fibres of a dark brownish-green colour (chloritised augite ?), surrounded by a ring of clear epidote. This epidote is separated from the epidote in the adjacent micro-ellipsoid by a thin band of grey dusty material, which widens out into tricuspate areas at the point of contact of three micro-ellipsoids, just as does the material between the large ellipsoidal masses in pillow-lava. Within the micro-ellipsoids are phenocrysts of more or less epidotised plagioclase and fresh augite (Plate xxvi., fig.10).

Another type of structure occurs in the rapidly chilled rocks, particularly in the fragments of spilite in the agglomerates associated with the limestones. This has been already described, and is illustrated in a previous paper (Part iii., p.665, and Plate xxvii., fig.2).

Occurrences of various types of dolerite and spilite.—The two widest masses of dolerite are those on Munro's Creek and Hanging Rock. The first is about five hundred yards wide. Its eastern margin, against a fine-grained tuff, is a very fine-grained mass of uralite and chlorite, with a few phenocrysts (1041). A yard from the margin, the grainsize is larger (0·2 to 0·3 mm.), though the rock is still considerably decomposed. From this there is a gradual increase in grainsize inwards, and also an increase in the amount of quartz. A wide zone occurs lying from one hundred to one hundred and fifty yards from the boundary marked by a gneissic (fluxional) structure. The inner quartz-dolerite has the composition given on p.139 (1021), while the rock outside the gneissic band is free from quartz and has a lower percentage of silica (1002). A narrow fine-grained margin appears also on the western side of the mass, and is separated from the invaded rock (tuff-breccia) by a few inches of a finely granular aplitic rock which merges into the tuff. Under the microscope(1182) it is seen to be made up of small (0·05 mm.), equidimensional grains of albite, frequently free from twinning; at other times so finely laminated with albite and pericline twinning as to appear like microcline, save that its optical character is positive. A few small crystals of augite, and a little ilmenite are also present.

The large mass of Hanging Rock, which is half a mile wide, has an acid central portion. The rock figured on Plate xxv., fig.1 (1065), from the central portion of the massif, is much richer in silica than that near the margin, which contains 54% SiO_2 (see analysis 145). The grainsize does not vary noticeably across the massif.

The dolerite of the Possum Tunnel and elsewhere, near Bowling Alley Point, has been invaded by a coarse pegmatitic dolerite, consisting of oligoclase-albite (not andesine), augite, and large ilmenite-plates with a little interstitial quartz and plagioclase. The rock is rather crushed, and much veined with quartz, epidote, and calcite.

The long string of spilite-occurrences, running from north of Tom Tiger to the Oakenville Creek, have been already described. The spilite first analysed is one of these (117, N.T.415, Part iii., p.704). It has a complex texture; coarse phenocrysts and glomero-porphyritic aggregates occur in a spilitic groundmass in which are vesicles filled with calcite, and surrounded by fine-grained, subvariolitic, hypocrystalline material (see Part iii., Plate xxvii., fig.1). The spilites of Moonlight Hill have a partially granular, partially ophitic texture, and pass laterally into fine-grained spilitic masses. No special textural features are to be seen in the dolerite that contains axinite in its vesicles, save in the widely differing character of the material filling adjacent vesicles. Quartz, epidote, chlorite, calcite, and axinite occur singly, or in association.

A small sill crossing Moonlight and Madden's Creeks exemplifies best the porphyritic spilites with basaltic groundmass (Plate xxv., fig.4). Its vesicles contain quartz, which also appears to be replacing the rock metasomatically. Both magnetite and ilmenite occurred, but the latter is now changed to titanomorphite. The sill, though only four yards wide, is much more finely granular on the margin than within, though there is no alteration in texture or composition.

The spilitic rocks in the Woolomin Series are not so varied in texture. They are rather basaltic in character, and the phenocrysts are not very abundant. In one instance only has a pillow-like mass been found in the Woolomin rocks of the Nundle district. The rock of which it was composed consists of a few phenocrysts, clear plagioclase and uralite, set in a base of the same materials. The felspar of the groundmass is fresh, often untwinned, and very fine-grained (Pl. xxv., fig.3). Other rocks show the same original structure, but are more crushed. A few coarse-grained dolerites occur among these. They are also greatly shattered, traversed by shearing lines and long bands of crushed minerals. The felspar is difficult of determination, owing to the poor development of twinning, but it can never be said to have a spongy structure. The pyroxene is almost entirely changed to uralite.

The Variolites and associated Dolerites.

These rocks form a small group quite distinct from the normal spilite-dolerite series. Two occurrences may be noted as examples. The first is only a single narrow dyke traversing the cherts opposite Lyons' house in Swamp Creek. Variolitic texture is very well shown among the felspars, while the remaining minerals have become almost entirely changed to carbonates. The second mass is much larger and diversified. It occurs in Munro's Creek. The field-relationships have been described above. The breccia-like rock on the eastern margin(1090) consists of fragments of crystalline rock, set in a light yellow-brown glass, which is hypocrystalline, in places approaching to the character of the fragments which it includes. The most abundant of these inclusions are those least different from the groundmass. They are porphyritic with albite phenocrysts in a grey hyalopilitic matrix, containing many laths of felspar. The proportion of glassy to crystalline matter, and the extent to which flow-structure is developed, differ considerably in the several fragments, as do also the size and abundance of the phenocrysts. A second type of inclusion is holocrystalline. It contains fewer phenocrysts than the above, and has a pilotaxitic to trachytic base, consisting of albite laths with a little ferromagnesian matter, chiefly epidote and actinolite pseudomorphs after pyroxene. Wide variations occur in the extent of development of the flow-structure and the amount of ferromagnesian minerals. The type passes into the one first described. In addition, there are isolated crystals of albite, which project into the inclusions of the first-described type in a manner which shows that these inclusions were still plastic while they were in the glassy groundmass. There can be little doubt that this is a rock produced by the consolidation of a moving magma, which was shattered and the fragments were incorporated in the crystallising moving melt, which chilled and solidified rapidly. In other words, it is a flow-breccia. When decomposed, this rock appears in handspecimen like a schistose tuff. A thick band of it crosses the eastern branch of Munro's Creek.

The most peculiar rocks are the variolites. There are several types of these. The most aphanitic stage is a dense, pale green rock containing white spherical spots, which have no definite outlines. It occurs in a narrow pillowy mass on the westernmost tributary of Munro's Creek, and again on the main creek near the Razorback(1034, 1089). Under the microscope, it is seen to possess a grey-green base divided up into acutely angular portions separated by straight colourless rods running in all directions(Pl.xxvi., f.9). These rods are quite sharply bounded, but their nature and composition cannot be determined. They suggest felspar by their appearance, but are untwinned and divided into irregular lengths, each occupied by a single transparent mineral, different in optical orientation from its neighbours. The elongation of these short portions of the rods may be positive or negative. Professor Gregory has described similar structures in the variolite of the Fichtelgebirge(**18**), and Michael Levy in that of Durance(**19**).* These authors suggest that these may be contraction-cracks filled with secondary felspathic material. The same explanation may hold for the rocks under discussion, but it is difficult to account for the absolute rectilinearity of the structures. Where these rods intersect, there are occasionally radiate spherulites of felspar (varioles). The angular spaces between the rods are composed of very fine green fibres, with a radial or curved arrangement about one or more centres, often recalling the arrangement of the line of force about a bar-magnet. They lie in a colourless, weakly birefringent groundmass. The greenish fibres extinguish at small angles, and are probably chlorite. No primary minerals or recognisable pseudomorphs occur in these rocks. In a more crystalline stage of this rock, the chlorite plates are more individualised; large plates are associated with

* For a summary of all the earlier work on variolites, see Gregory and Cole's paper, "Variolitic Rocks of Monte Génèvre," Quart. Journ. Geol. Soc., 1890.

epidote and are probably pseudomorphs after plagioclase. The rod-like structures still persist, but are either less well marked, or are emphasised by the development in them of lines of magnetite, or they are completely hidden by secondary minerals. Other types of variolite are porphyritic; they contain (*e.g.*, 1007) phenocrysts of decomposed augite and plagioclase, in a confused more or less variolitic base, composed of laths and skeletal forms of felspar, together with a little uralite, epidote, and chlorite; a little secondary quartz is scattered about in small irregular patches.

Associated with the rocks just described, is a very beautiful variolite which consists chiefly of felspar with a little interstitial augite. The characteristic radiating structure is well shown (Plate xxvi., fig 7). This rock forms the outer part of a pillow; it is unfortunately too decomposed to be suitable for chemical analysis, and there are in it abundant veins of pennine and clinozoisite. The felspar seems to be oligoclase, but its exact composition cannot be determined optically. In another rock with a similar groundmass there are numerous phenocrysts of albite(1078). The freshest rock, and the one that has been analysed(1109), has a texture intermediate between the variolitic and ophitic types, with a few phenocrysts. These consist of andesine; the felspar of the groundmass is rather more acid, being a basic oligoclase, with a small extinction-angle, but with a refractive index greater than that of Canada balsam. The augite is partly ophitic, partly in narrow, irregular grains or prismoids. There is a little scattered chlorite, but isotropic, probably colloidal, chlorite occurs, with a small amount of carbonates, clinozoisite, epidote, and a trace of pyrites. The analysis confirms the optical evidence of the basicity of the felspar developed, and the absence of any ferric minerals.

There can be little doubt that these rocks are members of the Middle Devonian series, but their greater richness in lime is not at present explicable.

The Keratophyres.

The keratophyres are a varied group of rocks which consist almost entirely of acid plagioclase. They are connected in two ways with the dolerite-spilite series. Quartz-dolerites, becoming richer in quartz and albite, pass into quartz-keratophyre. Many intermediate rocks have been found. The rarer type of passage is that in which, by decrease in the amount of pyroxene and increase in the iron ore of a spilitic rock, a black slaggy rock is produced, to which the name magnetite-keratophyre may be applied. Far more common, however, is the association of magnetite-keratophyre with keratophyre proper, quite apart from any passage into the spilite-group.

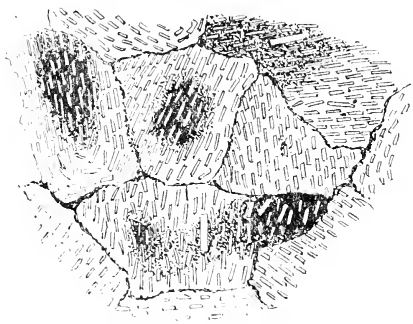
The true keratophyre is represented by the sill at the head of Oakenville Creek. It consists(1013) of almost pure albite, not acid oligoclase as stated in the earlier account. The analysis, making the same assumptions as before, shows that the felspar has the composition Ab_9An_1. There is, in addition, a little magnetite, limonite, chlorite, and carbonates. In some specimens there are little rods of hæmatite, which may be pseudomorphous after hornblende. (There are little pseudomorphs of this character in the porphyries of the Nundle district.) The texture of the keratophyre is trachytic, but not markedly so, and the laths are of uniform size, being about a fifth of a millimetre in length, with a few small phenocrysts (Plate xxvi., fig.11).

Just north of Folly Creek, near the track to Bowling Alley Point, is a slag-like rock(1084) with well marked trachytic habit, consisting of albite, magnetite, and chlorite pseudomorphous after augite. The magnetite is very abundant, and occurs in exceedingly minute but well shaped crystals. The felspar is in clear laths and microlites. This is an example of the passage-type between a spilite and a magnetite-keratophyre. It differs from the usual type of the latter rock in being quite massive, with little or no scoriaceous habit.

The keratophyre-complex by Hyde's Creek yields the most interesting types. The pinkish-white nodular rock to east and west of the magnetite-keratophyre, is made up of small fragments of very trachytic rock, the flow-directions in the several fragments lying without any regard to the flow-directions in adjacent fragments(1108). Each fragment is made up almost entirely of albite laths, the larger laths lying in a matrix of exceedingly minute microlites and a little quartz. The felspar is often very fresh, but some kaolinisation has taken place, spreading outwards in bands from the cracks separating the fragments of which the rock is composed. The reddish colour of the rock is due to the oxidation of scattered grains of pyrites.

Magnetite enters into these rocks in a variety of ways, one of the most remarkable being that seen in the nodular magnetite-keratophyres (1096) [Plate xxvii., fig.3]. The rock is divided up into roughly polygonal masses about four millimetres in diameter. Each polygon consists of an outer rim, rich in finely crystalline magnetite in a network of albite microlites. There follows within a zone of varying width, consisting of a finely granular mosaic or lathy felt of albite, which sometimes contains large, clear phenocrysts of the same mineral. There is usually no general circumferential or centripetal arrangement of the felspar laths within a nodule, but frequently a general trachytic structure continues without interruption throughout the whole nodule, and may be parallel or inclined to the trachytic arrangement in adjacent nodules. Besides the albite, a little chlorite may occur in this zone. Within this is a narrow passage-zone of felspar laths, sometimes more or less kaolinised, and containing rather abundant dusty magnetite. The inner part of the zone may be coloured yellow by the abundance of the oxidised chlorite. The central portion is of normal magnetite-keratophyre, composed of albite laths and abundant magnetite. Albite phenocrysts occur in this, and may project, quite unaltered, right out into the clear felspathic zone, or may even traverse two or three zones, retaining the general trachytic direction of the nodule. The above is the most complete type of polygonal nodule; in others less well developed, some of the zones may not be present. In a few instances, the central magnetite-keratophyre, with its more or less marked texture, is wrapped round by a zone of keratophyre free from magnetite, in which the laths have a circumferential arrangement. The boundaries of the several zones are never sharp. Where spaces occur between the nodules, they are filled with a mosaic of chiefly untwinned felspar. Except for the abundance of magnetite, this rock is allied in structure with the purely felspathic brecciated keratophyre last described.

There are also rocks of a more obviously brecciated appearance, angular fragments of black rock in a pinkish background. These show a brecciated structure similar to that of the foregoing; that is, they are divided up into areas, in which the general direction of the trachytic texture has no relation to that in the adjacent areas, and this diversity of flow-direction is seen both in the parts rich in magnetite and in those free from that mineral. As in the last rock, also, albite crystals may project from the dark ferruginous part into that surrounding it, which is composed entirely of felspar. The limits of the ferruginous parts are quite irregular; though, in handspecimen, they may appear to be very sharply bounded, under the microscope, they are seen to pass into non-ferruginous parts (Pl.xxvii.,f.4). In a few instances, the magnetite-keratophyre fragments are wrapped round by purely felspathic rock, in which the felspar laths are arranged circumferentially about it. Magnetite may also occur in cracks traversing the rock, sometimes running between adjacent trachytic patches, sometimes cutting across a single fragment. There are also segregations of magnetite lying isolated in areas usually free from that mineral. Chlorite occurs in large flakes. As regards actual mass, the magnetite is considerably less abundant than the felspar, but the very minute grains and crystals are so abundant that they render the whole portion of the rock in which they occur almost black. Fig.6 is a diagram showing the structure of these rocks. For clearness' sake, the size of the felspars has been enlarged proportionately to that of the individual rock-fragments.



Text-fig.6.—Diagram showing the structure of a brecciated magnetite-keratophyre.

A variety of the brecciated structure is seen in a few rocks, in which the fragments of trachytic rock are not in contact with one another, but are separated by a matrix of minute equidimensional grains of felspar, either untwinned, or twinned with exceedingly minute lamellæ. Quartz may also occur in this mosaic, but its determination is difficult. The trachytic fragments may be entirely felspar, or may be homogeneous magnetite-keratophyre, but generally they are keratophyre with a magnetitic core, and purely felspathic outer parts. Complementary to this type of rock, there is still another (1188) in which the non-trachytic matrix predominates, and is grey-coloured owing to a regular distribution of magnetite throughout; the inclusions are felspathic trachytic keratophyre, and sometimes contain a magnetitic core. Even in this rock there is a concentration into lines between the inclusions, giving a honeycomb-appearance. (Plate xxvii., fig.1).

In other rocks, the magnetite is more evenly distributed, and the rock begins to take on a more slaggy or scoriaceous habit, and its rough, irregular cavities are filled with calcite. After having removed the carbonate by hand, as far as was possible, during the rough crushing of the rock (1086), the remainder was analysed, with the result given(p.139). This confirms the optical determination of the felspar as albite, for the composition of the felspar, calculating from the analysis in the same way as before, should be $Ab_{10}An_1$. The amount of titanium present is rather less than might have been expected from an analogy with the chemical characteristics of the spilitic series. The same features are even more strongly developed in the very richly magnetitic keratophyre shown in Plate xxvi., fig.12. The association of areas rich in magnetite with others poor in that mineral, sometimes merging into one another, sometimes sharply defined, and the strongly marked trachytic texture, with occasional brecciated structure, are also distinctive features. The rock is strongly attracted by a magnet: the felspar is apparently pure albite and water-clear, but the rock is so scoriaceous, and so intimately mixed with calcite, that density-determinations or chemical analysis would be of little use.

Some of the magnetite-keratophyres of this complex contain more or less quartz. In one(1060) near the margin of the mass, the richly magnetitic areas lie in a matrix of quartz-keratophyre, in which some, at least, of the quartz is of secondary origin. Another of these rocks differs in that the magnetite occurs not only in finely divided masses, but in irregular aggregates from a tenth to a fifth of a millimetre in diameter. The rock(1110) has a brecciated structure, and the magnetite is segregated chiefly in long, irregular bands running between adjacent fragments, and in close association with the secondary quartz and calcite. It also occurs impregnating the central parts of some of the fragments. Apart from the presence of magnetite, the rock is similar to the quartz-keratophyres to be described below.

The magnetite-keratophyre that lies north of the jasper band differs from the above in having an amygdaloidal character. The vesicles are filled with quartz, and sometimes have a selvedge of chalcedony. The rock consists of a felt of albite-laths and small phenocrysts in a matrix darkened by dust-like magnetite; the latter is, for the most part, evenly distributed, but may be aggregated around the vesicles.

The magnetite-keratophyre of Silver Gully is similar to the rock last described. It is associated with a small patch of dense, slaggy, very heavy magnetite-keratophyre, similar to the most ferruginous parts of the Hyde's Creek rocks. As already mentioned, this mass of keratophyre seems to pass into a locally brecciated sill of dolerite, which extends about half a mile northwards. This dolerite has been more or less silicified in places, and more carbonates have been introduced. The dolerite of the Hyde's Creek complex, though it is not so intimately connected with the keratophyre, closely resembles the Silver Gully rock. It is very acid; indeed it may be considered as a passage-rock between dolerites and quartz-keratophyres: it consists of albite, chloritised pyroxene, and abundant interstitial quartz, together with a little ilmenite locally changed to sphene. The rock is rather crushed, and carbonates have been introduced into the zones of granulation.

Adjacent to the dolerite in the Silver Gully complex, is a fairly coarsely granular quartz and felspar rock which appears, at its eastern side, to be a massive quartz-keratophyre-porphyry, but which passes without a break into an obviously brecciated rock, filled with fragments both of igneous rock and of limestone. A microscopical examination of the apparently massive rock shows that it also is brecciated. It consists of large shattered crystals and angular fragments of quartz and felspar in a fine-grained felsitic base. Even more remarkable is the agglomeratic rock on the summit of the ridge between Silver Gully and Pipeclay Creek. This consists of a varied collection of rounded or angular fragments of porphyritic or trachytic keratophyre and magnetite-keratophyre in a matrix of trachytic keratophyre. Though there are no lines of contact with the sedimentary rocks exposed, it seems reasonable to consider this mass as the product of the intrusion of a keratophyre-magma filled with cognate xenoliths.* This is an extension of the conception of a brecciated intrusion which is necessary to explain the structure of the Hyde's Creek keratophyre.

The main series of rocks to which the name quartz-keratophyre is most directly applicable, run along the eastern side of Silver Gully, across Pipeclay Gully to Cope's Creek. Their macroscopic features have been already described. The composition of the rock is fairly uniform throughout, but variations occur. The predominant mineral is acid felspar. This generally, but not always, forms phenocrysts lying in a pilotaxitic, trachytoid or panidiomorphic granular base. With these are sometimes phenocrysts of augite with a large optic axial angle. The plagioclase of the base is rarely easily determinable, being often rather dusty: it does not appear, however, to be more basic than oligoclase. Augite may occur in the base as small prisms, but is generally changed to chlorite: magnetite, ilmenite or titanomorphite may occur in small amount. The greatest diversity arises in the mode of occurrence. A few of the rocks in this mass are free from quartz, but the majority contain it in a manner which raises suspicion as to its primary character. It may be interstitial, or form in little irregular patches against which the felspars are moulded, or it is present in intimate

* Compare with this the "Eruptive pseudo-conglomerate" described by Clements(5), p.135.

micrographic intergrowth with the felspar. In the last case, there can be no doubt that the quartz is primary. The larger grains apparently replace portions of the felspar-felt, and in no way resemble corroded phenocrysts, but have more the appearance of secondary introductions, especially when they occur in zones characterised by more than the usual amount of calcite or chlorite. Finally, in several of the rocks the quartz-grains are completely surrounded by chalcedony, which extends outwards into the felspar of the rock-matrix. This is clearly a secondary enlargement of the quartz-grains, and we may note at the same time, the abundance of chalcedony in the vesicles of some of the rocks. Chlorite and calcite also occur in the vesicles either singly, or in association with each other.

The Post-Peridotitic Dolerites..

These rocks form dykes in the serpentine, chiefly on the northern slope of Chrome Hill, and also in a small patch of serpentine that occurs west of the Peel River, south of Warden's homestead. They are usually very crushed and altered. The freshest rock(1107) has a very peculiar structure It is partly granulitic, the base consisting of angular or rounded grains of augite in a groundmass of platy felspar. There are a few large felspar-phenocrysts, and some ophitic glomeroporphyritic aggregates of felspar and augite, as well as isolated grains and crystals of augite. The pyroxene is pale in colour, and though there is no noticeable purplish tinge, hour-glass structure may occasionally be seen. The optic axial angle 2V is 51°. No difference is observable between the augite of the phenocryst and that of the smaller grains. Both are very fresh, though chlorite is abundant, at times pseudomorphous after augite. The plagioclase is not easily determinable. Some large zoned crystals occur, showing refractive indices greater than that of Canada balsam, but the extinction-angles do not yield determinative readings. The felspar of the groundmass is very dusty, and is frequently decomposed to a cloudy mass of epidote and clinozoisite. It seems to have the optical characters of an acid andesine. The composition calculated from the chemical analysis (see p.139) is

$Ab_{1\cdot 9}An_1$. Titanomorphite is very abundant, occurring in irregular grains or in long saw-like rows, as if developed from an ilmenite-plate. No undecomposed ilmenite remains.

More common than this are rocks which might be termed proterobases. They are more or less crushed and altered, and contain a reddish-brown hornblende, which forms isolated grains or peripheral intergrowths with the augite. The latter is generally fresh and similar to that in the rock last-described, though its optic axial angle may reach as low as $2V = 42°$. The felspar, on the whole, may be a little more acid. An outer zone of albite sometimes appears around the andesine-kernel, but an exact determination is rarely possible. Ilmenite is generally replaced by titanomorphite, and a very little apatite may sometimes be seen. The structure varies from granular to ophitic.

These rocks differ from the post-peridotitic dolerites of the Barraba district, and also from the spilitic group of rocks, though their chemical analysis repeats most of the features seen in the analyses of the spilitic rocks.

General Discussion.

The observations, of which an account has been given, raise a number of interesting and difficult problems. The most striking feature of the whole series of the Devonian igneous rocks is their richness in soda. This character they share with the spilitic rocks of England, and it will be of interest to see how far the explanations offered for the nature of these rocks are applicable to ours, and what alternative views may be considered.

Messrs. Flett and Dewey consider that the albite in the British spilite-lavas is secondary(2). They believe it to have been produced by a pneumatolytic change affecting the rocks shortly after their solidification. Solutions, rich in soda, traversed the rock, attacking, and replacing by albite, the originally basic felspar, and, at the same time, changing the pyroxene to chlorite, epidote, and calcite. The intrusive albite-dolerites are equally albitised, but, in them, the pyroxenes are rather better preserved. The secondary nature of the albite is seen by its spongy character. Associated with the English albite-dolerites is a hornblende-proterobase (minverite) in which the albite is chiefly primary, though a small amount of albite basic felspar may be recognised. The quartz-diabases in the same series are not albitised at all. By the escape of the sodic solutions from the igneous rock into the surrounding mudstones, adinoles are produced. The occurrence of the minverites shows that albite may crystallise directly from a differentiate of the spilitic magma, although, in the British rocks, according to this view, it was usually segregated into post-volcanic solutions that attacked and replaced the originally crystallised basic felspar. Bowen(**22**) and others describe the development of albitic facies in the upper portions of doleritic masses, and the escape of the albite into the overlying sediments, producing adinole. Bowen believes that the albitic rocks are the result of the intrusion of gabbroid magma into argillites, and that the water contained in the sediments has taken part in the transfer of the albite-molecule out of the normal magma. Daly supports this view, believing that the examination of sills, from the top to the bottom, will show an upward enrichment in albite. "The submarine origin of the pillow-lavas implies that the magma passed through wet sediments of greater or less thickness. Under these conditions, water-gas must play an important rôle in modifying the magma in the vents, and it seems impossible to doubt that, occasionally, the upper part of the magma-column, and also some of the extruded lava, will become albitised. Meanwhile, the general body of the igneous rock must often be profoundly altered by the absorbed water-gas or hot water, exactly as described by many authors writing of the spilitic masses. . . . . . The writer believes that the spilite rocks are pneumatolytic derivatives of normal basaltic magmas, and that the modifying gas is chiefly water of resurgent, not of juvenile origin."(**9**, p.340).

The spilitic rocks of the Nundle district differ from the majority of those discussed by Messrs. Flett, Dewey, and Daly, in the almost complete absence of signs of secondary origin of the felspar, and the rocks as a whole are fresh. Clear albite prisms may occur in ophitic intergrowth with undecomposed pyroxene, a thing difficult to explain on the hypothesis of the secondary origin of the albite, unless, in some circumstances, albitising solutions have no action on pyroxene. Certainly some decomposition-products occur, chlorite, epidote, and calcite, but they are not abundant, save in rocks that have obviously been in solution-channels (*i.e.*, shear-lines, and the boundaries of some sills) or have suffered the intense pressure that affected the rocks of the Woolomin Series. It must be noted, however, that our rocks are rarely, if ever, flows, and, as Messrs. Flett and Dewey have observed, pyroxenes, as a rule, are better preserved in the intrusive than in the extrusive rocks. Further, in the examination of the wide sills, there is no sign of greater albitisation of the upper parts. One cannot say definitely which is the upper part of the great sills on Munro's Creek and Hanging Rock, but it seems clear that the rock is equally albitised throughout a width of more than five hundred yards. The western, and probably upper side of the former mass contains veins of albite-dolerite-pegmatite. Another point of difference from the British spilitic rocks is the albitic character of the felspar in the quartz-dolerites. Certainly, in some quartz-dolerites, zoned felspar occurs, of which the central portion is andesine, but it is not usually present. They are, however, with the single exception noted, the only rocks in which felspar more basic than oligoclase is to be found.

Again, adinole is not developed along the contact of dolerites and cherts. Two specimens were analysed, which should have had every opportunity of becoming albitised had sodic solutions escaped from the cooling magma. These are (A) the chert in the mass between the pillows of spilite, illustrated in Fig.2b, and (B) the secondary chert from the specimen shown in Fig.1, in which the felspars of the invading dolerite(1040) are clear well crystallised prisms of labradorite. C and D are respectively radiolarian chert and cherty shales from the Tamworth Common. (A narrow sill of albite-dolerite occurs here, but, from the descriptions of Messrs. David and Pittman(**12**), it does not appear to have been in contact with these two rocks). The figures are those determined by Mr. Mingaye. E and F are from slightly altered, aud completely altered sediments, that are changed into adinole where they are in contact with diabases of the Harz Mountains.

	A	B	C	D	E	F
SiO_2 ...	67·87	70·06	91·06	80·50	69·27	75·25
Na_2O ...	1·10	1·04	0·28	1·18	2·25	7·54
K_2O ...	2·08	1·08	0·84	1·68	4·31	0·61

It is clear that the cherts from the Nundle district do not contain any noteworthy amount of albite. On the other hand, the presence of the albite-aplite above the Munro's Creek sill, shows that locally there was some slight albitic extrusion from the magma.

Termier has explained(**35**) the albitisation of some Alpine diabases, by the supposition that soda-bearing soil-waters draining off gneissic areas on to diabases may bring about a replacement of lime by soda, concurrently with the decomposition of the ferromagnesian minerals, and he has brought forward an interesting series of analyses in illustration of this. From the nature of the case, this hypothesis is quite inapplicable to the explanation of the Nundle rocks.

It seems permissible to suggest that albite in spilitic rocks may be either a direct magmatic crystallisation, or may have been concentrated into the magmatic aqueous solutions, and have then replaced the first-formed basic felspar. The albite of the Nundle dolerites and spilites, like that of the British minverites, seems to be chiefly primary. This does not preclude the possibility that it may be largely secondary in spilitic rocks in adjacent areas. The conditions, that would determine the one mode of crystallisation or the other, probably depend on the amount of water in the spilite-magma, its source, and its mode and time of escape.

In the keratophyres, there can be no doubt that, at the end of the sequence of differentiations, the magma was very hydrous, and post-volcanic processes were very active. The felspar of these rocks is almost pure albite, but even here there is no evidence of the secondary nature of the felspar. Neithammer, from a study of some Javanese rocks, concludes that the keratophyres may be albitised porphyrites(**23**). Sundius states that the felspar of the magnetite syenite-porphyry of Kiruna, Lappland, though originally acid, has been still further albitised(22). Nothing analogous to the features claimed by these authors as evidence of albitisation, has been noticed in the keratophyres of the Nundle district.

The development of magnetite in the keratophyres presents many features of interest. So far as can be learnt, the only rocks, at all analogous to these, are the Pre-Cambrian magnetite-syenite porphyries of Lappland, and a few isolated and less investigated occurrences in the Urals and elsewhere. The analogy is very clear, if we compare our rocks with the descriptions and illustrations in the papers of Sundius(23), Geijer(24, 25), and Lundbohm(26). Sundius, while employing Geijer's term, magnetite-syenite-porphyry, suggests that keratophyre would be a more suitable designation. It will be of interest, therefore, to summarise the views that have been put forward as to the origin of the Scandinavian rocks. The magnetite-syenite-porphyries are in intimate association with great deposits of iron-ore, and the explanation depends on the view adopted as to the origin of the iron-ores. Bäckström considered the iron-ores were of hydro-pneumatolytic origin, belonging to the last phase of volcanic activity(27). The volatile iron-salts rose through the igneous rocks, and, coming into contact with the sea-water above, were precipitated as magnetite. This hypothesis was supported by De Launay(28). On the other hand, Högbom considered the ore was the result of a differentiation from a syenitic magma(29), and Stutzer supported this view, adding to it the statement that pneumatolysis has played an important minor rôle in the formation of the ore(30). Geijer has studied the question in great detail. His monograph on the Kiruna field(31) is, unfortunately, not accessible in Sydney, but he has published an abstract of it in Economic Geology(24), and, more recently, a general review of the mode of occurrence of the iron-ores of Lappland(25). He supports the view of the magmatic origin of the iron-ores, as also of the magnetite-syenite-porphyries, believing that the latter differentiated out from the normal syenite-porphyry of the district, and had a lower temperature-range of crystallisation. He cites the researches of Lenarcic(32), and Day and Allen(33) on the lowering of the viscosity produced by the presence of a small amount of magnetite in an albite-melt, and notes that the eutectic albite-magnetite ratio of three to one, as determined by Doelter(34), seems to be a frequent one in the magnetite-syenite-porphyries. At the same time, he recognises the presence of a certain amount of pneumatolytic action, affirming that the ores stand in pegmatitic relation to the parent-magma, there being evidence for the presence of a considerable amount of magmatic water. (Apatite occurs with the ores.) His view differs from that of Stutzer chiefly in the advocation of an effusive, not intrusive, origin for the syenite-porphyries.

The most significant features of our rocks seem to be the following: they solidified from a magma under non-uniform pressure, and hence are not only strongly trachytic, but were broken up as they solidified, and the keratophyres now consist of closely compacted, minute fragments of trachytic rock, usually without any matrix, occasionally with a matrix of non-trachytic acid keratophyre, a consolidation of the residual magma under static conditions. Most of the fragments have preserved the straight direction of the flow-structure, some have been bent, some have been actually rolled up into a concentric arrangement, and this is most frequent when the fragment has a kernel of magnetite-bearing rock. The magnetite-keratophyre forms the central portion of the keratophyre-mass; around it is a zone of parti-coloured nodular or breccia-like mixtures of magnetite-keratophyre with purely albitic rock. In these, the distribution of the magnetite is most irregular, but, in the main, it is suggestive of the occurrence of two periods of crystallisation. It rarely, if ever, occurs as inclusions in the crystals of felspar, but lies in an extremely divided state between the felspar-laths. Part of it is segregated into nodules of rounded or irregular shape, sometimes broken across by the brecciation, and here showing a sharp fractured boundary, but more usually without any sharp boundary, passing out into the albitic rock, which may have a continuous rectilinear flow-direction, or may bend to more or less encircle the dark portion. This seems to show that the presence of magnetite toughened the rock against brecciation, which occurred either during the crystallisation of the felspar, forming the kernels around which the last-formed laths might wrap themselves, or immediately after the consolidation of the felspar, in which case the trachytic structure of the particular fragment would pass unhindered through the magnetitic nucleus. The latter is the more usual feature. The first epoch of crystallisation of the magnetite seems to have been a magmatic one: the magnetite-keratophyre and keratophyre proper must be differentiates from a common magma, and the peculiar mixed rocks form the transition-zone of incomplete differentiation. After consolidation and brecciation, there still remained a residual magma which consolidated between the fragments. This granular mesostasis may consist of quartz and albite, of quartz, albite, and magnetite, of quartz and magnetite, or of magnetite alone. The last two types of matrix sometimes form in such narrow crevices between the fragments, or in cracks traversing them, that it seems most probable that they are of the nature of hydro-pneumatolytic veins. In confirmation of this, we may note that they slightly impregnate the rocks on either side of the vein. In one specimen, the mesostasis retained nearly all the magnetite(1188). The nodular segregations of magnetite are quite different from those in the Scandinavian rocks, which, according to Bäckström, are vesicles filled by pneumatolytic deposits of magnetite, but, according to Geijer, are "concretionary bodies in the porphyries, and have crystallised under igneous conditions, and pass into the normal groundmass on the one hand, and into true vesicles on the other."(**25**, p.715).

Within the zone of these mixed brecciated keratophyres, lies the main mass of magnetite-keratophyre of the Hyde's Creek complex. It is much more uniform, and brecciation is not so very marked a feature. The slaggy, vesicular character is doubtless due to the former presence of magmatic gases, and the rough, non-amygdaloidal shape of these cavities is, perhaps, explicable on the assumption that the rock moved in jolts by successive brecciations of almost solid rock, and not entirely by steady viscous flow.

In the quartz-magnetite-keratophyres, brecciation is rarely seen. The vesicles are abundant, and are rounded or amygdaloidal. All the magnetite seems to have crystallised in the earlier period. As we pass to the quartz-keratophyres, there is increasing evidence of the action of silicifying waters, not only in the filling of the vesicles with quartz and chalcedony, but in the attacking of the rock itself, the formation of rings of secondary silica, quartz or chalcedony around the original quartz-grains, and the replacement of small parts of the rock-fabric by a finely granular quartz (agate?) mosaic.

The jaspers associated with the keratophyres are the last product of the spilite-keratophyre magma. Narrow veins of jasper occur in the keratophyre, and large independent masses are developed, which were deposited by successive bodies of siliceous solutions, rising through fault-planes, metasomatically replacing the country-rock, and depositing quartz and chalcedony, together with the last of the iron-ore, now completely oxidised to hæmatite. The last of the magmatic solutions, too feeble to form jaspers, have merely jasperised, and reddened, with hæmatite, the banded radiolarian cherts.

Thus the evidence of our magnetite-keratophyres series leads to the conclusion that they primarily originated by magmatic differentiation, but that hydro-pneumatolysis played an important minor rôle. This accords, to a great extent, with the views of Högbom, Stutzer, and Geijer, as to the origin of the Lappland rocks. The structures developed have been explained as the result of varying degrees of viscosity in the crystallising magma. Recapitulating, we have the following table :—

1. Pure albite-magma, with no vesicles or sign of pneumatolysis. Viscosity extremely high, amounting to partial rigidity; brecciation a very marked feature. The trachytic structure is probably the result of crystallisation under non-uniform pressure, rather than actual flow.

2. Albite-magnetite-magma, with a few irregular vesicles, and slight evidence of pneumatolysis. Less brecciation than in No.1, and more evidence of viscous flow.

3. Albite-magnetite-quartz-magma, with abundant smooth-walled vesicles, and evidence of the presence of magmatic water. Still further diminished viscosity, brecciation practically absent, and flow-structures more obvious.

4. Quartz-albite-magma, with abundant amygdules filled with silica, and evidence of the former presence of much magmatic water. No sign of brecciation, but every indication of considerable fluidity.

5. Quartz, chalcedony, and hæmatite, deposited from aqueous solution.

The knowledge of the relation between magma-viscosity and chemical composition is at present very imperfect(**40**), particularly in regard to the quantitative effect of fluxes, such as water; nevertheless, the sequence given above seems to accord with what might have been anticipated.

So far, only those jaspers that are immediately adjacent to the spilites or keratophyres can be said to have been derived from this source, and such jaspers are as yet known in the Bowling Alley Series only. The mode and period of origin of the far more abundant jaspers of the Woolomin Series are not yet known. They show many of the features common to the other jaspers, though they are more uniform in character, and less vein-like. The writer concurs with Professor David's present opinion, that they are mainly of secondary origin, alteration-products or metasomatic replacements of country-rock. They can hardly be merely ferruginous, abyssal oozes, as formerly suggested.

The formation of ferruginous jaspers and iron-ores by solutions derived from spilitic magmas is not without analogy. The same mode of origin has been claimed for much of the Lake Superior iron-ore(**37**), as also for the ores of the Rhenish Schiefergebirge in Germany(**39**) and elsewhere. In these cases, however, the iron-bearing solutions are believed to have escaped from basic lava-flows, and not after extreme differentiation.

Difficulties arise when one endeavours to determine the conditions under which the series of eruptions took place, which produced the rocks described. The spilite-pillows must have invaded sediments that were still watery, and capable of fluid movement; therefore, the magma must have come near to the surface (the sea-bottom), during the period of deposition. The more deep-seated magma (the dolerites), encountered consolidated sediment, and have rough, shattered lines of contact with the rocks they invade. The keratophyres, in particular, must have formed at some depth, and only after the complete consolidation and some faulting of the specimens. But the stratigraphical record shows that there was no important faulting or folding from Middle Devonian to Lower Carboniferous times, and we must accordingly consider these faults as merely local movements around the centres of Middle Devonian, submarine, igneous activity.

The discovery of the agglomeratic keratophyre, between Silver Gully and Pipeclay Creek, throws some doubt on the former assumption of a single ejectamental origin of the "tuffs," "breccias," and "agglomerates" of the Devonian stratigraphical succession. When first these rocks were discovered in the Tamworth district, they were considered as sills by Professor David(38), though later, upon the evidence of their microscopic structure, he stated that they were tuffs, and termed "intrusive tuffs" certain occurrences in which the relation of the igneous to the sedimentary rock seemed to be an intrusive one. More recently, the so-called tuffs in the Silurian Series, east of the Jenolan Caves, have been proved by Mr. Süssmilch to be really strongly differentiated, intrusive porphyries full of inclusions, not only of cognate igneous rocks, but of fossiliferous limestone, and the enclosing cherts and slates. The writer has seen these, under Mr. Süssmilch's guidance, and has noticed some analogy (first suggested to him by Professor David) between them and the agglomeratic rocks of the Tamworth Series. This analogy does not amount to a parallelism, however. In an earlier communication, the writer suggested that the apparently intrusive character of the acid tuffs into the Devonian chert might be due to the drying and cracking effect of hot ash falling on to damp mud. Other exposures have now been found, in which this explanation is inapplicable. In Swamp Creek, for instance, is a mass of acid igneous rock, resembling what has been termed "acid tuff," but clearly intrusive into the chert, and containing fragments of *Heliolites*, etc. Microscopically, it is entirely crystalline, and consists of shattered and corroded grains of quartz and albite in a finely granular felsitic mosaic. One may also recall the brecciated keratophyre that passes into calcareous agglomerate near Silver Gully. Another significant feature is the almost entire absence of glassy matter from these "tuffs" and "breccias," and the frequency with which fragments of keratophyre, and even magnetite-keratophyre occur in them. They have been found in the "tuffs" of the Moonbi, Attunga, Manilla, and Bingara districts, and also in the Baldwin Agglomerates. Though, at first sight, the term "intrusive tuff" may seem a contradiction in terms, yet intrusion-breccias are well known, and considerations similar to those explaining the close relation of intrusion and extrusion in suboceanic vulcanicity (see p.124) may assist in the explanation of this apparent anomaly.

Further evidence from the field and laboratory is necessary, before these rocks can be profitably discussed.

Summary and Acknowledgments.—The spilitic series of eruptions in the Nundle district included spilites, dolerites, and keratophyres. So far as can be seen, they are all intrusive into the sediments, and certain spilites intrusive into soft muds, have produced pillowy masses. They are nearly all rich in albite, which appears to be chiefly primary. They do not show at all clearly the evidence for the secondary character of the albite described by Messrs. Flett and Dewey, or that noted by Termier; nor is there evidence that the soda-content of the magma has been segregated in the manner discussed by Daly. Magnetite-keratophyres occur, and their development was brought about by magmatic differentiation assisted by pneumatolysis. Many of their features recall the magnetite-syenite-porphyries of Lappland. An attempt is made to explain their varied structural features by a consideration of magma-viscosity. The formation of ferruginous jasper-veins is described as a post-volcanic process. No complete account can yet be given of the mode of eruption of the rocks, and, in particular, of the manner of formation of the associated breccias.

The writer must gratefully acknowledge the help given by Dr. Flett (Edinburgh), Mr. Harker (Cambridge), and Dr. Nils Sundius (Stockholm). To Professor David, he is indebted for help and counsel, both in the field and in the laboratory, and for all facilities for research in the Geological Department of the University of Sydney.

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APPENDIX.

ADDENDA AND CORRIGENDA TO PARTS i., ii., iii.

Owing to the writer's absence from the State, it was impossible for him to see the proofs of the first three Parts of this series, and he regrets that a considerable number of errors appear in the published work. The following corrections should be made :—

Part i.

P.490, line 13 above the base—after "study", read "over wide areas".
P.499, line 9—for "schlueteri", read "schlucteri".
P.504—delete the last sentence.
P.511, line 3—for "peridolites", read "peridotites".
P.516, reference 16—for "opiolischen" read "ophiolitischen".

Part ii.

P.575, line 10—for "lens" read "limestone".
P.576, line 21—for "1000", read "2000".
P.581, line 2—for "they are", read "it is".
P.582, line 33—for "hartzbergite", read "harzburgite".
line 34—for "herzolite", read "therzolite".
P.592, line 5—for "(33). No", read "(33), no),".
P 594, line 13—for "Nundle", read "Woolomin".
Pl. xxii.—The colouring denoting the Woolomin Series has been extended over the zone between the serpentine-line and the eastern limit of the Nundle Series. This zone consists of the rocks of the Bowling Alley Series. A small patch of serpentine has been omitted; it occurs a mile south of Cope's Creek, co-linear with the other masses of serpentine.

Part iii.

P.663, line 10 from base—delete "primary or secondary".
line 2 from base—delete "mineralogical and".
P.664—delete the first footnote.
P.664—in second footnote, for "Mining Museum", read "University Museum".

P.668, line 8—for "(35)", read "(34)".
P.671, line 1—for "bending", read "banding".
P.671, line 29—for "marks", read "makes".
P.672, line 22—for "chrysolite", read "chrysotile".
P.642, line 31—for "bastite", read "magnetite".
P.673, line 31—for "chrysolite", read "chrysotile".
P.675, line 15—after "makes", read "conspicuous".
P.676, line 29—for "3·1", read "5·1".
P.678, line 3—for "chrysolite", read "chrysotile".
P.691, line 7—for "Narsatas", read "Nacatas".
P.692, line 10—for "Narsatas", read "Nacatas".
P.702, line 13—for "sanidine", read "andesine".
P.704—Analyses 2 and 3 have been interchanged. "Spilite, Tregidden" is that commencing with SiO_2 47·56% (to which must be added Fe_7S_8 0·06%). "Spilite, Mullion Island" commences with SiO_2 48·58%). Analysis 4 (M.B.12) CaO and MgO interchanged, read MgO 9·00% CaO 7·46%.

Analysis of pitchstone—for Walkom, read Browne.

P.705—Correct:—

N.T.383—for 100·42, read 101·33.
N.T.280—for 99·99, read 98·69.
M.B.197—for 99·89, read 99·79.
N.T.321—for 101·68, read 101·71.

P.706, N.T.118—for 99·31, read 99·39.
P.706, M.B.36—for 100·81, read 100·89.
P.706, Rodingite, Dun Mt.—delete NiCoO 0·28%.
P.720, line 6—for "fossiferous", read "fossiliferous.".
P.721, line 21—for (p.), read (p.668).
P.722, line 17—for "some", read "come".
P.723, Explanation of Plate xxvii.—Figures 5 and 6 are interchanged.

The following points may be noted, in which some modification or addition is required in the statements made;—

P.496—The stratigraphical disturbance in the Nundle region is greater than formerly realised, and the details of the succession must be taken with reserve. Particularly is this the case with regard to the breccias.

P.497—The abundance of *flows* of spilite-lava has been disproved in the communication herewith. Recent work shows that the identity of Bowling Alley Point limestone with that of Tamworth and Moore Creek can no longer be maintained. The absence of medium-grained tuff from the Tamworth Series is open to question.

P.500—The conformity of the Baldwin Agglomerates on the Tamworth Series has now been proved.

Pp.576 and 580—See note to p.496.

P.573—Abundant radiolaria have now been found in lenticular limestone beds in the clayshales near Nundle.

Pp.578-9—For reasons given in the paper herewith, the explanation suggested for the mixture of tuff and chert is withdrawn.

P.592—Another small pipe of basalt, about fifty yards in diameter, occurs by Hyde's Creek, at the western side of the alluviated plain.

P.676—The conclusion that serpentine does not increase in density to a noteworthy extent in passing from chrysotile into antigorite is open to question. Professor Becke* and Professor Grubenmann† hold the contrary view. The former gives the specific gravities of chrysotile and antigorite as 2·57 and 2·64 respectively; the latter gives 2·50 and 2·60. Leitmeier's collection of data on this point‡ shows that the evidence is rather incomplete.

P.680. line 25—Near the head of Oakenville Creek at Hanging Rock is a pyroxenite that consists almost entirely of diallage, together with a little hypersthene (1168).

P.696, line 6—To the list of porphyries may be added the following :--

Quartz-mica-porphyrite occurs on the eastern side of Munro's Creek. It is a grey rock, spangled by abundant plates of biotite. Under the microscope (1173), it shows idiomorphic plates of biotite, which is almost uniaxial, and contains abundant inclusions of zircon which are surrounded by dark haloes, also apatite and magnetite. A few phenocrysts of plagioclase and quartz are also developed. The base consists of finely divided plagioclase, with a little quartz and prisms of apatite and minute flakes of biotite. Carbonates occur in abundance. In hand-specimen this rock resembles a minette.

P.698, line 28—Insert :—An odinite dyke(1059) intersects the spilite on the Hanging Rock road. It is remarkable for the frequency with which the augite crystals occurred twinned on the (101) and (122) planes, producing cruciform or star-like aggregates.

P.703—The detailed account of the Tertiary volcanic rocks of the Western Coalfield§ shows their identity with the basalt-theralite teschenite series of rocks which are developed in the Liverpool and Mount Royal Ranges. The list of analyses given is especially worthy of attention.

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† Grubenmann, Die Krystallinen Schiefer, Second Edition, p.55.

‡ Leitmeier, Article on "Serpentin." Handbuch der Mineralchemie, Bd. ii., pp.387-403.

§ J. E. Carne, Memoirs of the Geological Survey of New South Wales, No.6, pp.71-152, and list of analyses on p.93.

DESCRIPTION OF PLATES XXV.-XXVII.

Plate xxv.

Fig. 1.—Intersertal Quartz-albite-dolerite(1065); centre of Hanging Rock. ($\times$ 20), polarised light.

Fig. 2.—Ophitic and spilitic albite-dolerite(1028); west of Swamp Creek Falls. ($\times$ 20).

Fig. 3.—Glomero-porphyritic spilite (155); Woolomin Series, Munro's Creek. ($\times$ 12).

Fig. 4.—Spilite with basaltic texture(1029); narrow sill in Moonlight Creek. ($\times$ 30).

Fig. 5.—Holocrystalline spilite(1055); central part of pillow, Happy Valley. ($\times$ 20).

Fig. 6.—Hypocrystalline spilite(1015); narrow sill(?), Munro's Creek. ($\times$ 24).

Plate xxvi.

Fig. 7.—Variolite(1025); margin of a pillow, Swamp Creek. ($\times$ 30).

Fig. 8.—Hypohyaline semi-variolite (1039); outer margin of pillow, Swamp Creek. ($\times$ 12).

Fig. 9.—Variolite with rod-like structures(1034); Munro's Creek. ($\times$ 30).

Fig. 10.—Micro-ellipsoidal spilite(1044); margin of pillow, Happy Valley. ($\times$ 30).

Fig. 11.—Keratophyre(541); Hanging Rock. ($\times$ 30), polarised light.

Fig. 12.—Magnetite-keratophyre(1075); Hyde's Creek. ($\times$ 30).

Plate xxvii.

Fig. 1.—Magnetite-keratophyre(1186); Hyde's Creek. ($\times \frac{2}{3}$).

Fig. 2.—Quartz-keratophyre(1088); Silver Gully, polarised light. ($\times$ 50).

Fig. 3.—Nodular magnetite-keratophyre(1096); Hyde's Creek. ($\times$ 9).

Fig. 4.—Magnetite-keratophyre(1100); Hyde's Creek. ($\times$ 18).

A NEW LEVAN-GUM-FORMING BACTERIUM.

(*Bacillus hemiphloiæ*, n.sp.)

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

While examining the bacteria in the tissues of a seedling of *Eucalyptus hemiphloia*, and of a gall (presumably Crown-gall) on the stem of a pear tree, I came upon a microbe which produced levan-gum from saccharose. Two bacteria possessing this property have already been described,* but this microbe differed from *Bac. levaniformans* in forming no spores, and from *Bac. eucalypti* in fermenting certain sugars with the evolution of gas.

The gum, as obtained from growing the bacterium in saccharose-peptone fluid and coagulating with alcohol, had all the chemical and physical properties of levan-gum. Like *Bac. levaniformans*, this microbe could bring about the deterioration of unheated saccharine solutions; and, like *Bac. eucalypti*, it might cause a fermenting gum-flux of certain Eucalyptus-trees.

On account of this apparent novelty, I suggest the name *Bac. hemiphloiæ*, after the plant from which it was first obtained. Its morphological and cultural characters are as follows.

Bac. hemiphloiæ, n.sp.

Shape, etc.—A short rod measuring 0·7 μ in breadth, and from 0·8 to 1·7 μ in length. It is actively motile, and possesses from one to nine peritricial flagella. No spores were observed.

Nutrient agar-stroke.—A white, raised growth.

Nutrient agar-plate.—Circular, white colonies which, microscopically, may have a smooth or erose edge, and uniformly-spread fine, central granules. The colony may have an annular marking, or it may be coli-like, with a dark centre.

* These Proceedings, 1901, p.589, and 1902, p.230.

Nutrient gelatine-stab.—A flat, spreading nail-head, the canal with arborescent outgrowths in the softened gelatine.

Glucose gelatine-stab.—As with nutrient gelatine, but a stronger growth and gas-bubbles in the medium.

Glucose gelatine-plate.—Circular, white colonies in a zone of softened medium. Finely granular structure.

Glucose gelatine-stroke.—A white raised growth softens then liquefies the gelatine.

Milk.—The casein is coagulated, with formation of a clear, acid whey.

Bouillon.—Turbid with film and sediment. Indol is produced, and nitrates are reduced to nitrites.

Starch-media.—A weak, filtered suspension did not react with iodine after two months; a stronger, unfiltered suspension gave a reddish-violet colour with iodine.

Potato.—A raised, fat-glistening, ivory-white growth; medium slightly darkened.

Saccharose-peptone-fluid.—Opalescent medium with film and sediment. Formation of levan-gum and inversion of saccharose.

Eucalyptus-manna-agar.—A raised, gummy growth.

Fermentation of sugars.—Acid and gas from dextrose, saccharose and lactose. Glycerine is not attacked.

While testing the action of the microbe upon the various sugars, I also tested a race of *Bac. levaniformans* obtained from refined sugar, and of *Bac. eucalypti* recently isolated from the tissues of an Angophora.

	Dextrose.	Saccharose.	Lactose.	Glycerine.
Bac. hemiphloiæ ...	Acid and gas	Acid and gas	Acid and gas	No action
Bac. eucalypti	Acid	Acid	No action	No action
Bac. levaniformans	Faintly acid	Faintly acid	No action	No action or faintly acid

By the numerical system of the American bacteriologists, the indices for these three microbes are—

Bac. hemiphloiæ, n.sp. ... Bac. 221·1113023.
Bac. eucalypti G.-S. ... Bac. 221·2322033.
Bac. levaniformans G.-S.... Bac. 121·2323022.

CONTRIBUTIONS TO A KNOWLEDGE OF AUSTRALIAN *CULICIDÆ*. No. ii.

By Frank H. Taylor, F.E.S.

(Plates xxviii.-xxix.)

(*From the Australian Institute of Tropical Medicine, Townsville.*)

The present paper contains descriptions of five new species, besides additional records for previously known species. The new species are distributed in the following genera:—*Stegomyia* (one), *Neomacleaya* (one), *Culicada* (one), and *Culex* (two).

The males of *Myzorhynchus barbirostris* var. *bancrofti* Giles, and *Culicelsa paludis* Taylor, are also described for the first time. The type-specimens have been deposited in the Institute-collection.

Myzorhynchus barbirostris van d. Wulp, var. bancrofti Giles.

♂. Similar to ♀; ungues of forelegs unequal, the larger with a tooth, of the mid and hind equal and simple. Antennæ with black plumes; palpi black, with a median pale band on the first joint. Thorax, abdomen, wings, and legs similar to ♀. Length, 6 mm.

Hab.—Port Douglas, Queensland.

This is the first time the male has been described.

Mucidus alternans (Westw.).

Theobald, Mon. Culicid., v., p.125(1910).

Hab.—Normanton, N. Queensland (F. H. Taylor).

This species was fairly common, during July, in the long grass near waterholes.

Stegomyia punctolateralis Theobald.

The Entomologist, Vol. xxxvi., p.156(1903).

Hab.—Queensland: Eidsvold (Dr. Bancroft); Burketown, Townsville (F. H. Taylor).

STEGOMYIA ATRIPES (Skuse). (Pl. xxviii., fig.1).

Scutomyia atripes (Skuse) Taylor, Proc. Linn. Soc. N. S. Wales, Vol. xxxviii., p.750 (1913).

I placed this species in the genus *Scutomyia*, but having examined fresh specimens, I am convinced that the narrow-curved scales on the head are accidental, and have probably been misplaced from the thorax.

Hab.—New South Wales: Milson Island (Dr. Ferguson), Blackheath (W. A. Thompson).

STEGOMYIA QUASIORNATA, n.sp. (Pl. xxviii., fig.2).

♂. Head black-scaled, with a band of greyish-blue scales round the eyes. Thorax pale, scantily clothed with small narrow-curved scales. Abdomen black, with prominent apical white spots, legs black, femora with two prominent white spots.

♀. Head black-scaled, with a border of greyish-blue scales round the eyes—deep blue in some lights—with black upright-forked scales at the base; antennæ black, verticillate hairs black, basal lobes testaceous: palpi black, with numerous black bristles; proboscis black.

Thorax yellowish, with a median and two lateral darker areas scantily clothed with small, black, narrow-curved scales; prothoracic lobes yellowish, clothed with small, black, flat scales: scutellum yellow, clothed with small, black, outstanding, flat scales; pleuræ densely clothed with white, flat scales.

Abdomen clothed with black scales, second segment with a small basal white spot, segments two to seven with prominent white apical spots; venter white-scaled.

Legs black-scaled, coxæ densely clothed with white scales; femora creamy beneath, with two white spots above on the apical third; tibiæ and tarsi black; ungues small, equal and simple.

Wings: costa black, spinose, veins clothed with dusky-brown scales, lateral vein-scales very scanty, fringe dusky; first fork-cell longer and narrower than the second, base of the latter nearer the base of the wing, their stems almost as long as their cells; anterior basal cross-vein longer than, and about one-half its length from the anterior cross-vein. Halteres with pale stems, and black knobs.

Length, 4·5 mm.

Hab.—Innisfail, Queensland (F. H. Taylor).

Apparently closely related to *S. ornata* mihi, but may be distinguished from it by the wing-characters, abdominal markings, and the spots on the femora.

PSEUDOSKUSEA BASALIS Taylor.

Ann. Report Commissioner Public Health, Queensland, p.27 (1912).

Hab.—Darwin, Melville Island, Northern Territory (F. H. Hill).

MACLEAYA TREMULA Theobald.

The Entomologist, Vol. xxxvi., p.155 (1903).

Hab.—Darwin, Point Charles, Northern Territory (G. F. Hill); Cairns, Queensland (F. H. Taylor).

NEOMACLEAYA AUSTRALIS, n.sp. (Pl. xxviii., fig.3).

Head clothed with brown scales. Abdomen black, unbanded. Legs brown. Thorax dark brown.

♀. Head clothed with light brown, flat, and black upright-forked scales, with a median line of pale brown narrow-curved ones; palpi black-scaled; antennæ dark brown, basal lobes brown; proboscis black.

Thorax dark chestnut-brown, clothed with bronzy-brown, narrow-curved scales; scutellum brown, clothed with bronzy-brown, narrow-curved scales.

Abdomen black-scaled, with lateral basal spots to all the segments; venter pale-scaled.

Legs brown, femora pale beneath; ungues equal and simple.

Wings with the costa spinose, veins clothed with black scales, first fork-cell longer, and about the same width as, the second, base of the former nearer the base of the wing; stem of the first fork-cell about one-third the length of its cell; stem of the second about two-thirds the length of the cell; anterior basal cross-vein longer than, and about its own length from, the anterior basal; halteres dusky.

Length, 4·5 mm.

Hab.—Halifax, North Queensland (F. H. Taylor).

Described from specimens taken at Halifax. It may be distinguished from *N. indica* Theobald, by its unbanded abdomen, ungues, and wing-venation.

Reedomyia pampangensis Ludlow.

Canadian Entomologist, Vol. xxxvii., p. 94 (1905).

A species, sent by Mr. G. F. Hill, differs slightly from the type in having the narrow-curved scales of the head uniformly pale. The thoracic markings are also very indefinite.

Hab.—Doctor's Gully, Northern Territory.

Culicada milsoni, n.sp.

Head clothed with pale, narrow-curved, and mixed pale and black, upright-forked scales, with black and white flat lateral ones. Thorax clothed with pale and dark brown narrow-curved scales, with white flat ones immediately in front of the scutellum. Abdomen with white basal bands. Tarsi with white basal banding.

♂. Head clothed with pale, narrow-curved, and pale black, upright-forked scales, with a large patch of brown narrow-curved ones on either side, separated from the eyes by a fringe of white narrow-curved scales, lateral ones flat, a narrow white patch above, then a large black patch; palpi black, shorter than the proboscis, apex of the second joint, and the third and fourth joints with black hairs beneath, second joint with a white, almost basal band, and another at the apex of the middle third, third and apical joints with white basal bands; antennæ with the nodes, last two segments, and plumes black, basal lobes pale, covered with white, flat scales; proboscis black.

Thorax dusky brown, clothed with dark brown, narrow-curved scales, with pale ones in the middle of the anterior half, and white ones on the lateral and anterior margins; and a patch of white, flat ones immediately in front of the scutellum, the latter brown, the mid-lobe with mixed flat, and narrow-curved, white scales, lateral lobes with narrow-curved ones, border-bristles black; prothoracic lobes prominent, clothed with white spindle-shaped scales; pleuræ brown, clothed with patches of white, flat scales.

Abdomen black, with white basal bands on segments two to five; venter denuded.

Legs black, fore- and mid-femora mottled beneath, hind- with the basal half white-scaled, the rest mottled; first and second tarsi of fore- and mid-legs with narrow, white, basal banding, the rest unbanded; first four tarsals of the hind-legs with broad, white, basal banding, fifth unbanded; ungues of fore-legs unequal, the larger with two teeth, the smaller with a single tooth, mid-ungues unequal, each with a single tooth, hind- equal and uniserrate. There is a thin and fairly long appendage, hairy at its apex, with its origin at the base of the fourth tarsus of the mid-leg, extending to the apex of the fifth.

Wings with the veins clothed with black scales; first fork-cell longer, and about the same width as the second, stem of the former about three-fourths of its cell, stem of the latter longer than the cell, base of the first fork-cell nearer the base of the wing; anterior basal cross-vein longer than, and about one-half its length from the anterior cross-vein, fringe dusky, halteres with pale stems and black knobs.

♀. Similar to ♂. Palpi black, with a few black bristles, second and third joints with white apical spots, apex white; antennæ black, ungues all equal and uniserrate.

Wings more heavily scaled than in the ♂; anterior basal cross-vein about its own length distant from the anterior cross-vein, stem of the first fork-cell about one-third, of the second about two-thirds the length of the cells.

Length, 5·5 mm. ♂; 6 mm. ♀.

Hab.—Milson Island, N.S.Wales.

I am indebted to Dr. E. W. Ferguson for one male and three females of the above species. It is readily separated from its congeners, owing to the thoracic clothing and the male ungues. The appendage on the tarsus of the mid-legs is very curious.

Two of the females show white, basal spots, instead of bands, but in other respects are typical.

Type ♂ in Coll. Dr. Ferguson

CULICELSA PALUDIS Taylor.

Rep. Aust. Inst. Trop. Med., 1911, p. 56 (May, 1913).

♂. Palpi black, with two pale bands on the second segment, one at the apex of the basal third, and one opposite the band on the proboscis, the third and apical segments also with basal pale banding, apex of apical segment also pale; antennæ with the last two segments brown, plumes dark brown; wing-venation similar to ♀, though it is not so heavily scaled; ungues of fore- and mid-legs unequal and uniserrate; of the hind- small, equal, and simple. Length, 5 mm.

The following is a description of the female wing, which was omitted from the original description through an error.

Costa black-scaled, veins clothed with dark brown scales; first fork-cell longer and narrower than the second, base of the latter nearer the base of the wing than that of the former; stems of the fork-cells about two-thirds the length of their cells; anterior basal cross-vein about twice its own length from the anterior cross-vein.

Hab.—Darwin, Northern Territory (G. F. Hill).

CULEX MOSSMANI, n sp. (Pl. xxix., figs.4-5).

Head clothed with grey, narrow-curved, and black upright-forked scales, and flat, white ones laterally. Thorax with pale narrow-curved scales. Abdomen with basal bands; tarsi with basal and apical banding.

♂. Head clothed with grey, narrow-curved, and numerous black, upright-forked scales, and flat, white ones laterally; proboscis black, with a creamy band on its apical third; palpi black, first segment with a broad band at the base of the apical third, a basal band on the third and apical segments, the latter also with the apex broadly banded; antennæ pale, nodes black, last two segments brown, plumes dusky.

Thorax dark brown, clothed with pale, narrow-curved scales; scutellum similar to thorax; prothoracic lobes prominent, with numerous light brown hairs; metanotum brown, pleuræ dark brown.

Abdomen clothed with chocolate-brown scales, and basal creamy bands, incomplete on segments five to seven; venter apparently similar to dorsum.

Legs black, femora pale beneath, tibiæ, first and second tarsals with creamy apical and basal banding, third basally banded; ungues of fore- and mid-legs unequal, each with a single tooth, hind- small, equal and simple.

Wings with the veins clothed with black scales, with three creamy spots on the costa, the basal one above the base of the anterior branch of the fifth long vein; the apical spot is situated at the apex of the first long vein, the second spot is midway between the other two, and extends to the base of the first fork-cell, the basal and apical spots extend to the first long vein, the anterior branch of the fifth vein is also creamy except the base and apex; first fork-cell longer, and narrower than the second, their stems about two-thirds the length of the cells, base of the second nearer the base of the wing; anterior basal cross-vein longer than, and about four times its length from the anterior cross-vein; fringe dusky, except at the apex of the posterior branch of the fifth long vein, where it is pale; halteres pale.

♀. Similar to the ♂. Palpi black, apex pale; antennæ dark brown, basal lobes pale, base of second segment pale; ungues all equal and simple; wings similar but more heavily scaled.

Length, ♂ 4; ♀ 4·5 mm.

Hab.—Mossman, Northern Queensland.

This species is closely related to *Culex mimeticus*. The wing-ornamentation and leg-banding are, however, quite distinct. It was bred from larvæ by Drs. Breinl and Priestley.

CULEX NORMANENSIS, n.sp. (Pl. xxix., fig.6).

Head clothed with pale, narrow-curved scales, and pale, flat ones on the sides. Abdomen with basal spots. Legs black, tarsi with white basal banding.

♂. Head clothed with grey, narrow-curved, and black, upright-forked scales, and pale, flat ones at the sides; palpi black, last two joints densely clothed with black hairs; antennæ densely clothed with black plumes; proboscis black; eyes blue-black.

Thorax brown, clothed with brown, narrow-curved scales; scutellum paler, clothed with pale scales, border-bristles pale, and long; pleuræ brown, clothed with small, white, flat scales; metanotum brown, prothoracic lobes prominent, clothed with dark, narrow-curved scales.

Abdomen brown clothed with brown scales, and with median, white, basal spots to the segments, which extend to the sides in some specimens; venter brown.

Legs brown, femora and tibiæ mottled with white scales, first and second tarsals of fore- and mid-legs with narrow, basal banding; first three tarsals of hind-legs with narrow basal banding, ungues of fore-legs unequal, the larger with two teeth and the smaller with one, of mid-legs unequal, each with a single tooth, hind- equal and simple.

Wings: costa black, vein-scales dark brown, first fork-cell longer and narrower than the second, base of the latter nearer the base of the wing, their stems nearly the length of their cells; anterior basal cross-vein longer than, and about its own length from, the anterior cross-vein. Halteres pale.

♀. Similar to ♂. Palpi black; antennæ brown. Thorax clothed with bronzy-brown, narrow-curved scales.

Wings similar to ♂, but more densely clothed. Ungues of fore- and mid-legs equal and uniserrate, of hind-legs equal and simple.

Length, ♂ 3·5-4; ♀ 4-4·5 mm.

Hab.—Normanton, Queensland (F. H. Taylor).

Described from a series of each sex, which were bred from larvæ.

CHRYSOCONOPS AURITES Theobald.

Mon. Culicid., ii., p. 209 (1903).

Hab.—Banker's Jungle, Northern Territory (G. F. Hill).

SKUSEA FUNEREA Theobald.

Mon. Culicid., iii., p. 292 (1903).

Hab.—Darwin, Northern Territory (G. F. Hill); Cairns, Innisfail, Queensland (F. H. Taylor).

SKUSEA UNIFORMIS Theobald.

Rec. Ind. Mus. iv., p. 33 (1910).

Hab.—Cairns, Queensland (F. H. Taylor).

I am unable to find any distinctions between specimens from the above locality, and Theobald's description.

HODGESIA TRIANGULATUS Taylor.

Trans. Ent. Soc. Lond., 1914, Part i., p.204.

Hab.—Darwin, N. Territory (G. F. Hill); Innisfail, Queensland (E. Jarvis and F. H. Taylor).

This species was originally described by me from Lakekamu Gold Fields, Papua.

EXPLANATION OF PLATES XXVIII.-XXIX.

Plate xxviii.

Fig. 1.—*Stegomyia atripes* (Skuse), ♀; wing.
Fig. 2.—*S. quasiornata*, n.sp., ♀; wing.
Fig. 3.—*Neomacleaya australis*, n.sp., ♀; wing.

Plate xxix.

Fig. 4.—*Culex mossmani*, n.sp., ♂; head.
Fig. 5.—*C. mossmani*, n.sp., ♀; wing.
Fig. 6.—*C. normanensis*, n.sp., ♀; wing.

FURTHER NOTES ON THE *LEPIDOPTERA* OF EBOR SCRUB, N.S.W.

By A. Jefferis Turner, M.D., F.E.S.

I had hoped to have explored this Scrub more thoroughly this season, but circumstances have prevented me from paying it more than two short visits, on February 2nd and 4th, 1915. On these visits, I took thirty species of Lepidoptera, of which only seven were obtained last year, but the additions are of some interest.

I now believe that the species I described as *Tortrix paraplesia* is really *T. sobriana* Wlk. I took an exactly similar specimen at Ebor, some miles from the Scrub; and it is also recorded from N.S.W.: Sydney, Bulli – Vic.: Melbourne, Warragul, Gisborne—Tasm.: Hobart. Out of thirty species* taken last year, four were known from other localities; twenty-two were described as new, and six were undetermined; but of the last, I now describe three more, having obtained further material. Of the twenty-three additional species taken this year, thirteen are known from other localities, nine are here described as new, and two remain undetermined. Undoubtedly my first impression as to the peculiarity of the fauna is to some extent corrected, but it still remains marked; for, of a total of fifty-five species, thirty-two appear new, eighteen are known from elsewhere, and five are undetermined. No doubt when the scrubs of the neighbouring district, as at Dorrigo, are explored, the Ebor Scrub fauna will appear less isolated.

* The following corrections must be made in my former list. Of *Xysmatodona polystona*, I have an example taken at Jenolan, N.S.W.; *Enchoptila idiopis*, as pointed out to me by Mr. Meyrick, belongs to the Amphitherinæ, and a species of *Cnephasia*, previously overlooked, is described below.

I append a complete list of the species taken this year, preceded by a tabulation of the total captures.

		Sp. in Jan., 1914.	Sp. in Feb., 1915.	Total sp.	Not known from elsewhere.	Found elsewhere.	Undetermined.
ARCTIADÆ:	*Lithosianæ*	2	3	4	2	2	—
GEOMETRIDÆ:	*Larentianæ*	1	3	4	—	4	—
	Geometrinæ	—	1	1	1	—	—
	Boarmianæ	1	2	2	1	1	—
PYRALIDÆ:	*Pyralinæ*	1	—	1	1	—	—
	Pyraustinæ	—	2	2	—	2	—
TORTRICIDÆ:	*Tortricinæ*	5	7	10	5	3	2
	Eucosminæ	2	1	3	2	—	1
TINEIDÆ:	*Gelechianæ*	1	—	1	—	—	1
	Œcophorinæ	14	8	20	16	3	1
	Heliodininæ	1	1	1	1	—	—
	Gracilarianæ	1	1	2	2	—	—
	Hyponomeutinæ	1	—	1	—	1	—
	Amphitherinæ	1	1	2	1	1	—
	Tineinæ	1	—	1	—	1	—
		32	30	55	32	18	5

Fam. ARCTIADÆ.

Subfam. LITHOSIANÆ.

APISTOSIA CHIONORA.

Lithosia chionora Meyr., Proc. Linn. Soc. N. S. Wales, 1886, p.702.

Apistosia chionora Hmps., Cat. Lep. Phal., ii., p.226.

One ♂. Also from Q.: Nambour, Brisbane, Mt. Tambourine—N.S.W.: Sydney.

PALÆOSIA BICOSTA.

Lithosia bicosta Wlk., Cat. Brit Mus., ii., 506; Meyr., Proc. Linn. Soc. N. S. Wales, 1886, p.702. *Palæosia bicosta* Hmps., Cat. Lep. Phal., ii., p.227.

One ♂, larger than usual (37 mm.) and with hindwings of a deeper ochreous colour. In this species, vein 11 may either anastomose with 12 or run free; this point cannot be relied on, therefore, for generic distinction. Also from N.S.W.: Glen Innes, Sydney—Tasm.: Hobart—S.A.: Mount Lofty.

TRISSOBROCHA EUGRAPHICA.

Turn., Proc. Linn. Soc. N. S. Wales, 1914, p.548.

One ♂, just like type except that discal spot of forewings is not pale-centered. There is an error in the description of this genus; 3 and 4 of hindwings are stalked, not connate.

Fam. GEOMETRIDÆ.

Subfam. LARENTIANÆ.

EUCHŒCA RUBROPUNCTARIA.

One ♀. A common and widely distributed species. Also from Q.: Duaringa, Brisbane, Coolangatta, Toowoomba—N.S.W.: Ben Lomond (4,500 ft.), Newcastle, Sydney—Vic.: Melbourne, Fernshaw, Gisborne, Birchip—Tasm.: Mt. Wellington, George's Bay. And from New Zealand.

EULYPE LEUCOPHRAGMA.

One ♀. The species of this genus are attached to ferns. Also from Q.: Mt. Tambourine—Vic.: Melbourne, Beaconsfield, Lorne.

Xanthorhoe sodaliata.

♀.*Cidaria sodaliata* Wlk., Cat. Brit. Mus., xxv., p.1410.

♂.*Coremia divisata* Wlk., Cat. Brit. Mus., xxxv., p.1682.

♀.*Xanthorhoë subidaria* var. *urbana* Meyr., Proc. Linn. Soc. N. S. Wales, 1890, p.865.

One ♂; I took two males also in Ebor, outside the scrub. This species has been confused with *X. subidaria* Gn.; the ♂ is very similar, but the ♀ widely unlike. I am indebted to Mr. L. B. Prout for examining Walker's types. It is a very abundant and widely distributed species, recorded from N.Q.: Atherton, Herberton, Townsville – Q.: Eidsvold, Gayndah, Brisbane, Stradbroke Island, Mt. Tambourine, Coolangatta, Toowoomba, Nanango, Killarney – N.S.W.: Murwillumbah, Glen Innes, Sydney— Tasm.: Hobart.

Subfam. Geometrinæ.

Prasinocyma lychnopasta, n.sp.

λυχνοπαστος, sprinkled with light.

♂.30 mm. Head and face green. Palpi $1\frac{1}{2}$, slender; terminal joint nearly as long as second; green, beneath whitish. Antennæ green; pectinations in ♂ very long (12), apical $\frac{1}{5}$ simple. Thorax green. Abdomen green, beneath whitish. Legs whitish, dorsal aspect green; posterior tibiæ in ♂ moderately dilated, and grooved on internal surface. Forewings triangular, costa moderately arched, more strongly towards base, apex rounded, termen nearly straight, slightly oblique; 3 and 4 connate, 6 short-stalked with 7, 8, 9, 10, 11 anastomosing with 12; bluish-green, apices of scales paler, causing an extremely fine transverse striation; a sparse irroration of lustrous green-whitish scales; a dark fuscous discal dot slightly before middle; antemedian and postmedian lines slightly darker and faintly indicated, the latter edged with a paler shade posteriorly; cilia pale green. Hindwings with termen bowed, slightly wavy, with a slight dentation on vein 4; as forewings, but discal dot minute, antemedian line obsolete, postmedian line irregularly dentate.

One ♂ in good condition. Nearest *P. calaïna* Turn., from Mt. Tambourine.

Subfam. BOARMIANÆ.

PHILOLOCHMA CELÆNOCHROA.

Turn., Proc. Linn. Soc. N. S. Wales, 1914, p.550.

One ♀ in good condition; larger than ♂ (35 mm.) and not so dark, especially in hindwings, which are concolorous with forewings, with a fuscous discal spot before middle, an incomplete fuscous line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, succeeded by a parallel row of fuscous spots.

PLANOLOCHA AUTOPTIS.

One ♂. Also from N.Q.: Herberton— Q.: Nambour, Brisbane, Mt. Tambourine, Killarney— N.S.W.: Jenolan— Vic.: Melbourne, Lorne.

Fam. PYRALIDÆ.

Subfam. PYRAUSTINÆ.

MUSOTIMA NITIDALIS.

Several examples. This species, which is attached to ferns, has a wide distribution. Q.: Nambour, Brisbane, Mt. Tambourine, Killarney— N.S.W.: Murwillumbah, Sydney— Vic.: Melbourne, Fernshaw— W.A.: Albany. Also from New Zealand.

SCOPARIA APHRODES.

One ♀, taken at rest on a tree-trunk, This rare species has a considerable range. Also from Q.: Killarney— N.S.W.: Sydney.

Fam. TORTRICIDÆ.

Subfam. TORTRICINÆ.

ISOCHORISTA sp.

An obscure little species, probably new; two ♂ examples, too much rubbed for description.

CAPUA sp.

Two ♀ examples of the species noted before, both rubbed; expansion 11 mm. I think I have the same species from Southern Queensland.

CAPUA PARALOXA.

This species was beaten abundantly out of the dead, lower fronds of the treeferns. I took ten examples (2♂, 8♀). Also from Q.: Mt. Tambourine—N.S.W.: Bulli, Lawson—Vic.: Beaconsfield.

CAPUA HEDYMA, n.sp.

ἥδυμος, sweet, pleasant.

♂. 16-17 mm. Head pale ochreous, sides brownish-tinged. Palpi long (3½); brown, inner surface whitish. Antennæ whitish-ochreous sharply annulated with dark fuscous; ciliations in ♂ 1. Thorax reddish-brown. Abdomen whitish. Legs whitish; anterior pair, except coxæ, fuscous. Forewings suboblong, costa strongly arched, apex rounded-rectangular, termen slightly rounded, scarcely oblique; brown, with 8 or 9 broken transverse lines partly reddish-brown, partly pale ochreous; terminal area rarely pale ochreous; costal fold broad, extending to $\frac{2}{5}$, reddish-brown, with 3 or 4 fuscous strigulæ; a pale ochreous spot on midcosta, succeeded by two similar dots; a large semilunar yellowish spot on dorsum from $\frac{1}{5}$ to $\frac{3}{5}$, its anterior portion more or less suffused, its posterior edge sharply defined by a fuscous line; sometimes there are a few fuscous dots on the transverse lines; a terminal series of obscure fuscous dots; cilia reddish-brown, apices pale ochreous. Hindwings and cilia whitish.

A distinct and attractive species; eight examples, all of the same sex.

CAPUA POLYDESMA, n.sp.

πολύδεσμος, many-chained.

♀. 18-22 mm. Head ochreous-brown. Palpi 3½; ochreous-brown, internal surface whitish. Antennæ pale ochreous-brown with some dark fuscous annulations. Thorax ochreous-brown. Abdomen whitish-grey Legs whitish; anterior pair fuscous-tinged. Forewings suboblong, costa strongly arched at base, then straight, apex rectangular, termen sinuate beneath apex; ochreous-brown, with numerous, fine, interrupted, fuscous-brown transverse lines; central fascia more or less obsolete, indicated by a fuscous shade on midcosta and on termen at $\frac{2}{3}$; a triangular fuscous spot on $\frac{3}{4}$ costa, sometimes entirely obsolete; cilia pale ochreous-brown, with a fuscous basal line, on tornus grey. Hindwings with termen sinuate; grey-whitish; cilia whitish.

Two ♀ examples.

Tortrix psarodes.

Five specimens (4 ♂, 1 ♀). Apparently not a winter species in this locality. Also from Q.: Brisbane, Warwick—Vic.: Gisborne, Sale - Tasm.: Hobart.

Arotrophora labyrinthodes, n.sp.

λαβυρινθώδης, intricate.

♂. 18-22 mm. Head fuscous. Palpi 5; fuscous. Antennæ fuscous; in ♂ dentate, ciliations $\frac{1}{3}$. Thorax fuscous. Abdomen grey. Legs fuscous; posterior pair ochreous-whitish; anterior and middle tarsi annulated with whitish. Forewings dilated, costa strongly and evenly arched, apex rounded, termen obliquely rounded; fuscous-grey, finely strigulated with ferruginous and dark fuscous; basal patch indicated by a fine dark fuscous line from $\frac{1}{6}$ costa to $\frac{1}{3}$ dorsum, dentate in middle; immediately beyond this a whitish fascia is sometimes developed, narrow on costa, dilated and less distinct in disc, narrow again on dorsum, but it may be wholly obsolete; median fascia very obscure on costa, better marked towards dorsum, irregularly dentate; discal area beyond this whitish or grey; sometimes four double whitish strigulæ on apical part of costa; cilia fuscous, with darker basal and postmedian lines. Hindwings pale grey, strigulated with darker grey; cilia pale grey, with a darker basal line.

Three ♂ examples. The much wasted ♀ previously referred to *Tortrix*, is probably referable to this species.

Cnephasia thiopasta, n.sp.

θειοπαστος, sulphur-sprinkled.

♂. 10-13 mm. Head fuscous. Palpi 3, pale fuscous. Antennæ fuscous; in ♂ slightly serrate and moderately ciliated ($\frac{2}{3}$). Thorax fuscous mixed with ochreous. Abdomen fuscous. Legs pale fuscous; posterior pair whitish. Forewings suboblong, costa strongly arched at base, thence straight, apex rounded, termen nearly straight, slightly oblique; whitish more or less suffused with fuscous and finely irrorated with ochreous scales; basal area fuscous on costa and dorsum and with its outer margin indicated by a line of dark fuscous and ochreous scales; median fascia indicated by a dark fuscous blotch on mid-costa, another obliquely beneath and partly confluent, and a paler and indistinct blotch on tornus; a dark fuscous blotch on $\frac{3}{4}$ costa succeeded by a smaller spot; cilia fuscous. Hindwings with termen sinuate; grey; cilia grey.

Three examples taken in January, 1914.

Subfam. EUCOSMINÆ.

BATHROTOMA CATAPASTA, n.sp.

καταπαστος, embroidered.

♂. 16 mm. Head dark fuscous. Palpi 3; terminal joint and apex of second joint grey. Antennæ fuscous; in ♂ with a dorsal notch at $\frac{1}{5}$, ciliations minute. Thorax dark fuscous, with a grey posterior spot. Abdomen grey, with some fuscous scales. Legs grey, with dark fuscous irroration. Forewings narrow-oblong, in ♂ with a broad costal fold reaching to $\frac{2}{5}$, narrowing towards extremity, costa bent at end of fold, apex rectangular, termen slightly sinuate; fuscous, towards base irrorated with grey, towards dorsum and tornus partly suffused with ochreous; a fine whitish line from $\frac{2}{5}$ dorsum to mid-disc, limiting fuscous basal area; some indistinct grey striæ on middle of costa; three double, white striæ on apical part of costa; a triangular blackish spot on dorsum before tornus, edged by a broad silvery line from tornus; a semilunar silvery line from above tornus, with a silvery dot between it and apex, and a blackish spot between it and white costal striæ; cilia grey, bases whitish, but in sinuation blackish. Hindwings with tornus prominent and acute; dark grey; cilia grey.

One ♂ example.

Fam. TINEIDÆ.

Subfam. ŒCOPHORINÆ.

PAROCYSTOLA HAPLOPHARA, n.sp.

ἁπλοφαρος, simply clothed.

♂. 14 mm. Head and thorax whitish-brown. Palpi ochreous-whitish; external surface of second joint, except at apex, fuscous. Antennæ ochreous-whitish, annulated with fuscous; ciliations in ♂ 1. Legs fuscous; posterior pair ochreous-whitish; anterior and middle tarsi annulated with ochreous-whitish. Forewings slightly dilated, costa moderately arched, apex rounded, termen obliquely rounded; whitish-brown, with a few scattered fuscous scales; discal dots dark fuscous, first at $\frac{1}{4}$, second on fold obliquely beyond first, third in middle, larger, rarely double; sometimes a fine fuscous subterminal line, usually represented by a few scales only; cilia whitish-brown. Hindwings and cilia whitish-grey

This species was rather common at the edge of the scrub, not taken inside, nor at any distance from it. Nine ♂ examples.

CŒSYRA SYNECHES.

Turn., Proc. Linn. Soc. N. S. Wales, 1914, p.558.

One ♂ example.

PROTOMACHA CATHARA.

Turn., Proc. Linn. Soc. N. S. Wales, 1914, p.559.

One ♀, not differing from ♂ type.

PHILOBOTA ISOMORA, n.sp.

♂. 18 mm. Head ochreous-whitish. Palpi ochreous-whitish; second joint suffused on outer surface with fuscous except at apex. Antennæ grey; ciliations in ♂ 1. Thorax ochreous-whitish, shoulders narrowly fuscous. Abdomen grey, tuft whitish-ochreous. Legs fuscous; posterior pair ochreous-whitish. Forewings not dilated, costa gently arched, more strongly towards base, apex pointed, termen nearly straight, oblique; ochreous-whitish with a very few scattered fuscous scales; costal edge near base dark fuscous; four fuscous discal dots, first at $\frac{1}{4}$, second on fold slightly beyond first, longitudinally elongate, third at $\frac{3}{5}$, fourth slightly beyond and beneath third; cilia ochreous-whitish. Hindwings grey; cilia ochreous-whitish.

Very similar to *Peltophora osteochroa* Turn., from Mount Tambourine, though with darker hindwings; certainly distinguished by the shorter ♂ ciliations. One ♂ specimen.

PHLŒOPOLA PANARCHA, n.sp.

πανaρχος, ruling all.

♂. 30 mm. Head fuscous mixed with ochreous; face grey. Palpi dark fuscous, inner surface of second joint, base and apex of terminal joint whitish, some ochreous scales on outer surface of second joint towards apex. Antennæ fuscous; ciliations in ♂ 2. Thorax dark fuscous; a posterior spot and apices of patagia white. Abdomen grey. Legs dark fuscous annulated with ochreous-whitish; posterior femora and tibiæ mostly ochreous-whitish. Forewings elongate, not dilated, costa rather strongly arched, apex rounded, termen obliquely rounded; fuscous irrorated with whitish towards margins; a whitish streak containing some fuscous scales from base along dorsum to $\frac{4}{5}$, dilated at extremity; a broad blackish streak from base of costa along fold to $\frac{2}{5}$; a blackish discal spot at $\frac{1}{4}$ confluent with this streak; a blackish spot in mid-disc preceded by a smaller blackish spot, and confluent with the apex of a blackish streak to apex of wing; a blackish spot on costa at $\frac{2}{3}$; a subterminal series of blackish dots, partially confluent, and ending in a large spot on tornus; cilia fuscous mixed with whitish. Hindwings pale grey; cilia grey-whitish, at apex grey. One ♂ example.

EULECHRIA STIGMATOPHORA.

Turn., Trans. Roy. Soc. South Aust., 1896, p.11.

Antennal ciliations in ♂ 2.

One ♂ (probably from the edge of the Scrub). I also took one ♂ at Ebor, some miles from the Scrub. Also from N.Q.: Kuranda near Cairns, Herberton—Q.: Caloundra, Brisbane, Stradbroke Island, Mount Tambourine, Killarney.

EULECHRIA sp.

One ♂ example, of rather large size (25 mm.), but too rubbed for identification.

EUTORNA EURYGRAMMA.

Two examples, ♂ and ♀. I took this also at Ebor, some miles from the Scrub. Also from N.S.W.: Mount Kosciusko—Vic.: Gisborne. And Tasmania.

Subfam. GRACILARIANÆ.

GRACILARIA LOXOCENTRA, n.sp.

λοξοκεντρος, with oblique centre.

♀. 12 mm. Head fuscous-bronzy; face whitish. Palpi white annulated with dark fuscous. Antennæ whitish annulated with dark fuscous. Thorax fuscous-brown. Abdomen dark grey. Legs brownish with fuscous annulations; posterior pair whitish with fuscous annulations. Forewings ochreous-whitish mostly suffused with brownish and strigulated with fuscous; median area paler, containing an outwardly oblique brownish fascia, from midcosta to dorsum beyond middle, narrow on costa dilated on dorsum; a broad dark fuscous fascia from $\frac{3}{4}$ costa to tornus, its anterior edge toothed beneath costa, posterior edge straight, oblique; followed by a pale triangular costal spot: cilia ochreous-whitish, on tornus fuscous, on dorsum grey. Hindwings and cilia dark grey.

Closely allied to *G. plagata* from Brisbane, but darker in colour, with complete posterior fuscous fascia, without dorsal and apical spots, and differing in other details. One ♀ example, taken on a mossy tree-trunk.

Subfam. HELIODININÆ.

STATHMOPODA CRYERODES, n.sp.

κρυερωδης, icy.

♀. 9 mm. Head, thorax, and palpi white. Antennæ white, towards apex greyish. Abdomen ochreous-whitish, towards apex grey, tuft white. Legs white; anterior pair dark fuscous anteriorly; posterior tibiæ with a blackish apical ring. Forewings narrow; shining white with apices of scales grey; a very faint suffused median transverse grey fascia; apical area suffused with grey; cilia grey. Hindwings linear; grey; cilia grey.

One specimen; I took one also on my previous visit.

Subfam. AMPHITHERINÆ.

AMPHITHERA MONSTRUOSA.

Turn., Proc. Linn. Soc. N. S. Wales, 1913, p.223.

Two ♂ examples, with the white apical patch more developed than in the type from Herberton, North Queensland. I was surprised to take this curious species so far from the locality first recorded.

HYDROIDS FROM NEW SOUTH WALES.*

By E. A. Briggs, B.Sc., Zoologist, Australian Museum, Sydney.

(Communicated by A. R. McCulloch.)

(Plates xxx.-xxxi., and Text-fig.1.)

i. *Introduction.*

In 1911 Dr. Ritchie described, under the name of *Sertularella longitheca* Bale, var. *robusta*, several hydroid specimens obtained by the "Thetis" Trawling Expedition off the coast of New South Wales. He had only sterile specimens for examination, but several additional colonies bearing gonangia occur among some Polyzoa, which were dredged by the same Expedition in Newcastle Bight, N.S.W., at a depth of 26-40 fathoms. In view of the totally distinct gonangia, these specimens cannot be regarded as belonging to a variety of *Sertularella longitheca*. The characters are so distinct from those recorded, that it is necessary to raise Ritchie's variety to specific rank. The name *robusta* is preoccupied in the genus, and, therefore, I substitute *Sertularella ritchiei*.

The second species here under discussion is represented in the Australian Museum collection by some fine colonies from Maroubra Bay, near Sydney, N.S.W.

ii. *Description of the Species.*

Order **Calyptoblastea.**

Family SERTULARIDÆ.

Genus Sertularella Gray.

Sertularella ritchiei, nom.nov.

(Plate xxx., figs.1-2; Plate xxxi., fig.2; and Text-fig.1.)

Sertularella longitheca Bale, var. *robusta* Ritchie, Mem. Austr. Mus., iv., 16, 1911, p.841, Pl. lxxxviii., fig.8.

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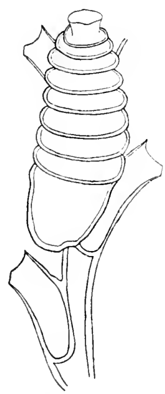
* Contributions from the Australian Museum.

Trophosome.—Colonies attaining a height of 40 mm. Stem monosiphonic, geniculate, lax in growth, with rare and irregular branches, which spring, with a long internode, from directly beneath a hydrotheca. The branches reach a length of 20 mm, and are divided into regular internodes, each of which bears a hydrotheca towards its distal extremity. The internodes are zig-zag, bending from one side or the other in gentle curves, which follow the inner lines of the hydrothecæ and give a geniculate form to the stem. In the older portions of the colonies, owing to the great thickness of the perisarc, the nodes usually become obscured, although a slight constriction immediately distal to a hydrotheca generally indicates their position. In the majority of the stems there is no trace of division into internodes.

The hydrothecæ are alternate and lie towards the distal ends of the internodes, to which they are adnate for about two-thirds of their length. They are remarkable for their great depth and for the length of the adnate portion. They are not quite tubular, but reach a maximum diameter at the point where they become free, tapering slightly downwards until they end in a rounded base, and less markedly towards the mouth. The margin of the hydrotheca is divided into three teeth, one adcauline, central and projecting, the others forming an abcauline lateral pair. The teeth are separated by shallow embayments. The free adcauline wall of the hydrotheca is marked by several definite undulations. The hydrothecal walls are strongly developed. There is a tendency to regeneration of the hydrothecæ, many of the margins being repeated twice or thrice. The colour of the colonies is dark brown.


Text-fig. 1.—*Sertularella ritchiei*, part of stem, with gonangium, seen from the anterior, × 16.

Gonosome.—The gonangia are borne on the stems and branches. They lie along the anterior of these, and are so closely appressed to the branch that the adcauline portion of the gonangium becomes hollowed out into a longitudinal furrow to fit it, as in the case of *Sertularella adpressa* Ritchie* and *Thecocladium flabellum* Allman†. The insignificant stalk of the gonangium arises from the side of the stem or branch opposite the base of a hydrotheca. The gonangia are large and ovate, with a short tubular neck with a slightly everted lip, and three short apical teeth. They are surrounded by eight annular ridges, except on the back where the longitudinal furrow, into which the annulations do not extend, is appressed to the branch. The lower proximal portion is smooth, or with very faint traces of annulation. The extreme distal portion of the gonangium projects forward, and has the ridges completely annular. The gonangia average 1·8 mm. to 2·1 mm. in length, by 0·70 mm. to 0·80 mm. in maximum diameter. The aperture has an internal diameter of 0·20 mm. to 0·24 mm., with a slightly everted lip 0·26 mm. to 0·31 mm. across.

Dimensions.

Internode, length	0·75-0·94 mm.
Internode, diameter	0·22-0·29 mm.
Hydrotheca, length adnate	0·57-0·66 mm.
Hydrotheca, length free	0·38-0·43 mm.
Hydrotheca, diameter at mouth	0·28-0·32 mm.
Gonangium, length	1·80-2·10 mm.
Gonangium, maximum diameter	0·70-0·80 mm.

As the above measurements show, there is some variation in the proportion of the adnate part of the hydrotheca, but the proportion is generally over a half, and frequently as much as two-thirds may be adnate.

In his Report on the Hydrozoa of the "Thetis" Expedition, Ritchie has described several specimens as a variety of *Sertularella longitheca* Bale, although "none of the characteristic gonangia were present, but in spite of this, and of the divergences from typical specimens. . . . I do not hesitate to regard these as belong-

* Ritchie, Mem. Austr. Mus., iv., 16, 1911, p.838.

† Allman, Rep. Sci. Results "Challenger" Exped., Zool., xxiii., Hydroida, Pt. ii., 1888, p.81.

ing to a form of *Sertularella longitheca*."* Additional colonies with gonangia were obtained from Newcastle Bight, N.S.W., and in view of the totally distinct structure and habit of the gonangia they cannot be associated with that species. I now raise Ritchie's variety to specific rank; the name *robusta* is preoccupied in the genus, and, therefore, I substitute *Sertularella ritchiei*.

In the absence of gonangia, *Sertularella ritchiei* may be distinguished from *Sertularella longitheca* by its coarser growth, larger hydrothecæ, geniculated stem, and internodes which slope successively in opposite directions. The shapes of the hydrothecæ differ in the two species; in *S. longitheca* a hydrotheca is regularly tubular in shape; in *S. ritchiei* a hydrotheca is not quite tubular, but reaches a maximum diameter at the point where it becomes free, tapering slightly downwards until it ends in a rounded base, and less markedly towards the mouth. Also, as a general rule, the hydrothecæ of *S. ritchiei* are rather more curved, the lower portion being more erect, and the outward curvature of the upper part more marked than in *S. longitheca*, in which, however, the extreme top of the hydrotheca often shows a slight tendency to curve upward. The latter species, however, does not show any indications of rugosity on the free adcauline wall of the hydrotheca. The proportions of the hydrothecæ also differ; in *S. ritchiei* the hydrotheca is more robust, and is adnate for over a half, and for as much as two-thirds of its length; while in *S. longitheca* only from one-third to one-half of the hydrotheca is adnate. In *S. ritchiei* the embayments between the teeth on the margin of a hydrotheca are much shallower, and the teeth, therefore, appear less prominent than do those of *S. longitheca*. Lastly, the dimensions of *S. ritchiei* throughout are much larger.

Locality.—"Thetis" Station 22, Newcastle Bight, N.S.W., six to five miles from shore; depth, 40-26 fathoms; bottom, grey sand to mud and shell; 2nd March, 1898; several colonies with gonangia growing on the horny axis of an Alcyonarian.

Type Specimen.—In the Australian Museum, Sydney.

* Ritchie, Mem. Austr. Mus., iv., 16, 1911, p.842.

Family PLUMULARIDÆ.

Genus HALICORNARIA Busk.

HALICORNARIA GONIODES, sp.nov.

(Plate xxx., figs. 3-7; Plate xxxi., fig. 1.)

Trophosome.—Hydrocaulus monosiphonic, 28 cm. in height, unbranched, or with a few branches near the summit. The main stem gives off at irregular intervals short peduncles, which spring from the front, curve upward, and fork into two branches, which diverge at right angles, and have their anterior aspect directed towards that of the stem. A perfect distinction is thus maintained between the stem and branches. The latter reach a length of 11 cm., and each may give rise, midway between its point of origin and its distal extremity, to a peduncle which also bifurcates into two new divisions. The peduncles are divided into internodes, usually eight or nine in number. They are devoid of hydroclades, but are armed with a series of large sarcothecæ along their anterior and posterior aspect. The stem is divided into internodes, which bear two hydroclades. In the branches, the internodes fall roughly into two size-groups—those on the lower part of the branch which bear two hydroclades, and those on the distal part, which, as a rule, bear only a single hydroclade each, and are about half the length of the former. The hydroclades are alternate, 10 mm. in length, both series springing from the anterior of the stem and branches. They are set at an angle of about 40°, and are divided into a series of internodes, each of which bears a solitary hydrotheca.

The hydrothecæ are sub-cylindrical, narrowing towards the base; the axis of the hydrotheca lying away from the hydroclade at an angle of about 45°. The thickened adcauline wall of the hydrotheca makes a very abrupt angle, and even in many cases is prolonged past the actual base of the cell. The apocauline wall meets the base at almost as sharp an angle, while the base itself is straight. The margin of the hydrotheca is scalloped into seven very distinct teeth, of which the median anterior one is well developed and slightly recurved; while the three, which occur on each side, occupy a more or less erect position, although the abcauline two show a tendency to bend outwards. The back is entire. There is no intrathecal ridge. The aperture between the hydrotheca and the internode is surrounded by minute sharp denticles projecting into the hydrotheca. There are no septal ridges in the internode.

The mesial sarcotheca is based on the much elongated proximal part of the internode, and projects at a wider angle than the hydrotheca, to the basal part of which it is adnate most of its length, but with a short free projecting portion. The mesial sarcotheca is small, and stops considerably short of the margin of the hydrotheca. The terminal and inferior apertures are distinct, though closely approximate. The terminal aperture is small and circular. The lateral sarcothecæ are adnate, saccate, with a circular sub-tubular orifice directed downwards from the hydrotheca and outwards, and distinct from the wide lateral aperture. There are three cauline sarcothecæ; two on the anterior surface of the rachis at the base of each hydrocladium, large and swollen, with two circular orifices bordering the free margin; the third is similar to the laterals in shape and is situated at the back of each axil.

Gonosome.—Unknown.

Colour.—Light brown, stem and branches darker.

Dimensions.

Stem internode, length	0·71-0·78 mm.
Stem internode, diameter	0·38-0·43 mm.
Branch internode, length	0·38-0·73 mm.
Branch internode, diameter...	0·24-0·29 mm.
Hydroclade internode, length	0·33-0·36 mm.
Hydroclade internode, diameter	0·19-0·22 mm.
Hydrotheca, depth	0·23-0·24 mm.
Hydrotheca, breadth at mouth (lateral aspect) ...	0·19-0·21 mm.
Anterior cauline sarcotheca, greatest width ...	0·14-0·17 mm.

The habit of the colonies is striking. The stems spring from a dense mass of hydrorhizal filaments and either remain simple, or towards their distal extremity give off, at irregular intervals, two or three short peduncles. These spring from the front of the hydrocaulus, and, at their origin, are directed forward, so as to take them out of the plane of the stem; soon, however, they take a characteristic curve upward, become erect, and divide into two equal branches with their anterior aspect directed towards that of the stem. Each successive branch grows in the same manner. The hydroclades are borne on the anterior of the stem and branches, often only one on an internode on the distal part of a branch. Sometimes an internode occurs with three hydroclades.

Another striking feature is the angularity of the hydrotheca, especially at the base where the thickened adcauline wall makes a very abrupt angle, and even in many cases is prolonged past the actual base of the cell. The apocauline wall meets the base at almost as sharp an angle, while the base itself is straight. The chitinous projection within the mesial sarcotheca is well-developed, swelling out as soon as it passes beyond the point of attachment of the sarcotheca. The latter organ has a very wide basal portion, and is based on the much elongated proximal part of the internode.

Locality.—Maroubra Bay, near Sydney, N.S.W.

Type Specimen.—In the Australian Museum, Sydney.

EXPLANATION OF PLATES XXX.-XXXI.

Plate xxx.

Fig. 1.—*Sertularella ritchiei* Briggs, part of stem with hydrothecæ and base of branch, ×20. (After Ritchie).

Fig. 2.—*Sertularella ritchiei* Briggs, part of stem with hydrothecæ, ×33.

Fig. 3.—*Halicornaria goniodes* Briggs, portion of hydroclade with hydrothecæ, lateral aspect, ×48.

Fig. 4.—*Halicornaria goniodes* Briggs, portion of hydroclade with hydrothecæ, anterior aspect, ×62.

Fig. 5.—*Halicornaria goniodes* Briggs, hydrotheca, lateral aspect, ×90.

Fig. 6.—*Halicornaria goniodes* Briggs, hydrotheca, anterior aspect, ×80.

Fig. 7.—*Halicornaria goniodes* Briggs, part of stem with the bases of four hydroclades, anterior aspect, ×30.

Plate xxxi.

Fig. 1.—*Halicornaria goniodes* Briggs. Photograph of the type, 28 cm. in height, from Maroubra Bay, near Sydney, N.S.W.

Fig. 2.—*Sertularella ritchiei* Briggs. Photograph of colonies from "Thetis" Station 22, Newcastle Bight, N.S.W., 40-26 fathoms. Nat. size.

CORRIGENDUM.

The legend of Plate xxx. should read :—

1-2. *Sertularella ritchiei*, nom. nov. 3-7. *Halicornaria goniodes*, n. sp.

PRELIMINARY NOTE ON THE REMARKABLE, SHORTENED DEVELOPMENT OF AN AUSTRALIAN SEA-URCHIN, *TOXOCIDARIS ERYTHROGRAMMUS.*

By Dr. Th. Mortensen, Copenhagen.

(Communicated by Dr. S. J. Johnston.)

During a visit to Australia in August-October, 1914, I was very anxiously looking for opportunities for studying the development of Australian Echinoderms in continuation of the researches carried out in Japan, in April-July of the same year. It proved, however, to be a very unfavourable time of the year for that purpose, not a single species of Echinoderms having ripe sexual products – except the small *Asterina exigua*, which, as has been made known by Whitelegge, has care of its brood, like the European species, *Asterina gibbosa.* I had then to alter my plans to some extent, and went to New Zealand in the beginning of November, one month earlier than originally planned. In that way, I could arrange for a stay in Sydney during the later part of the summer, February-March, at which time it might be expected that the majority, at least, of the littoral Echinoderms of Port Jackson would prove to have ripe sexual products.

To my surprise, even this turned out to be a little too early in the season for my object. Of the Echinoderms, of which material in any sufficient quantity was available, only one species —always *Asterina exigua* excepted—was really in the breeding season now, namely, *Toxocidaris erythrogrammus.* Of the three other common littoral sea-urchins, one, *Centrostephanus Rodgersii*, was still very far from having ripe sexual products; it must, evidently, have its breeding season in the middle of the winter; the two others, *Phyllacanthus parvispinus* and *Holopneustes purpurascens*, were nearly ripe, but not quite. Among the other Echinoderms, of which material was available, not one was found with quite ripe eggs. It was thus alone *Toxocidaris erythrogrammus*, the development of which could be studied. But this proved, in return, to be quite unusually interesting, so that it was thought advisable to publish this short preliminary account of it.

The eggs of *T. erythrogrammus** are large, ca. 0·5 mm. in diameter, red-yellowish, and quite intransparent, evidently full of a yolky substance; they are *floating at the surface of the water*, a case not hitherto observed in Echinoderms. The cleavage is total, and, in the first stages in any case, quite regular. The gastrulæ are not bound to the surface, but swim free in the water, with the usual rotating movement. The aboral end, which evidently contains the main part of the yolk, and thus is the lighter end, is always turned upwards and remains so during the whole of the development.

Just above the oral end, a slight widening of the body of the body of the embryo occurs, though not quite constantly, it seems. This may perhaps represent a rudiment of the postoral larval processes; but they do not develop further, and there is no indication of the typical Pluteus-shape at all; and, moreover, so

* In Th. Whitelegge's "List of the marine and freshwater Invertebrate Fauna of Port Jackson and neighbourhood" (1889), this species is mentioned under the name of *Strongylocentrotus erythrogrammus*. As I have shown in my work on the Echinoidea of the Danish Ingolf-Expedition (Part i., 1903), the genus *Strongylocentrotus* must be restricted to a certain group of northern species, the species *drœbachiensis* being the type of the genus; the species *erythrogrammus*, together with several other species from the Pacific, must be referred to the genus *Toxocidaris*. It is quite probable that the name *erythrogrammus* will ultimately have to be changed. The species figured under that name by Valenciennes (Voyage de la Frégate Venus) is evidently the South American species *Loxechinus albus*, and not the common Australian species. Which name should then eventually be substituted for *erythrogrammus*, I cannot say at present, having, of course, no access to literature here. I may take the opportunity to point out here that the other species of *Strongylocentrotus* mentioned in Whitelegge's List, *Str. tuberculosus*, is no true *Strongylocentrotus* either; and, moreover, it is by no means specifically identical with the common Japanese *Toxocidaris tuberculatus*. What the correct name of this species will be, I am not prepared to say at present, having not had the necessary literature or time for investigating this matter.

far as I have been able to ascertain on the quite intransparent living embryo, there is no trace of a larval skeleton.

There is a general ciliation of the whole body of the embryo, but no special ciliated bands. A ring of red pigment is formed round the mouth, and gradually more or less of a reddish pigment develops all over the body. Some specimens, however, have scarcely any pigment at all; such probably give rise to the very light-coloured specimens, which are often found among the otherwise generally dark-coloured specimens of this species.

The young sea-urchin develops on one side of the embryo, just above the mouth, and here the primary tube-feet are soon seen to protrude. The aboral part of the body, which serves as a reservoir of nourishment for the embryo, gradually shortens, and ultimately becomes completely overgrown by the young urchin, and enclosed within its body. The first spines to appear are of the trifid, embryonal type; but soon the spines of the usual, pointed shape, make their appearance.

When the first rudiments of the sea-urchin begin to appear, the embryo generally sinks to the bottom, remaining there in the usual position, mouth downwards; many specimens, however, remain swimming until the metamorphosis is nearly completed; especially a number of specimens remained at the surface, at the contact-line between the water and the glass. The whole metamorphosis is completed in the course of 4-5 days.

The details of the formation of the enterocœl and all the internal transformation-processes, upon the whole, can only be studied by means of sections. That must be postponed till after my return to Copenhagen. Likewise, the development of the skeleton of the young urchin will have to be studied carefully later on, the conditions, under which I had to carry out my experiments, being far too unfavourable for such minute and partly very difficult research.

This is the most reduced development hitherto known in any Echinoid with free-swimming embryos. The development of *Laganum decagonale*, described in my paper "On the development of some Japanese Echinoderms" (Annot. Zool. Japonenses, Vol. viii., 1914), is not nearly so reduced, the typical larval shape being there still distinctly recognisable, But I feel quite convinced that this will not be a unique case. I think I may predict rather safely that a quite similar shortened development will prove to obtain in two other of the common Echinoids of Port Jackson, namely in *Phyllacanthus parvispinus* and *Holopneustes purpurascens*. In both of these, the eggs are large and intransparent, and float at the surface. (I succeeded in finding a few ripe eggs in a specimen of *Phyllacanthus,* and got them fertilised; but, unfortunately, none of the embryos obtained survived the Gastrula-stage). It is remarkable to find such a large percentage of the littoral Echinoids of the New South Wales coast having such an aberrant type of development, and one can scarcely help thinking that the natural conditions there may account for that. But which are the real factors to which such influence on the development is due, nobody, of course, can say, at present at least.

I may still mention that *Holopneustes purpurascens* shows a very marked difference in the coloration of the gonads of the two sexes; the male genital organs are bright pink, the female gonads dark olive-coloured. The black intestine also affords a very conspicuous contrast in colour to the generally pink test and spines. Judging from the different size and colour of the eggs in the same gonad, this species would appear to breed twice in the season.

On board s.s. "Sonoma,"
The Pacific, 2°S., 172°W., March 20, 1915.

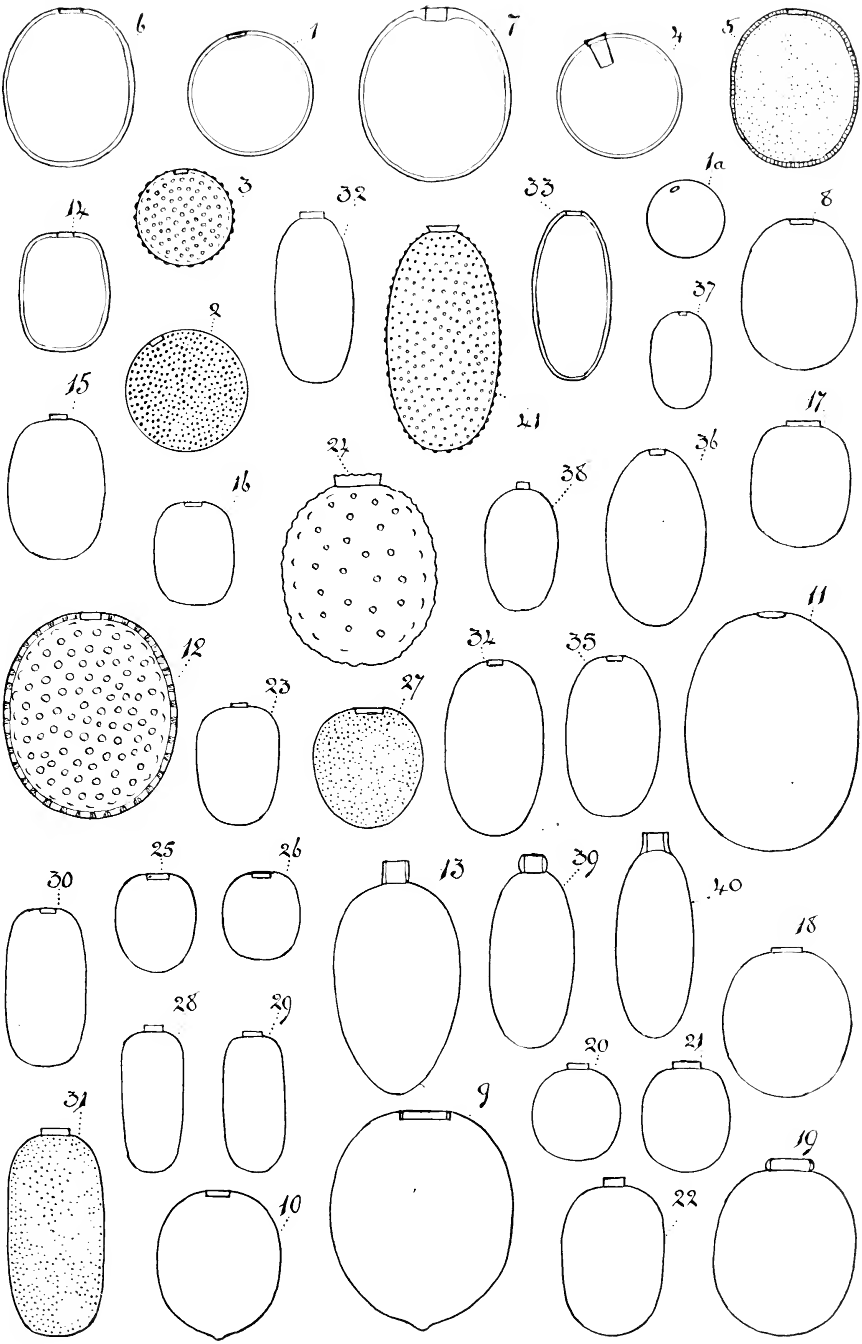
Postscript: added June 4th, 1915—Lyman Clark assigns the name *Heliocidaris* to the group of species to which I have applied the name *Toxocidaris*. As I cannot, of course, go deeper into these matters of nomenclature here [Honolulu], I shall, at present, at least, keep the name *Toxocidaris*, leaving the possible change till later, when I have had the opportunity of carefully considering Clark's reasons for this use of the name *Heliocidaris*.

Mr. Hedley exhibited a recent conchological work published in Japan, illustrating in colours one hundred Japanese shells, the first Part of "Illustrations of one thousand Shells," by Y. Hirase (1915). The exquisite native art of Japan is here employed in the service of science.

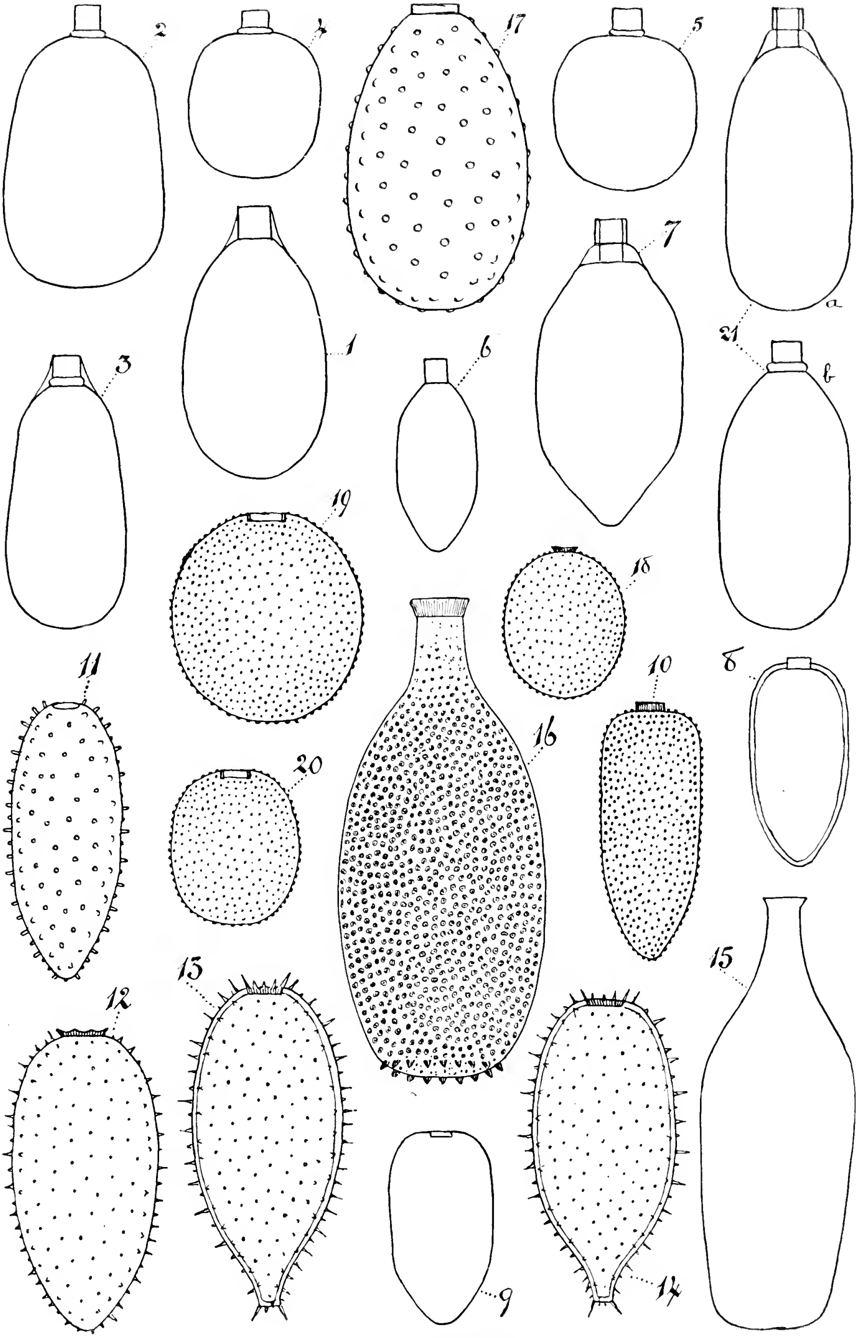
Mr. E. Cheel exhibited specimens of *Digitaria glabra* Beauv., (*Panicum glabrum* Gaud.) from additional localities to those already recorded in these Proceedings (1910, p.688), namely:—Botany Swamp (W. F. Blakely; January, 1912); Cundletown, Manning River (M. Ahronson; December, 1913); Hill Top (E. Cheel; March, 1914). This grass is of annual duration, but of very little value as a forage-plant, and can be regarded only as a weed, unsuitable as a lawn-grass. Specimens of *D. didactyla* Willd., (*Panicum didactylum* Kunth) were also exhibited, for comparison, as this latter species has been previously mistaken for *D. glabra*, and recorded for Nudgee, Queensland (Queensland Agric. Journal, xvi., p.410, 1906), and apparently for this State also; as, although it has been stated to be common at Vaucluse (*vide* these Proceedings, 1910, p.804), three visits to this locality resulted in failure to find it. Mr. F. M. Bailey has corrected his determination of the Nudgee specimen in his "Comprehensive Catalogue of Queensland Plants"(p.603).—Specimens of *Panicum globoideum* Domin, from Moree, together with authentic specimens of *P. flavidum* Retz., from the Gangetic Plain, North-Western India, collected by Duthie; and from the Philippines, collected by C. M. Weber (No.1048), were also exhibited to show that *P. globoideum* Domin, is a very different and well marked species. Specimens of *P. ramisetum* Scribn., and *P. Reverchoni* Vasey, natives of Texas, from the National Herbarium Collection, were likewise exhibited for comparison, to show the much closer resemblance to, and relationship with *P. globoideum* than with *P. flavidum*. Hitchcock and Chase, in "Contributions from the U. S. National Herbarium" (xv., p.22, 1910), have set up a subgenus, *Paurochætium*, under which both *P. ramisetum* and *P. Reverchoni* are included. Mr. F. M. Bailey, Colonial Botanist of Queensland, has recognised *P. globoideum* as a distinct species, as he records it as a Queensland plant in his "Comprehensive Catalogue of Queensland Plants" (p.604, 1909). *P. globoideum* and *P. gracile* R.Br., appear to be closely allied, and should be classed under the subgenus *Paurochœtium.*

Mr. A. A. Hamilton showed specimens of *Phlox* (perennial) Hort.var. (Sydney, Botanic Gardens; W. M. Carne; February, 1915) showing prolification of the inflorescence accompanied by virescence. In the initial stage, a loss of colour in the flower is noted, with exceptional mortality among the buds; later, most of the flowers have lost their colour, the corolla-tube is reduced in length, the stamens are dilated and have lost their fertility, and the ovary is attenuated. In the third stage, the corolla-tube has disappeared, and the lobes have separated into distinct segments; the stamens, which in the normal plant are situated in the throat of the corolla-tube and are nearly sessile, have developed lengthy filaments, and are seated on the base of the corolla segments; the ovary is reduced to a callosity at the top of the peduncle, from which supernumerary flowers emerge. In the final stage, the whole of the floral organs are reduced to a whorl of leaves, the floral character of those representing the corolla being indicated by an abortive attempt at coloration.—*Carduus lanceolatus* Linn., (The Manager, A.J.S. Bank; Armidale; January, 1905) showing prolification of the inflorescence, accompanied by fasciation and spiral torsion. A series of flower-heads are seen spirally arranged on several united, dilated, twisted stems, The strain of the contortion of the capitula has displaced the spines on the involucral bracts to such an extent as to make them appear reversed. The stigmas of the female florets are infertile, and the achenes attenuated and abortive.—*Podocarpus spinulosa* R.Br., (T. D. Mutch; Manly; February, 1915) showing multiplication of seeds. Dr. Masters (Vegetable Teratology, p.368) says: multiplication of seeds is not a common occurrence in plants in which the number of seeds is normally small, and he remarks that it is usually noted in conjunction with some change, such as a foliaceous condition of the carpels. In this case, there is normally but one seed, to which, in some

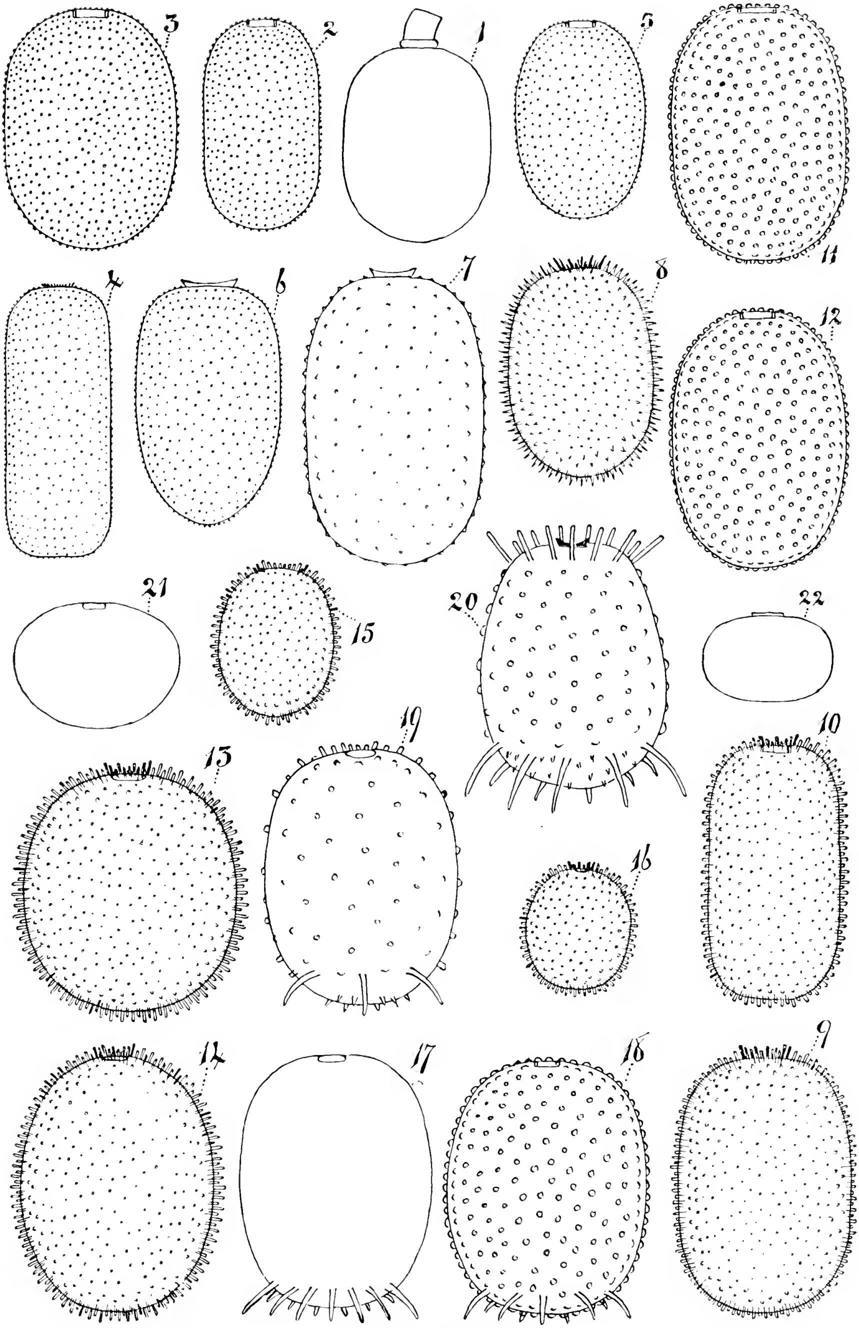
[Printed off, 12th June, 1915.]



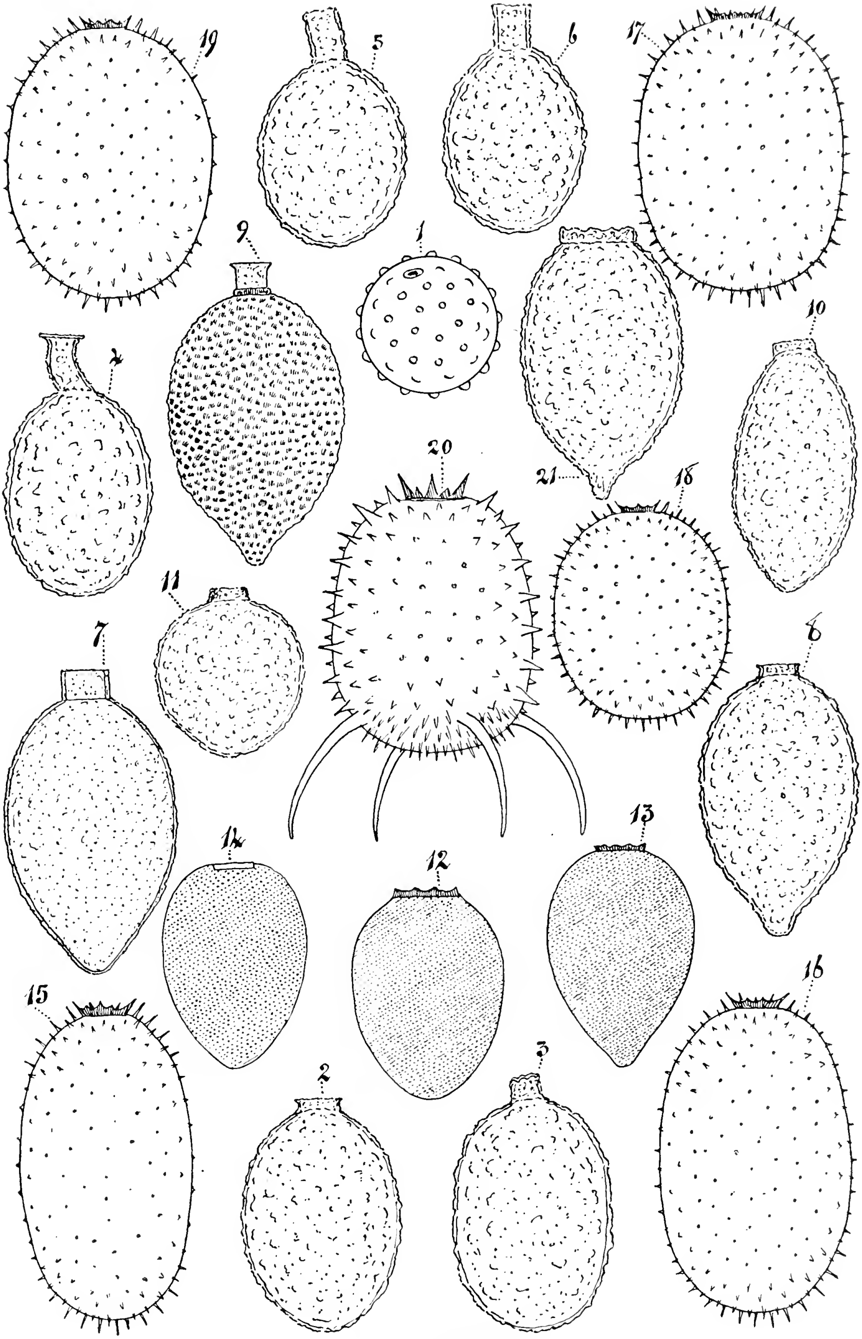
Forms of *Trachelomonas.*



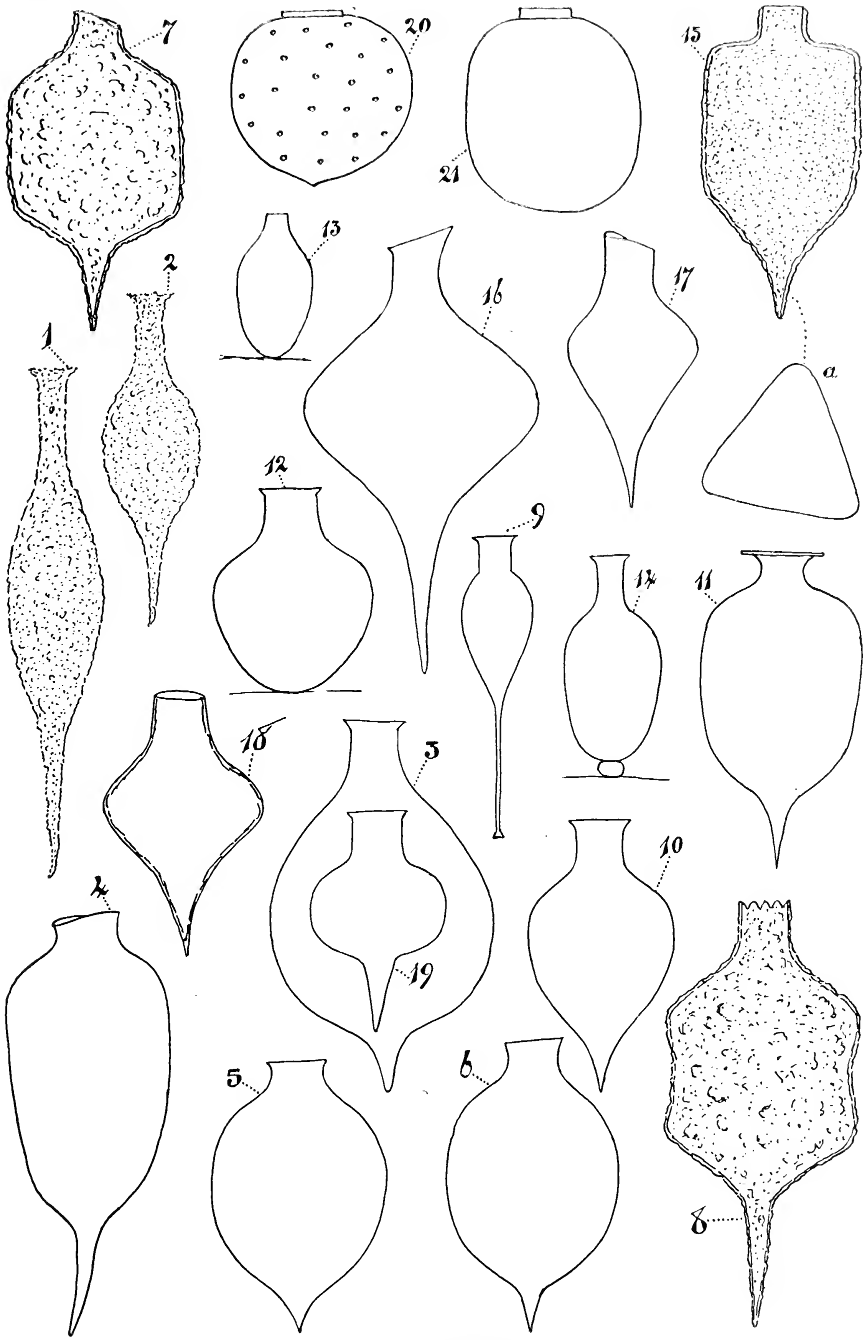
Forms of *Trachelomonas*.



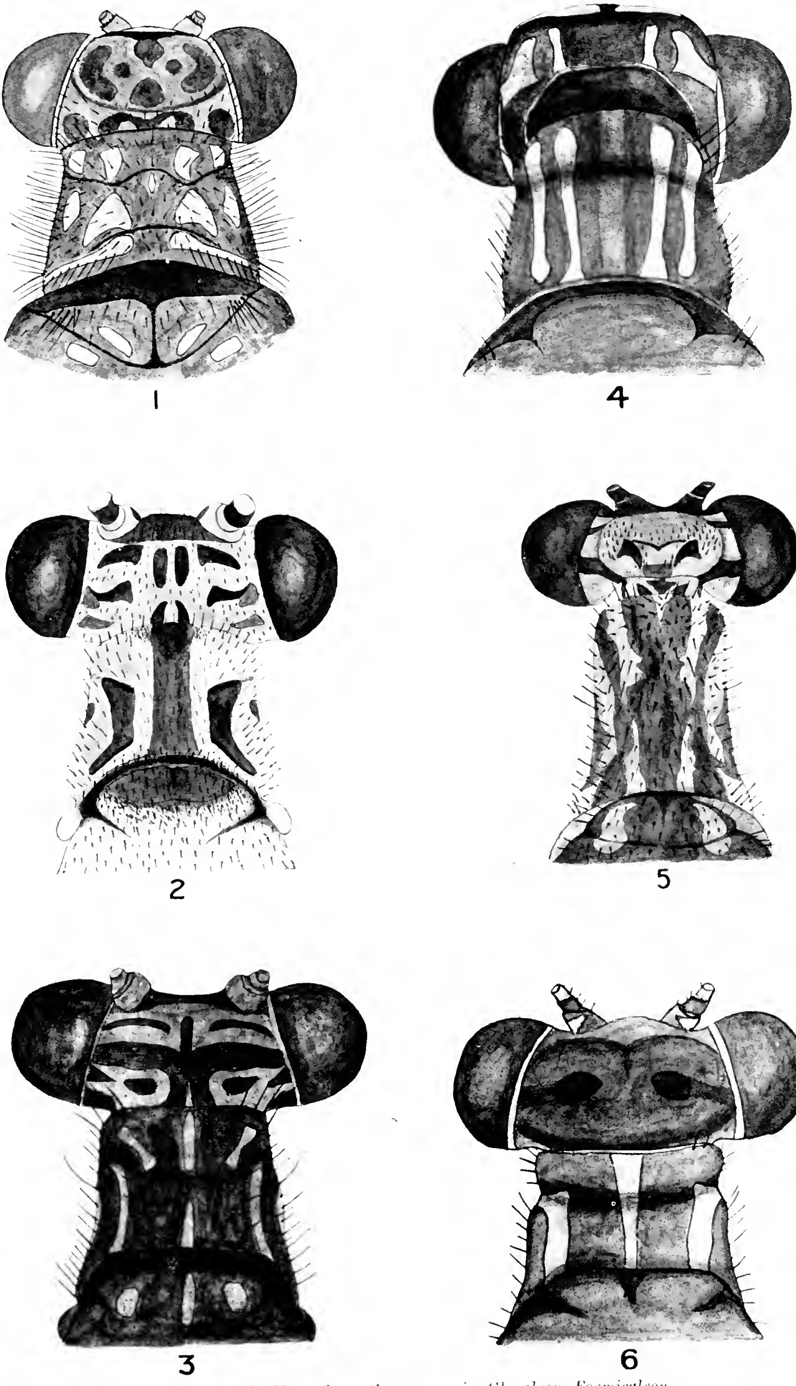
Forms of *Trachelomonas*.



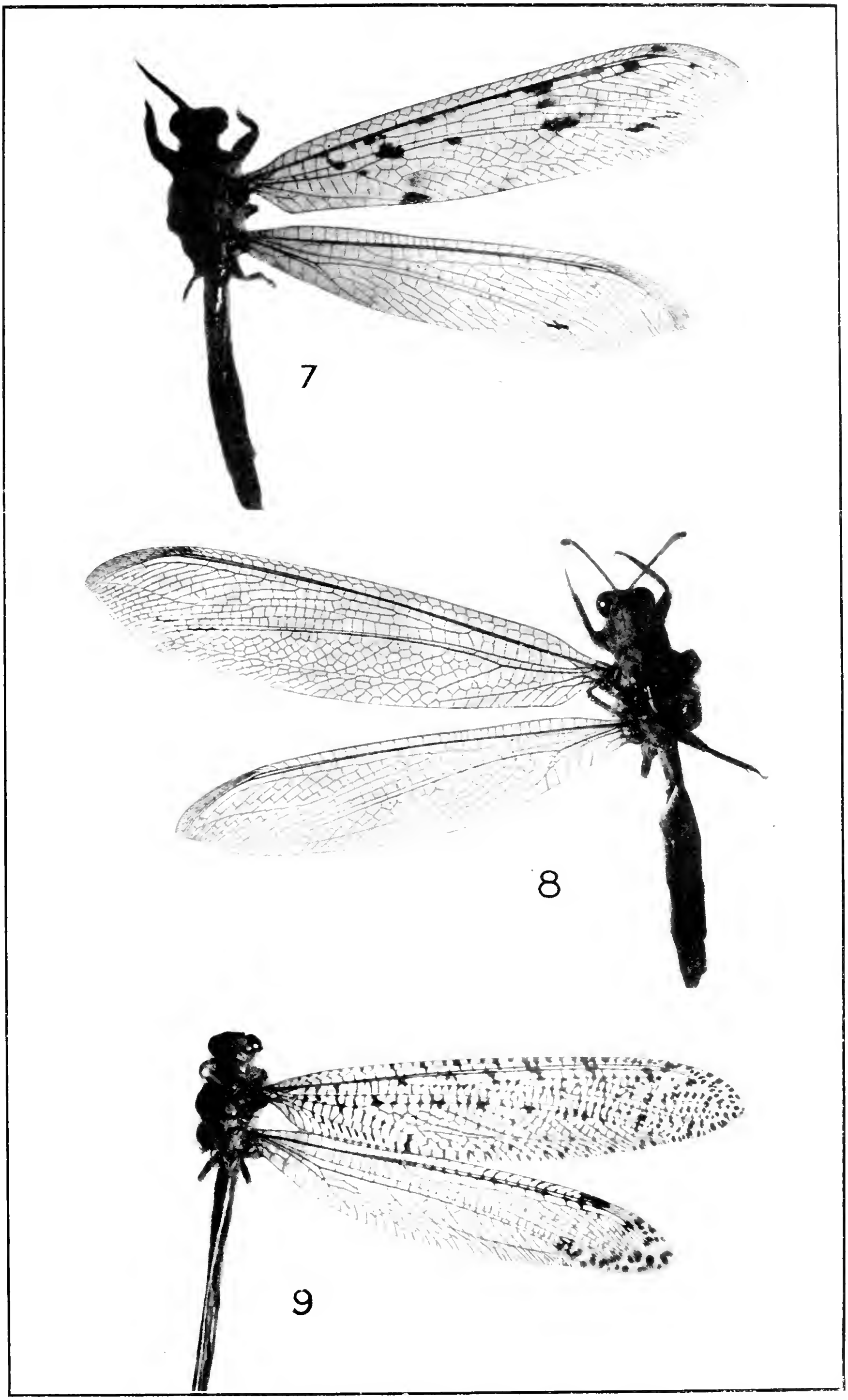
Forms of *Trachelomonas.*



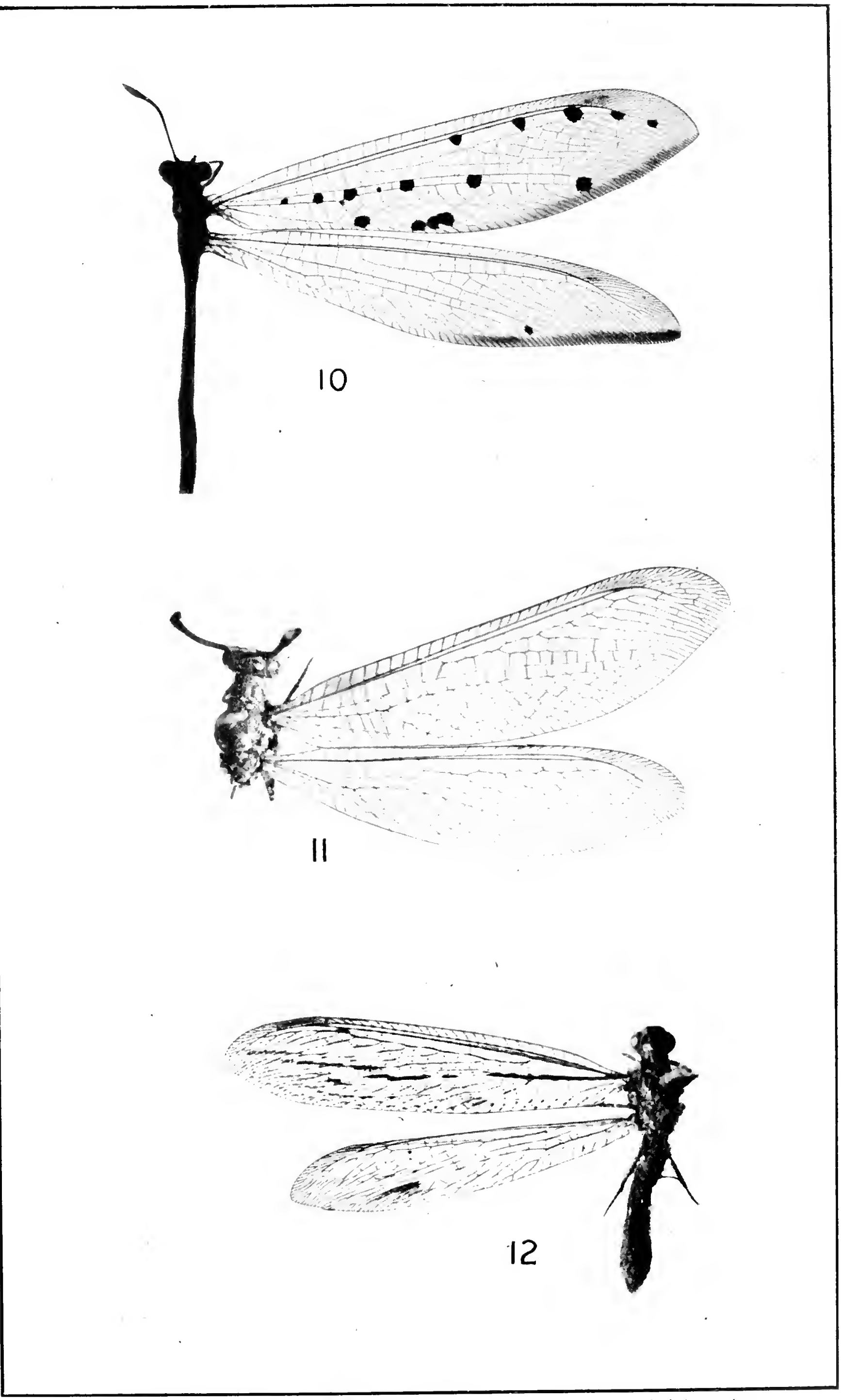
Forms of *Trachelomonas.*



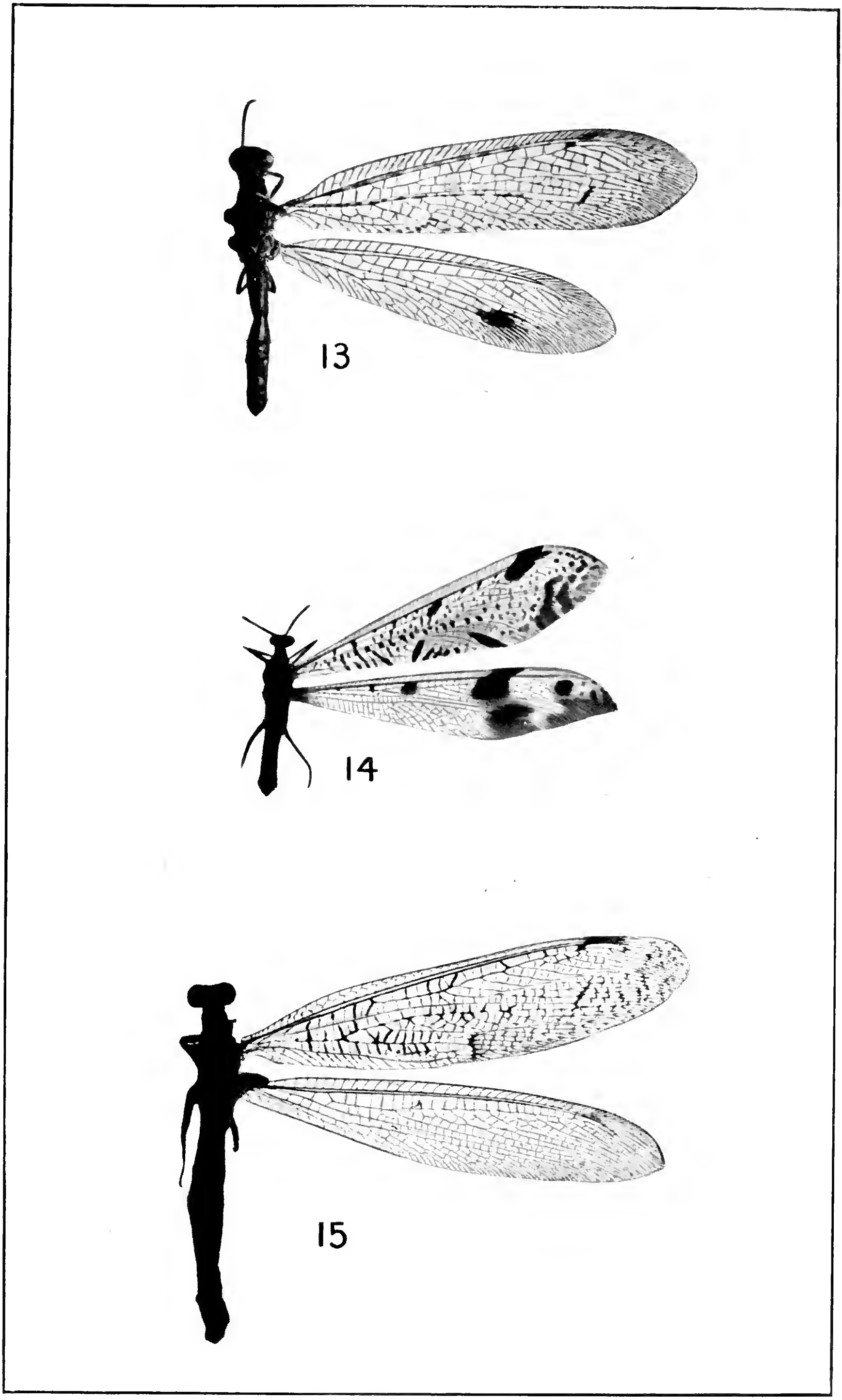
Acanthaclisis, Myrmeleon, Gymnocnemia, Glenoleon, Formicaleon.



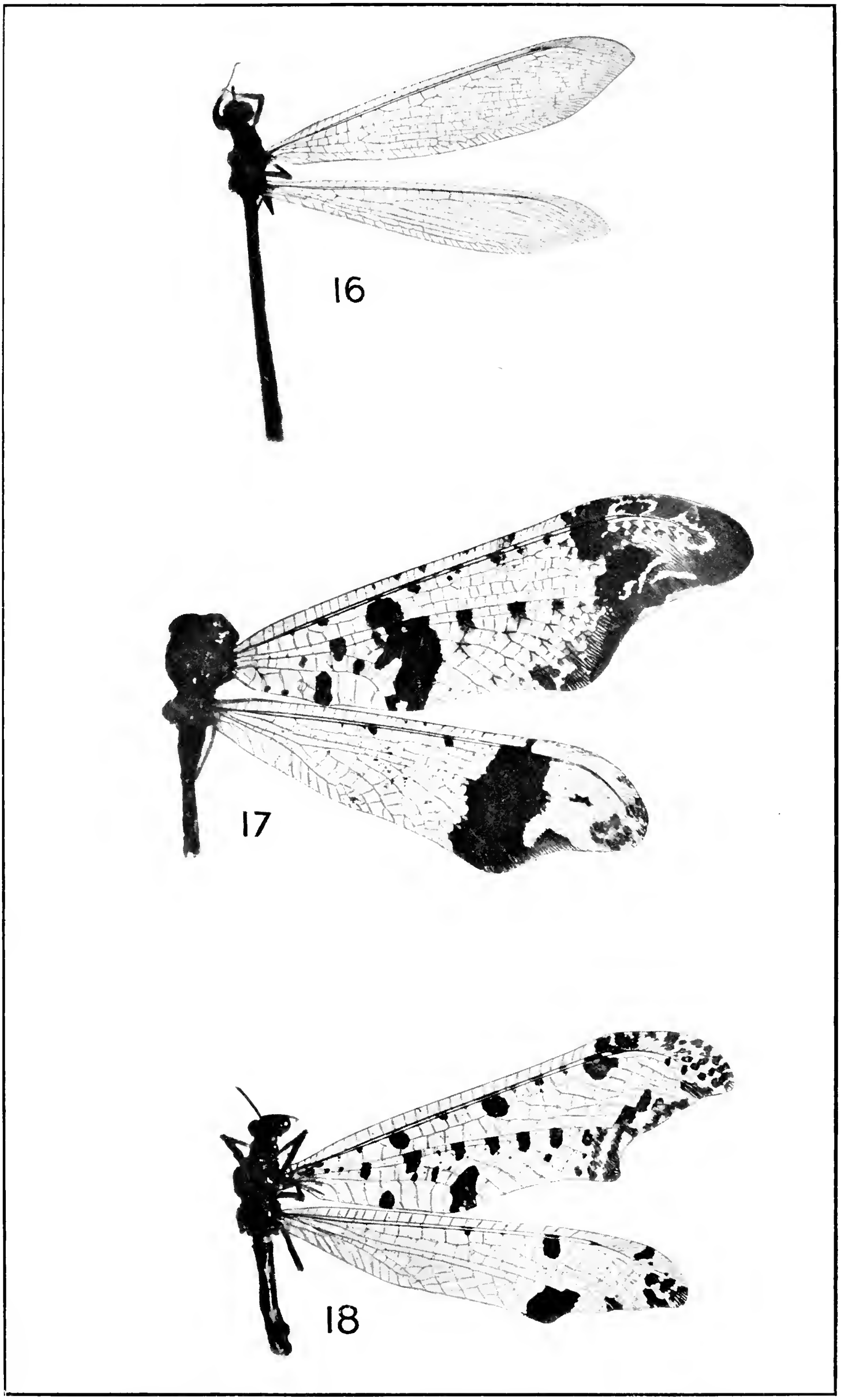
7. *Acanthaclisis subtendens.* 8. *A. fundata.* 9. *A. annulata.*



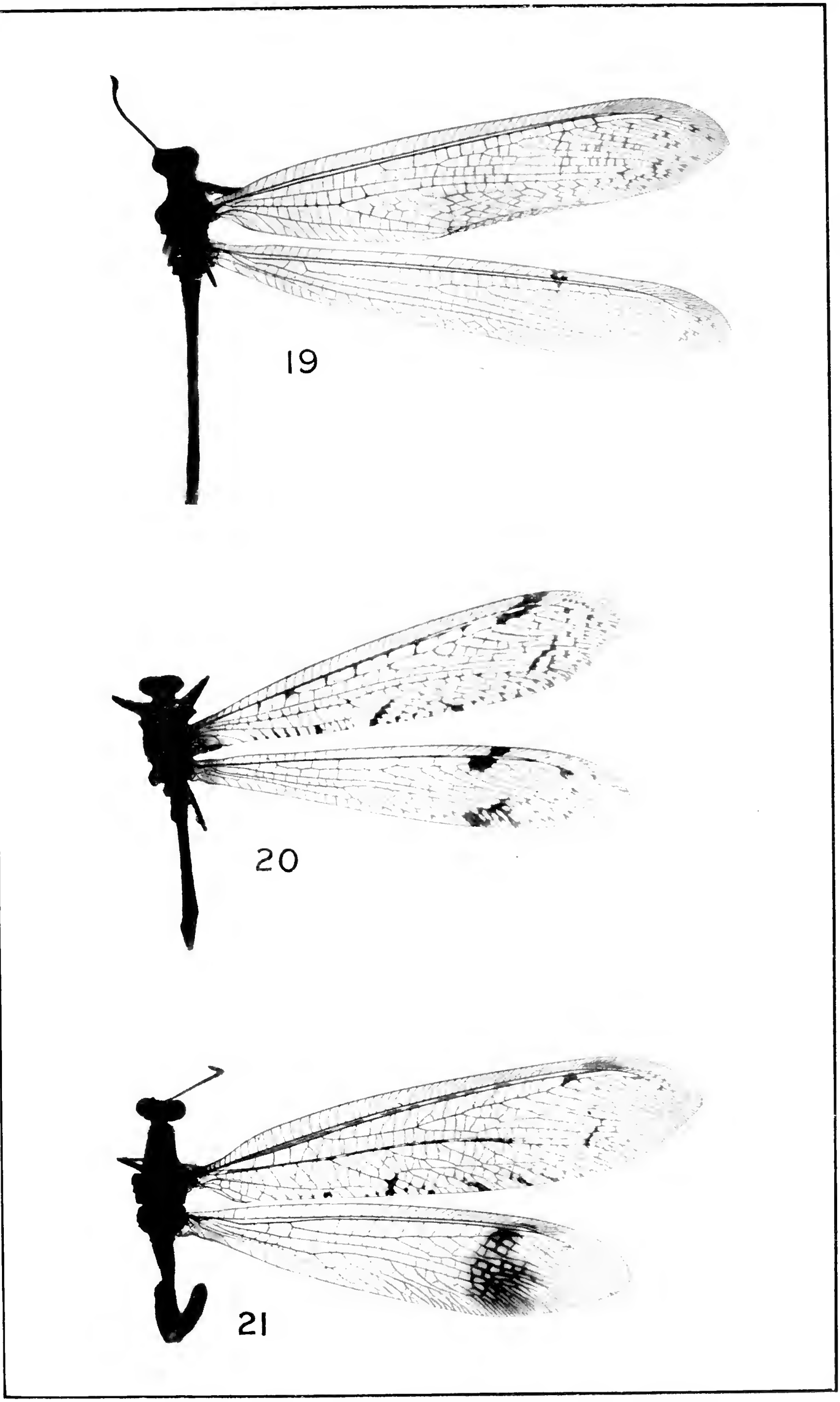
10. *Callistoleon illustre.* 11. *Myrmeleon diminutus.* 12. *Gymnocnemia interrupta.*



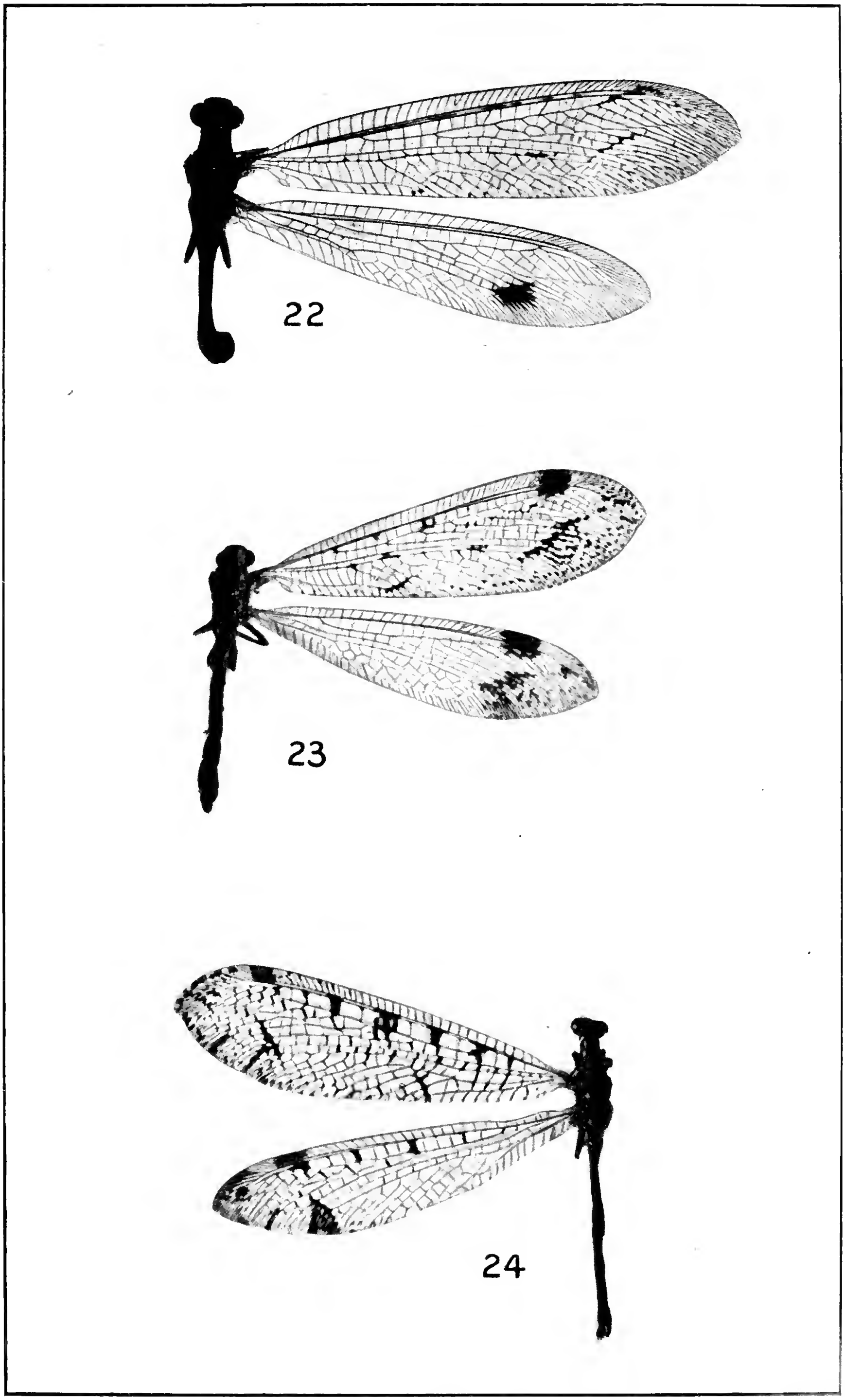
13. *G. bipunctata.* 14. *Froggattisca pulchella.* 15. *Protoplectron venustum.*



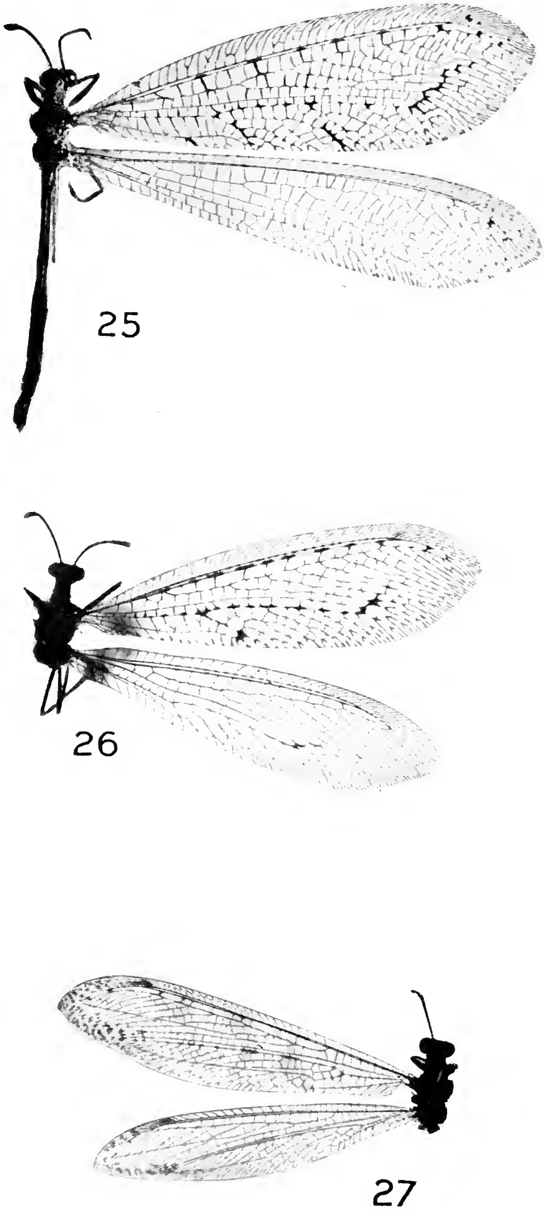
16. *Pseudoformicaleon nubecula.* 17. *Periclystus circuiter.* 18. *P. laceratus.*



19. *Formicaleon australis.* 20. *Dendroleon longipennis.* 21. *Glenoleon falsum.*



22. *Glenoleon meteoricum.* 23. *G. dissolutum.* 24. *G. radiale.*



25. *G. indecisum.* 26. *G. annulicorne.* 27. *Acanthaclisis subfasciata.*

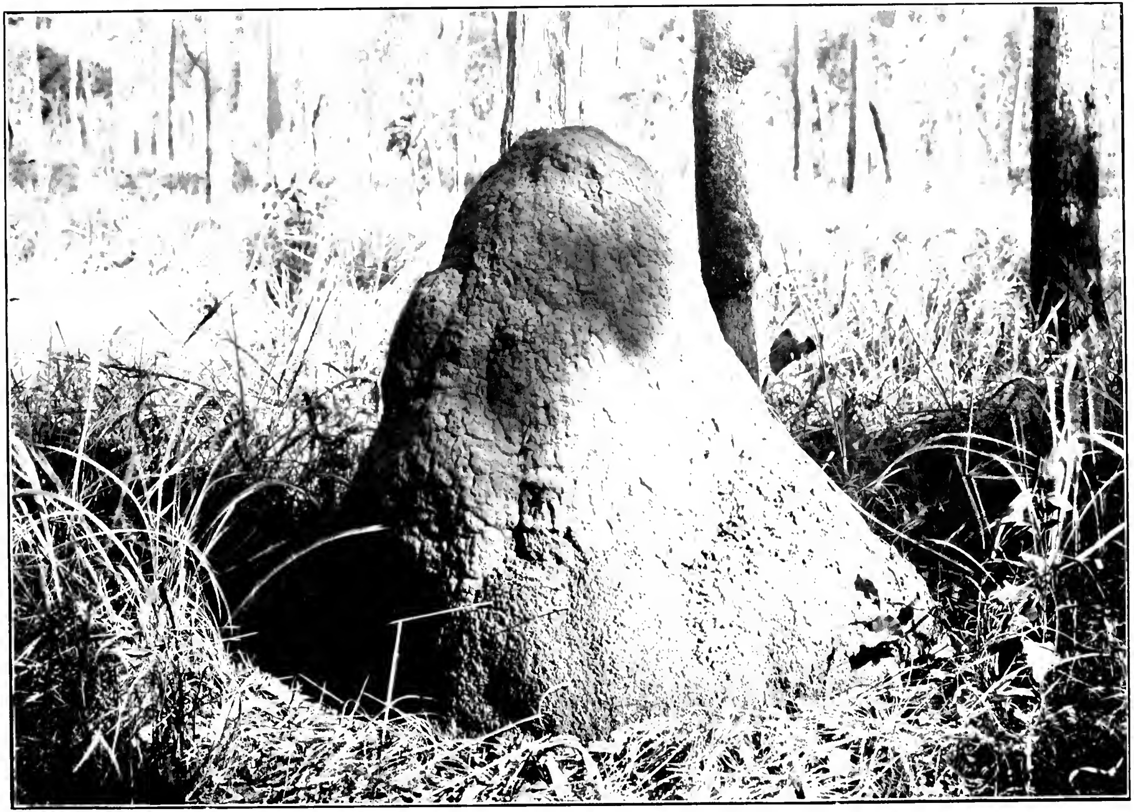
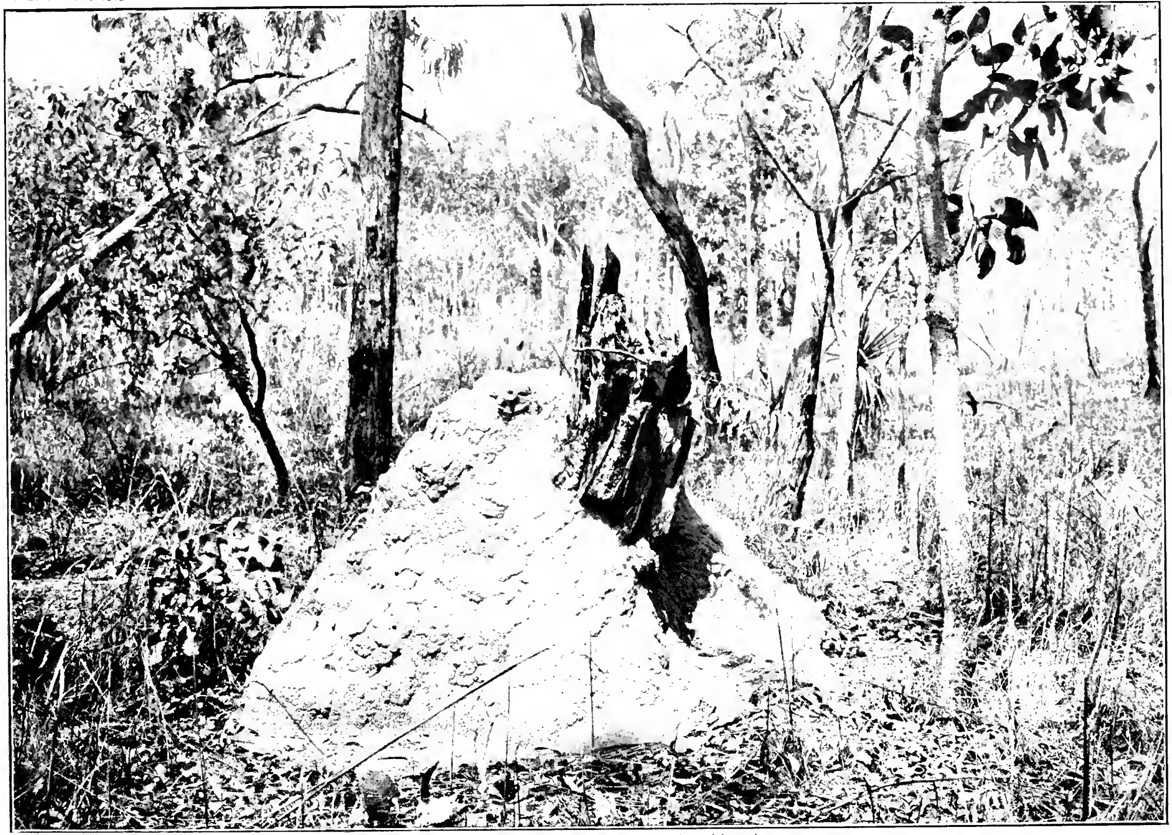
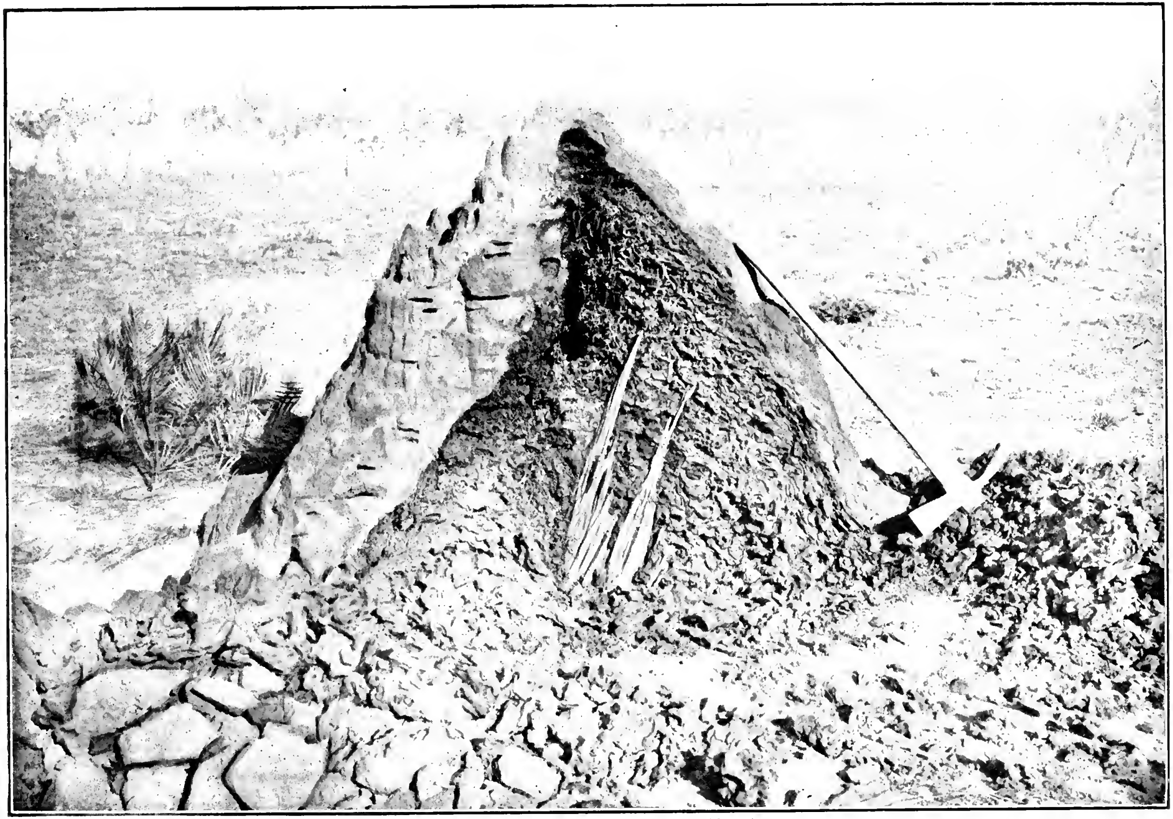


Fig. 1. Termitarium of *Coptotermes acinaciformis* Froggatt.



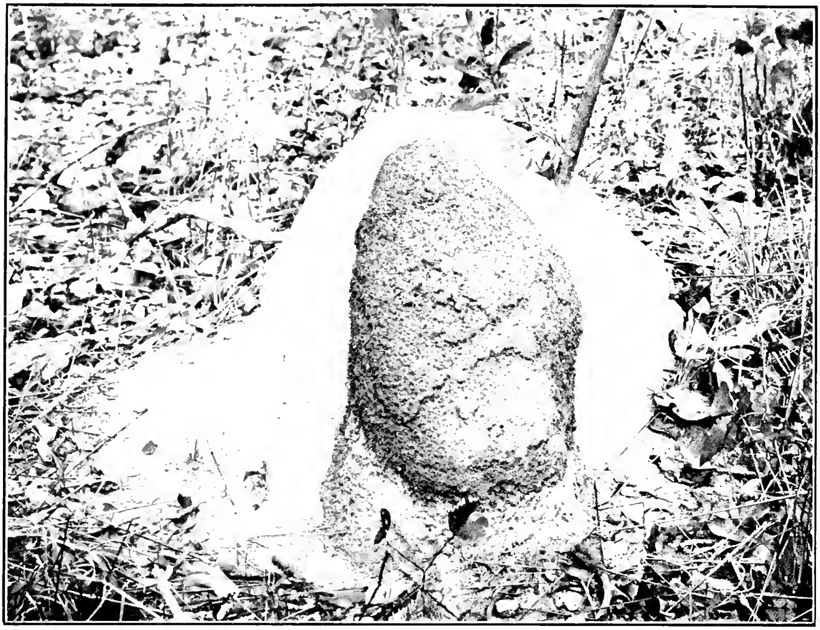
2. Termitarium of *Coptotermes acinaciformis.*



3. *Section of termitarium of C. acinaciformis.*

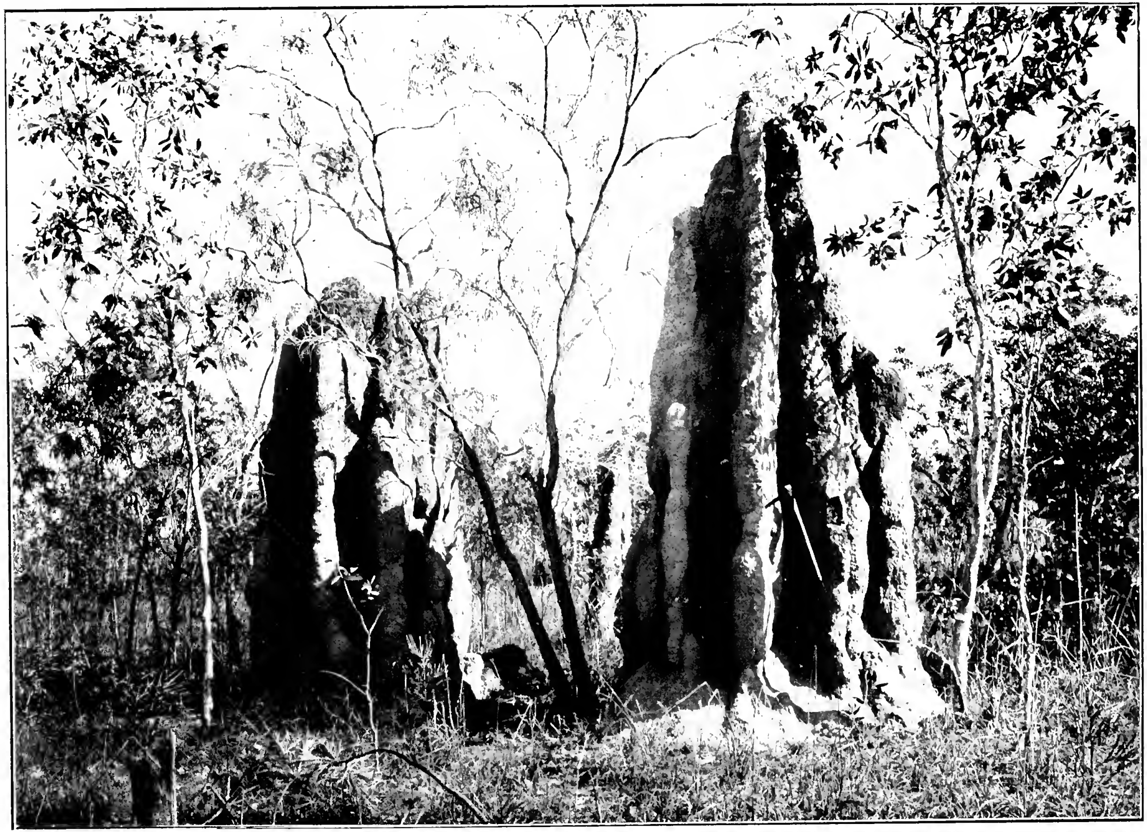
4. Termitarium of *C. acinaciformis* in termitarium of *Eutermes triodiæ*.

5. Termitarium of *C. acinaciformis* in termitarium of *E. triodiæ*.

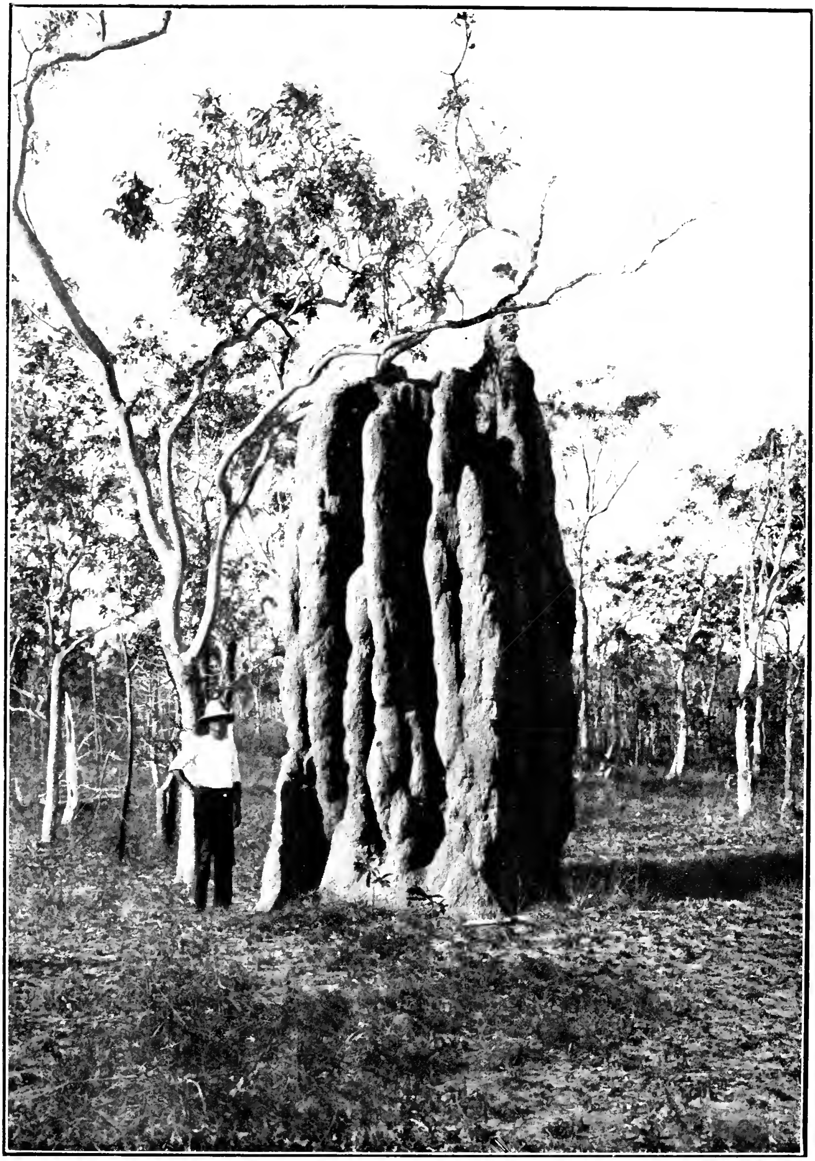


6. Termitarium of *Eutermes pastinator*, showing recently added portion.

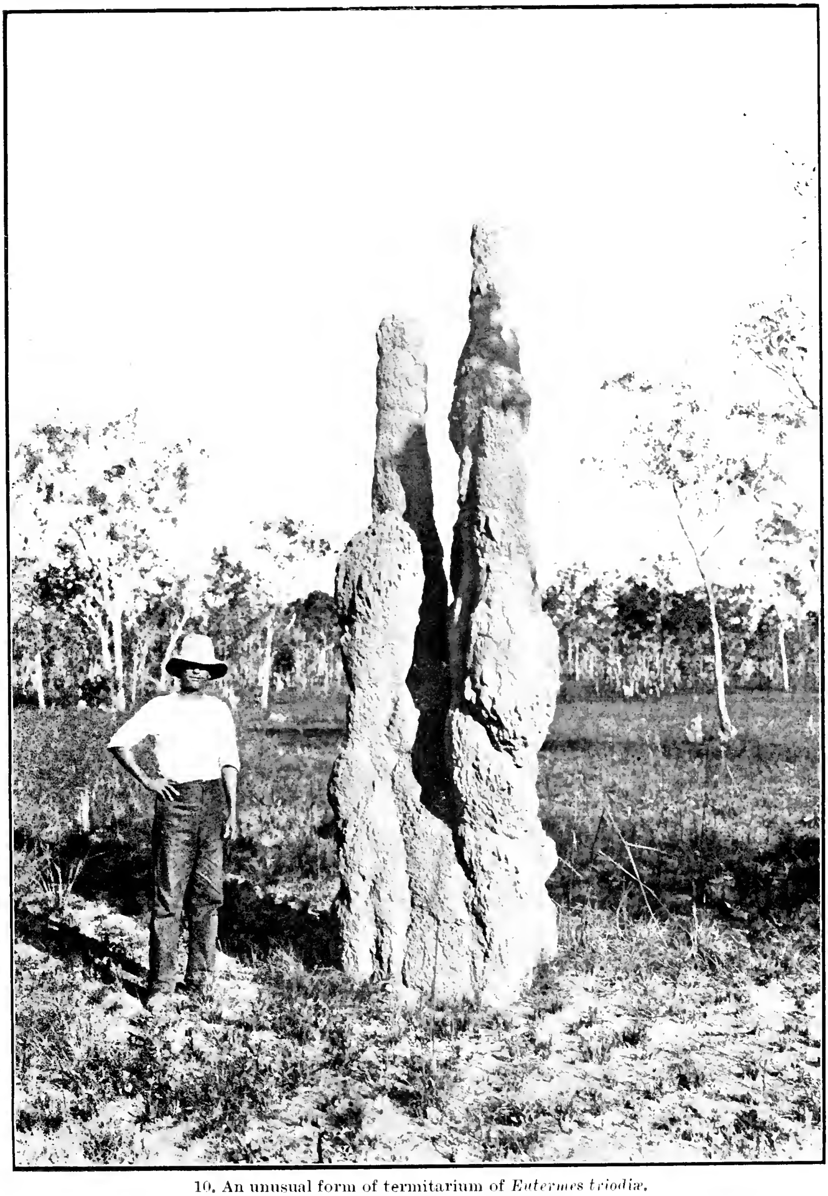
7. Termitarium of *E. pastinator*; recently added portion broken away.



8. Typical termitaria of *Eutermes triodiæ*.



9. Large termitarium of *Eutermes triodiæ.*



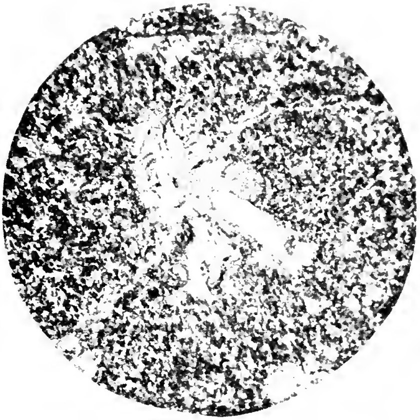
10. An unusual form of termitarium of *Eutermes triodiæ*.

11. Termitarium of *Eutermes triodiæ*.

Feeding-tracks of *Limax maximus* Linn.

1.

2.



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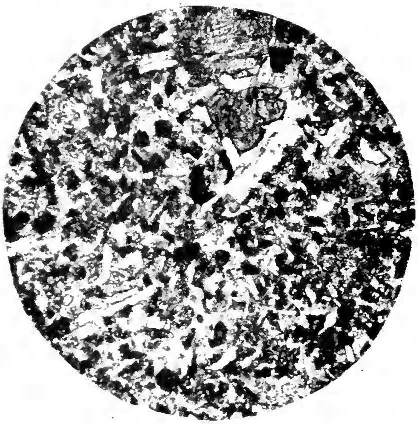

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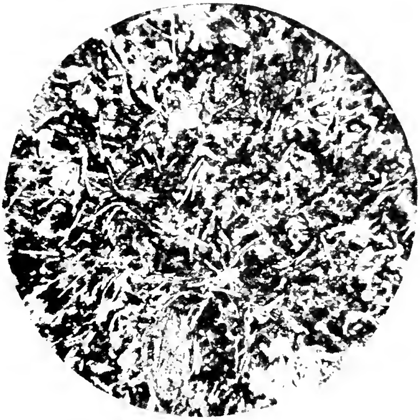

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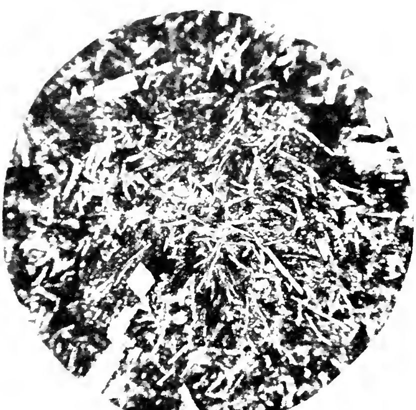
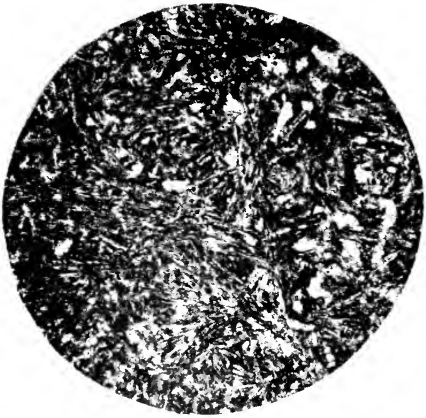


6.

1. Intersertal Quartz-albite-dolerite (×20).
2. Ophitic and spilitic albite-dolerite (×20).
3. Glomero-porphyritic spilite (×12).
4. Spilite with basaltic texture (×30).
5. Holocrystalline spilite (×20).
6 Hypocrystalline spilite (×24).



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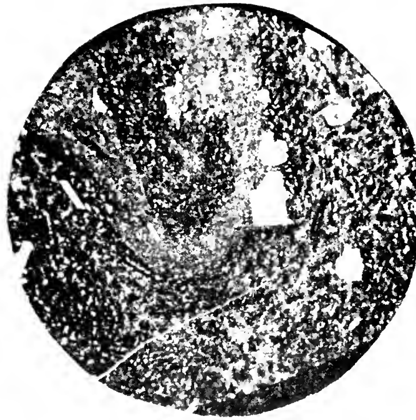

8.

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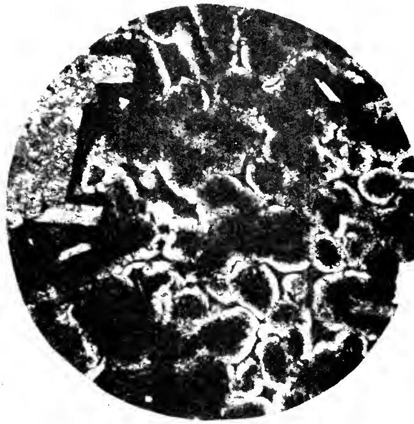
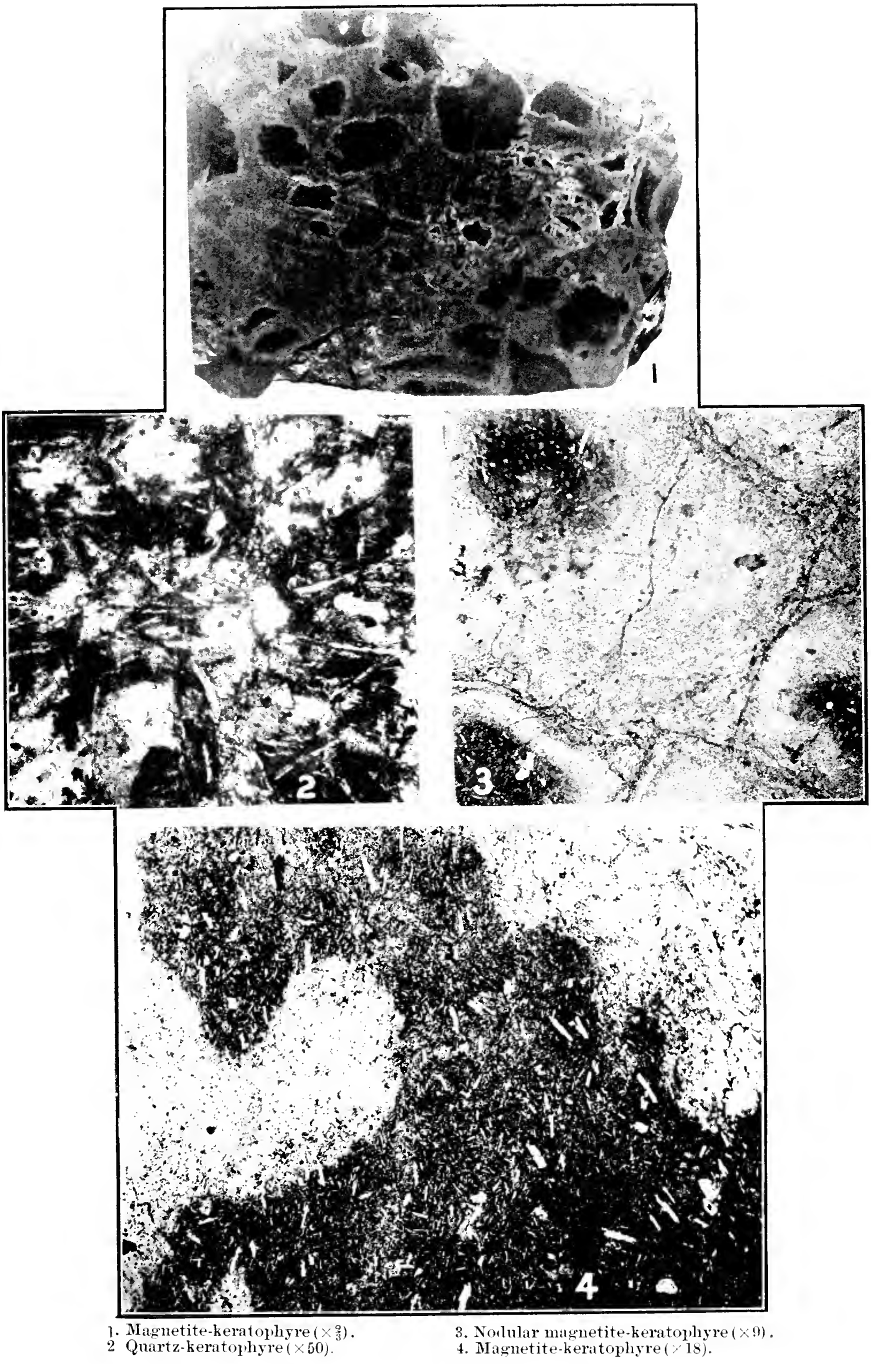


10.

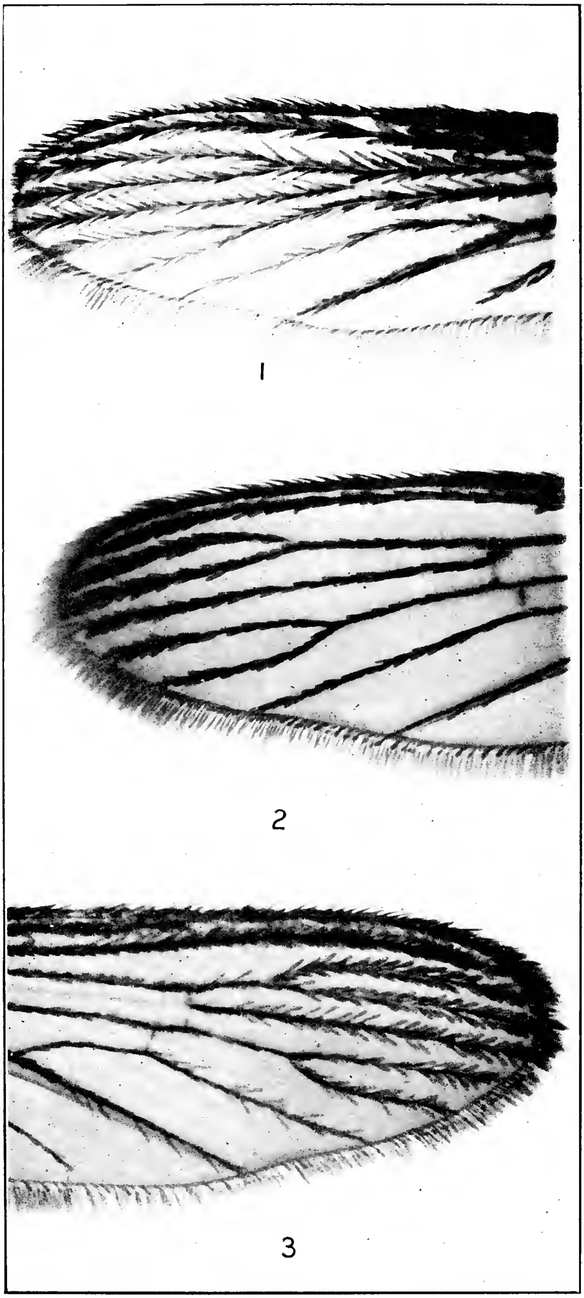
11.

12.

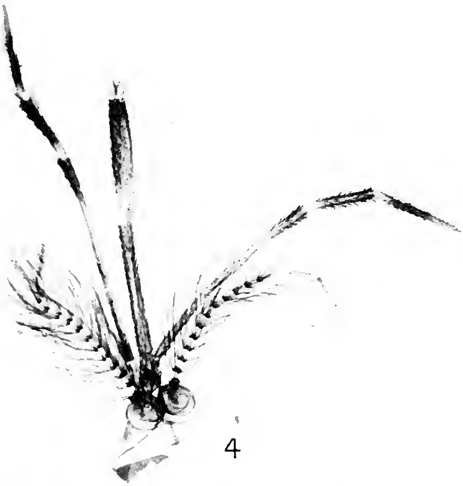
7. Variolite (×12).
8. Hypohyaline semi-variolite (×12).
9. Variolite (×30).
10. Micro-ellipsoidal spilite (×30).
11 Keratophyre (×30) polarised light
12. Magnetite-keratophyre (×30).



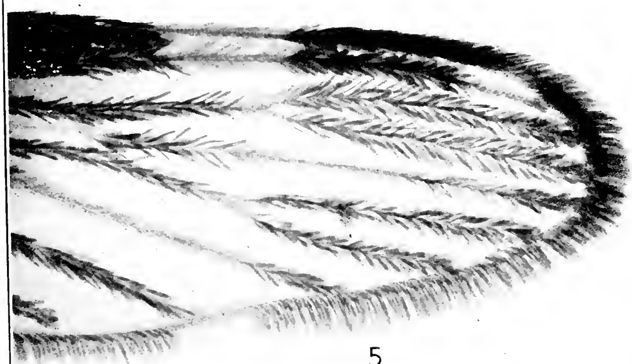
1. Magnetite-keratophyre ($\times\frac{2}{3}$).
2 Quartz-keratophyre ($\times 50$).
3. Nodular magnetite-keratophyre ($\times 9$).
4. Magnetite-keratophyre ($\times 18$).



1. *Stegomyia atripes* (Sk.) 2. *S. quasiornata*, n.sp. 3. *Neomacleaya australis*, n.sp.



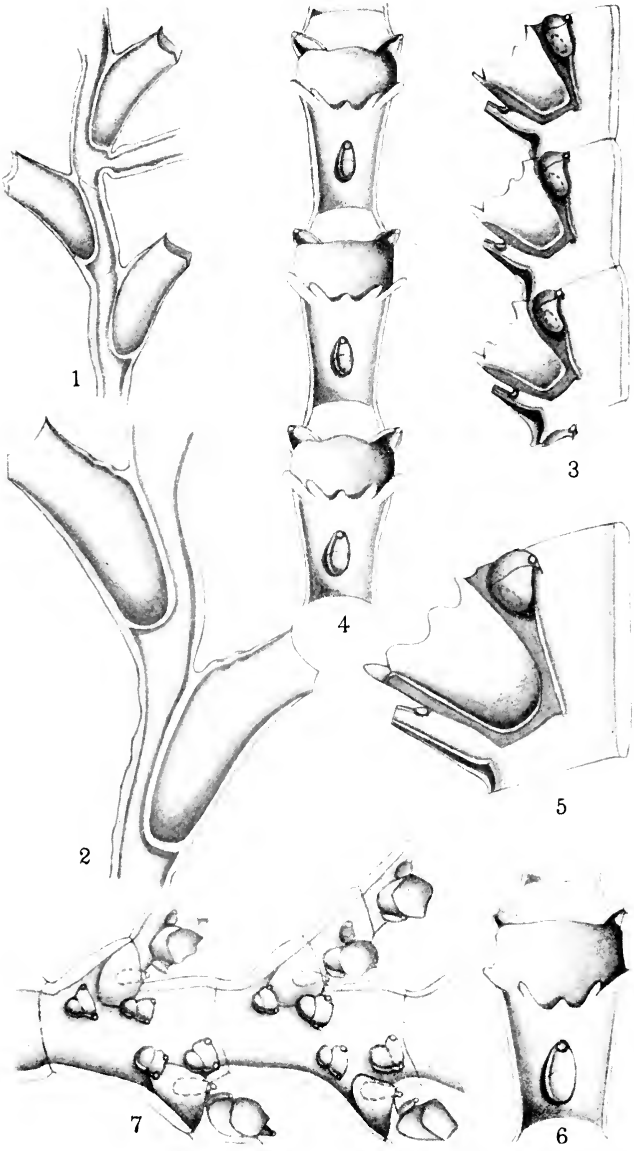
4



5

6

4-5. *Culex mossmani*, n. sp. 6. *C. normanensis*, n. sp.



Halicornaria goniodes, n. sp.

1 2

1. *Halicornaria goniodes*, n. sp. 2. *Sertularella ritchiei*, nom. nov.

examples, a second is added of equal size, the fleshy receptacle becoming sufficiently dilated to allow both to be seated side by side. With the exception of the extra seed, no unusual condition is present.—*Cassinia aculeata* R.Br., (Wentworth Falls; A. A. Hamilton; January, 1915) showing leaf-variation as a result of seasonal growth. The Blue Mountains experienced, in the Spring and Summer of 1914-1915, one of the best seasons for many years. This seasonal change is well marked in the specimens exhibited, which were all taken from a single bush about 6 feet high. The leaves of examples from the old wood range from 2-7 lines long; those of the Spring-growth from ½ to above 1 inch; while occasional leaves on the Summer-growth reach a length of nearly 2 inches. The crowded leaves of the older, as opposed to the more distant, open foliage of the later growth, is also representative of the differential seasons.—*Acacia discolor* Willd., (Cook's River; A. A. Hamilton; December, 1914). In his key to the Bipinnatæ division of Acacias, Bentham (Fl. Austr., ii., 318) places *A. discolor* Willd., under a group with 2-4 pairs of pinnæ (rarely 5-6 pairs), the opposing group being credited with 8-15 pairs. In the specific description (*loc. cit.*, p.414) the leaflets are given as 3-4 lines long. The pinnæ, in the specimens exhibited, range from 1 to 8 pairs (one shrub being noted with the whole of its leaves having 7 pairs), and the leaflets from 3 to 7 lines long.—*Eustrephus Brownii* F.v.M., (Cook's River; A. A. Hamilton; July, 1914). The leaf-variation noted in this species is inconsequential, the leaves differing chiefly in the formation of the apex, and a divergence in length, compared with breadth.

Mr. Fred Turner exhibited a beautifully variegated leaf-specimen of *Sechium edule* Swartz, from the garden of Mr. A. Gale, Stanmore. Although the exhibitor had grown this plant for many years and observed it under cultivation in many parts of New South Wales and Queensland, he had never previously seen it in that condition. If this aberrant growth can be propagated and the plant retain its remarkable variegation, it will be a decided acquisition as an ornamental climber.

Rev. W. W. Watts showed an abnormal form of the common Bracken Fern (*Pteridium aquilinum*).

Mr. Froggatt exhibited a series of specimens of the Golden Stagbeetle, *Lamprima latreillei*, cut out of a dead log of Peppermint Gum (*Eucalyptus* sp.) from Salisbury Court, near Uralla. This log was portion of a tree-trunk cut down last September, the bark having dried onto the sap wood, in which the larvæ had been feeding before pupating in the cavities eaten out of the sapwood. The perfect beetles were cut out on March 24th, and as these beetles do not appear on the foliage of the Eucalypts until well into the summer (about December), it is remarkable to find them as perfect beetles torpid all through the winter-months. Also, on behalf of Miss F. Sulman, leaves of a cultivated Waratah attacked by a leaf-mining larva of most remarkable form, probably a dipterous maggot.

ORDINARY MONTHLY MEETING.

June 30th, 1915.

Mr. A. G. Hamilton, President, in the Chair.

Mr. Charles Oswald Hamblin, B.Sc., Department of Agriculture, Sydney, was elected an Ordinary Member of the Society.

The President made regretful reference to the decease of Mr. F. Manson Bailey, C.M.G., Colonial Botanist of Queensland since 1881, and a Corresponding Member of the Society since 1877, on 24th inst., at Brisbane, in his 89th year. It was resolved that a letter expressive of the Society's appreciation of Mr. Bailey's long-sustained and unremitting efforts to develop and extend a knowledge of the Queensland flora, and of sympathy with his family, should be sent to Mr. J. F. Bailey.

The President gave notice of a Special General Meeting to be held after the next Monthly Meeting on 28th July, 1915. *Business:* to confirm the Resolution carried at the Special General Meeting on 30th June, 1915.

The Donations and Exchanges received since the previous Monthly Meeting (26th May, 1915), amounting to 3 Vols., 45 Parts or Nos., 8 Bulletins, 4 Reports, 7 Pamphlets, and 1 Map, received from 42 Societies, etc., and two authors, were laid upon the table.

ON THE DEVELOPMENT OF THE WING-VENATION IN ZYGOPTEROUS DRAGONFLIES, WITH SPECIAL REFERENCE TO THE *CALOPTERYGIDÆ*.

By R. J. Tillyard, M.A., B.Sc., F.E.S., Science Research Scholar in the University of Sydney.

(Plates xxxii.-xxxiv., and Text-figs.1-6.)

In a previous paper concerning the development of the wing-venation in Dragonflies,* I dealt partly with the case of the *Zygoptera*. At that time, no larvæ of the family *Calopterygidæ* were available for study. As this family undoubtedly includes the most archaic forms amongst the *Zygoptera*, it was clear that the solution of the problems still outstanding must be sought for within it. In indicating this in my former paper, I ventured the statement that "the many forms of *Calopterygid* larval wings will one day yield a wonderful harvest to the fortunate student who has a chance of investigating them." The *Calopterygidæ* are, however, nearly all tropical forms. Even if a collector with the requisite knowledge could visit the places where they abound, there still remains the almost insuperable difficulty of photographing the wing-tracheæ in the recently-killed larva. The apparatus required for this purpose is too costly and too cumbersome to be taken on an expedition of this kind. The larvæ, too, require running water to live in, and do not take kindly to captivity. Hence they would not stand a long journey back to a base suitable for operations.

It seemed, therefore, that important problems awaiting solution might be indefinitely postponed unless some efforts were made to obtain at least those *Calopterygid* genera that were nearest to hand. In Australia, we have only one genus, *Diphle-*

* "On some Problems concerning the Development of the Wing-Venation of *Odonata*." These Proceedings, 1914, xxxix, Part i., pp.163-216, Plates xi.-xii.

bia. This enjoys the unique position of being the most *Agrionid*-like of all *Calopterygidæ*. It is the most highly specialised genus of the subfamily *Epallaginæ*. That subfamily is, however, the most archaic in the family. Hence, the phylogeny of *Diphlebia* is of such a nature as to offer good hopes for the solution of some of our problems. These solutions could not, in any case, be allowed to rest on evidence from a single genus, or from two or three closely related genera. Now the genus *Calopteryx*, which also—but in a direction quite different from that of *Diphlebia*—combines high specialisation with a number of archaic characters, is available in Europe. I, therefore, wrote last year to Dr. Ris, of Switzerland, urging him to do his utmost to secure larvæ of *Calopteryx* in the spring, with a view to photographing the tracheation of the larval wing. Meanwhile, I searched assiduously for the rare larva of *Diphlebia lestoïdes* Selys, of which I had previously found only one specimen in the course of nine years' collecting.

A further difficulty confronting us was the fact that the wing-cases of *Calopterygid* larvæ are tough, hairy, and opaque, offering very poor material for photographic work. Dr. Ris had already mentioned this to me as a point which had previously deterred him. I suggested to him that it would be necessary to secure larvæ that had just undergone ecdysis, so as to photograph them before the wings had had time to harden up and become opaque. My letter reached him in April, 1914. A few days later, he went to a known locality for *C. splendens* Harris, and was both surprised and delighted to find a number of larvæ exactly in the most suitable stage. The wing-tracheation of these specimens was photographed. I have to thank Dr. Ris for his kindness in offering me these beautiful photographs for use and publication in this paper (Plate xxxiv., figs.1-3).

Meanwhile, the search for *Diphlebia* larvæ went on without result until September last. For their discovery, I am indebted to the kindness and energy of Mr. F. W. Carpenter, M.A., of Sydney Grammar School. While staying with me at Wentworth Falls, he kindly offered to make an exhaustive search of the rocks in Lilian's Bridge Creek—a locality which I had indicated as likely to yield good results. As a result of two days' searching, six fine larvæ of *D. lestoïdes* were taken, clinging close to the undersides of rocks. Two were in the last instar, two in the penultimate, and two in the antepenultimate. One of the first was apparently approaching metamorphosis. I, therefore, killed it at once, and made camera-lucida drawings of the wing-cases. These drawings led to an interesting discovery, but were not reliable guides to the problems on hand. On my return home, a week later, the other larva in the last instar was so advanced that it had to be dealt with at once. The wing-cases were exceedingly hard and opaque, so that it was most difficult to obtain any photographic results of value. The results are shown in Pl. xxxiii., figs.1-2. Of the other four larvæ, one in each stage was dealt with at once. The wings were fairly hard, and yielded only moderately good results (Pl. xxxii., fig.3). The other two were kept alive, in the hope that they might undergo ecdysis. They both gradually grew weaker, but one managed just to survive an ecdysis, and yielded fairly good results (Pl. xxxii., figs.1-2: Pl. xxxiii., fig.1).

In the broad outlines of venation, the *Epallaginæ* are more archaic than the *Calopteryginæ*. I shall, therefore, deal with *Diphlebia* first, and then indicate the chief points in which *Calopteryx* either agrees with, or differs from it.

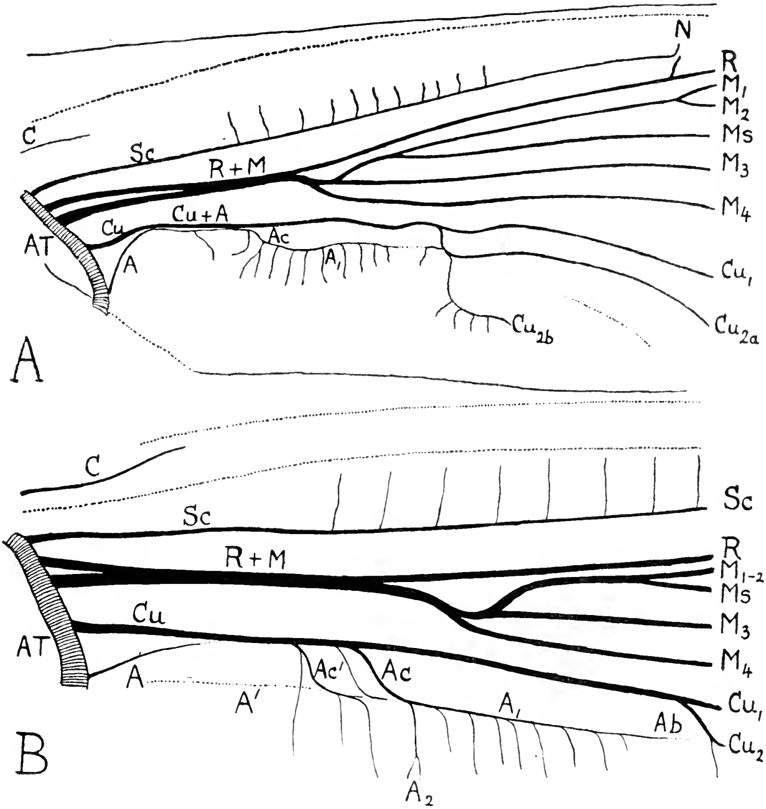
The Wing-Tracheation of *Diphlebia lestoïdes* (Text-figs.1-2; Pl. xxxii., figs.1-3; and Pl. xxxiii., fig.1).

The last three instars were studied, but only the antepenultimate and the penultimate showed the tracheation; the larvæ, in the last stage, had the tracheation masked by cuticularisation (see below). In both instars, the following results were noted—

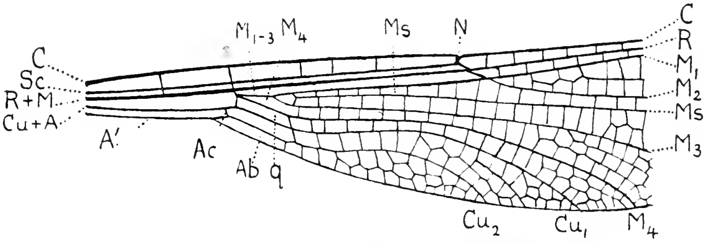
(i.) R is a straight trachea without a single branch. (The waviness in the photographs is due to unavoidable displacement in cutting off the wings).

(ii.) The basal contact between R and M is not very close.

(iii.) M is a stronger trachea than R, and gives off *four* posterior branches. Three of these come off close together near the level of the bifurcation of Cu. The fourth comes off under the subnodus (level of N in figures).



Text-fig. 1.—Tracheation of larval wing of *Diphlebia lestoïdes* Selys. A. Antepenultimate instar. B. Penultimate instar. Compare Pl. xxxii., figs. 1-3, Pl. xxxiii., fig. 1.



Text-fig. 2.—Imaginal venation of *Diphlebia lestoïdes* Selys, for comparison with Text-fig. 1.

(iv.) Cu bends very little, and is continued on by Cu_1 almost in a straight line. Cu_2 comes off posteriorly in a gentle curve.

(v.) A is almost completely suppressed. We can make out (*a*) a small basal piece, A_1, arising from the alar trunk AT, and running up towards Cu, (*b*) the severed distal piece, Ac, attached to and depending from Cu as a weak branch a little basad from the level of the arculus.

The Wing-Tracheation of *Calopteryx splendens* (Text-figs.3-4, and Pl. xxxiv., figs.1-3).

Dr. Ris's photographs show the last two instars. We notice that :—

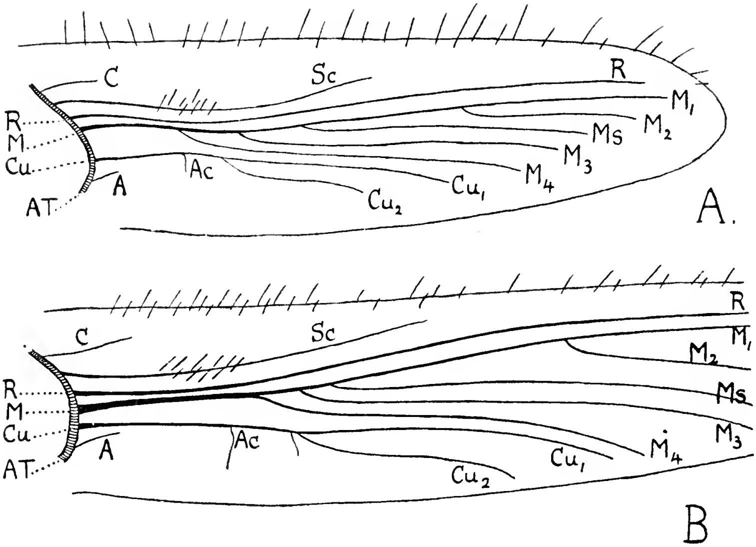
(i.) R is a straight trachea without any branches (as in *Diphlebia*).

(ii.) The basal contact of R and M is very close for a considerable length.

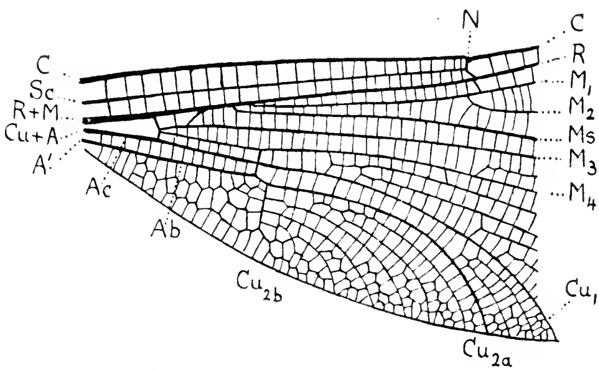
(iii.) M is much stronger than R. It has four posterior branches situated as in *Diphlebia*. But, in *Calopteryx*, on leaving R, M bends sharply downwards to give off its two most basal branches, and then bends quite as suddenly upwards so as to come to lie again close under and parallel to R before giving off its next branch. The last branch comes off before the subnodus (as in *Diphlebia*).

(iv.) Cu bifurcates some distance beyond the level of the future arculus; Cu_1 runs straight on (as in *Diphlebia*). Cu_2 dips suddenly, curving away distally, but giving off posteriad a short but distinct branch, Cu_{2b}.

(v.) A is distinctly seen arising from the alar trunk, AT, and running towards Cu. In the penultimate instar, fine strands of A seem to be present, running just below Cu. (This may be due to displacement). Ac comes off from Cu at a considerable distance from the base (but before the level of the arculus), and turns distad to run beneath and parallel to Cu towards the curve of Cu_2. This portion is clearly A_1. A distinct branch given off posteriad from A_1, at a level just beyond Ac, may be provisionally taken to be A_2. In the last stage, another trachea corresponding to Ac may be seen depending from Cu, between Ac and the base. This formation is, I believe, quite unique.



Text.fig.3.—Tracheation of larval wing of *Calopteryx splendens* Harris. A. Penultimate instar. B. Last instar. Compare Pl. xxxiv., figs. 2-3.



Text-fig.4.—Imaginal venation of *Calopteryx splendens* Harris, for comparison with Text-fig. 3.

This trachea may be called a "supplementary anal crossing," and labelled Ac′.

We are now in a position to deal with our problems in the light of the facts disclosed.

A. *The Problem of the Radial Sector.*

This question is of outstanding importance, since it lies at the very root of the relationships between *Zygoptera* and *Anisoptera*. It will be recalled that Professor Needham, in his famous paper,* showed how, in the *Anisoptera*, the radius R in all cases gives off a sector Rs, the *radial sector*, which crosses over $M_{1\text{-}2}$, and so gives rise to the peculiar formation of the bridge and oblique-vein. Needham pointed out that in *Lestes*, the only *Zygopterid* which he examined in the larval stage, R appeared to be unbranched, while M had an extra branch taking the place of Rs. He explained this by assuming that, during the narrowing process in the *Zygopterid* wing, the basal piece of Rs, lying between R and M, had got nipped off and had become aborted, so that Rs finally became attached to M.

Now this explanation has been tacitly accepted by all students of *Odonata*, including Dr. Ris and myself, for a good many years. Even when, on the completion of my last paper on this subject (*loc. cit.*), I was faced with the fact that, in all the *Lestidæ* and *Agrionidæ* examined by me, R was always unbranched, and that in the *Agrionidæ* there was neither a bridge nor an oblique vein, I still retained Needham's notation, and accepted his explanation. The peculiar case of *Neosticta* (*loc. cit.*, Pl.xiii., fig.4), of course, supported this view. Further examination of this highly reduced form has convinced me that it is extremely doubtful whether the trachea, which I believed to be Rs, really does come off from R. The dense pigmentation renders examination most difficult, and I have not yet been able to get a larva which has just undergone ecdysis for study. In any case, the trachea in question is so weakly developed, that it represents a special case of extreme reduction, which can be laid aside provisionally during the more general discussion on less reduced forms.

* "A Genealogic Study of Dragonfly Wing-venation." Proc. U. S. Nat. Mus., xxvi., 1903, pp.703-764, Plates xxxi.-liv.

It was in the hopes that the *Calopterygidæ* would show us some clue to the phylogenetic developyment of Rs, that I took up the work embodied in this paper. It seemed certain that they alone held the key. So, indeed, it has turned out, but how different (and how much simpler, after all!) is the solution they give us from the one we expected. I feel that I cannot present the case better than by quoting from Dr. Ris's letter, accompanying the photographs of *Calopteryx* larval-wings. And I must here add, that to Dr. Ris undoubtedly belongs the credit of first seriously entertaining the new ideas, which were slowly forcing themselves upon us, but which both he and I, for so long a time, remained unwilling to accept. He says:—"Now what do you think of this troublesome matter of zygopterous venation, with those ontogenetic documents in hand? I said to myself: 'Supposing you did not know a word of anisopterous venation, of Rs crossing over branches of M, of bridges, oblique veins, and the rest—how would you interpret this nymphal tracheation'? Well, I think the obvious interpretation would be—Vein R in this wing is *unbranched*; all the sectors are branches of the media M! With comparatively little modification (shifting of second and third branches of M—numbered from base—distad) of this scheme, you arrive at what is shown in the *Agrionidæ*. And still, with not *very great* modification, you arrive at *Lestes* and *Synlestes*, as shown by Needham's and your own photos.; shift the second branch still further distad, until it becomes a tributary of the third one, and let it be united (for obvious mechanical reasons!) to the main branch by a bridge—and you will have the *Lestine* type of venation. All this is so very simple (and ruinous to my favourite construction of November last!) that I do refrain from accepting it as given truth. Can there be anywhere in development a shifting of an existing radial sector over to the media, and the traces of this fact be so utterly lost as it appears from the examined wings? Now please think of that matter, and let me know again!"

In a later letter he replied to some criticisms of mine: "You know, I am hesitating in interpretation of *Zygopterous* veins; old views are shaken; new ones not yet fully established; my opinion regarding the unbranched radius is tentative; I am ready to give it up at any serious evidence for the contrary."

Finally, after studying the photographs of the wings of *Diphlebia* which I sent him, and which I pointed out were conclusively in favour of the new theory, he wrote: "I now think that the Unbranched Radius Theory will win the day."

I may add that the study of *Diphlebia* and *Calopteryx* at once convinced me that we had to deal, in the *Zygoptera*, with an originally unbranched radius, which has remained unbranched right down to the present day. We may summarise the evidence for this under three headings, as follows:—

1. *Direct Evidence from the Larval Wings.*

In every *Zygopterid* larval wing so far examined* (and these by now amount to a considerable number of genera), R is unbranched, and M has one branch more than in the *Anisoptera*. The differences between *Calopterygidæ*, *Agrionidæ*, and *Lestidæ* are distinct, but of a lower order of significance. They may be stated thus:—

(*a*). *Calopterygidæ*—M gives off three branches in rapid succession close to the arculus, and a fourth at the level of the subnodus.

(*b*). *Agrionidæ*—M gives off one branch at the arculus, two more at about the level of the subnodus, (one usually exactly below it), and a fourth placed more or less distad from the subnodus.

(*c*). *Lestidæ*—M gives off two branches close to the arculus; the third and fourth come off distad from the subnodus by means of a common stem, which soon bifurcates. From the lower of these two branches, a long bridge is developed backwards towards the main stem of M.

2. *Ontogenetic Evidence.*

We know the condition of R in the last *two* instars of *Calopteryx*, in the last *three* instars of *Diphlebia*, and in the last *four* stages of *Austrolestes*. Earlier than this, I have not been able to go, the tracheation being too feeble to deal with. In all of

* With the doubtful exception of the problematical *Neosticta*.

these, R is unbranched. As a contrast to this, in the *Anisoptera*, I find Rs present as a distinct sector in the very earliest stages of *Hemicordulia* and *Æschna* of which it is possible to obtain a photograph. Dr. Ris also finds it present in a very early stage of *Libellula depressa*, and Needham shows the same condition for all ontogenetic stages of *Gomphus descriptus*. Thus, the ontogenetic evidence points to an originally unbranched radius for all *Zygoptera*, and an originally branched radius for all *Anisoptera*.

3. *Palæontological Evidence.*

In the *Protodonata* (Upper Carboniferous and Permian), the family *Meganeuridæ* offers important evidence. The best-known species, *Meganeura monyi* Brongniart, has R *unbranched* in the hindwing, but with *two distinct branches* in the forewing. A smaller species, *Meganeurula selysi* Brong., has R *unbranched* in both wings A Permian species, *Typus* (*Tupus*) *permianus* Sellards, has R *branched* in both wings, and shows clear evidence of having possessed the bridge and oblique vein of the *Anisoptera*. Thus, it is fair to conclude that, in the *Protodonata*, forms that were otherwise closely allied had a variable condition of the radius, which might be branched or unbranched in both wings, or branched in one wing and unbranched in the other.

In the *Odonata* of the Lias and Upper Jurassic, we find definite *Anisoptera* with the radius branched, the oblique vein and bridge present. We also find a few undoubted *Zygoptera* (*Calopterygidæ*) with the radius unbranched. There remain the group which Handlirsch named *Anisozygoptera*, and which he claimed to be intermediate between true *Anisoptera* and *Zygoptera*. A careful examination of these forms shows :—

(*a*). That the *Heterophlebiinæ* have an unbranched radius, with a long bridge developed as in the *Synlestinæ*.

(*b*). That all the other forms have an unbranched radius and no bridge.

Intermediate forms, like *Meganeura monyi*, are not found in the Mesozoic strata. Every form so far known can be, therefore, definitely classed as *Anisopterous* or *Zygopterous*, according to the condition of its radius.

On the totality of the above evidence, which I consider to be very strong, a new view of the venation of *Zygoptera* seems to me to be not only indicated, but absolutely necessary. For this new view, which I now present for the first time, no better name than the "Unbranched Radius Theory" (the name given by Dr. Ris) can be found. We may enunciate the theory as follows.

The basic difference between *Anisoptera* and *Zygoptera* is the condition of the radius, a difference which is more radical than that of the presence or absence of the triangle, since it goes further back in point of geological time. In all *Anisoptera*, the radius has a single branch, the *radial sector* (Rs), which crosses two branches of the media ($M_{1\text{-}2}$); a short bridge is also developed in connection with it. In all *Zygoptera*, the radius is unbranched; a bridge is absent,* except in *Lestidæ*, when it is very long. In *Anisoptera*, the media (M) gives off only *three* posterior branches, so that Rs lies between the second and third, counting from the base. In *Zygoptera*, the media gives off *four* posterior branches, one of which takes the place of Rs, *i.e.*, supplies (in the larval wing) the area lying between the second and what is here the fourth branch of M, counting from the base.

In the *Protodonata*, the condition of the radius was variable, and of no greater than generic value. Fixation of the condition was most probably correlated with the formation of arculus, nodus, and pterostigma, which began in the Permian. Difference in wing-breadth may have been the original determinant whether Rs was to be present or not. In any case, intermediate forms died out before the Lias was reached. We there find the *Odonata* represented by a race of robust forms—the *Anisoptera*—with the radial sector present, and the discoidal cell divided into triangle + supertriangle; and by a race of slenderer forms (many of them still of large size)—the *Zygoptera*—with the radial sector absent, and the discoidal cell not definitely divided.

The development of the three main types of *Zygopterid* wing-venation may be shown thus:—A glance at Fig.3,A,B, shows that, on the ontogenetic evidence, the *Calopterygidæ* have tended

* There may be a *very short* bridge in *Rhinocypha* and *Chalcopteryx*, but the larvæ are not available for examination.

to move the three most basal branches of M closer together. Thus the *Calopterygidæ* and *Agrionidæ* have a common origin in forms in which these three branches lay further apart than in recent *Calopterygidæ*, but not so far apart as in recent *Agrionidæ*. The reduction of the prenodal area in the latter family is clearly correlated with the extended condition of the medial branches. For, obviously, three branches are not needed to support so short a prenodal area. As regards the *Lestidæ*, I find that the most distal branches of M arise by a common stem in all the last four instars of *Austrolestes*, and in all instars of *Synlestes* (three) that I have examined. Thus, I conclude that this is a primitive condition, probably independently inherited, and not brought about (as Dr. Ris suggested) by the movement distad of one branch so as to become a "tributary" of the other. Support for this view is forthcoming in the fact that the Liassic *Heterophlebia* shows this condition fully formed, as in our recent *Synlestes*. The same fossil supports the view that, in *Lestidæ*, when the prenodal area became reduced, the second branch of the media (counting from the base) travelled basad away from the nodus, and took up a position similar to that seen in *Calopterygidæ*. If that be so, this particular character was independently evolved in these two families, and cannot serve to indicate a close relationship between them. The totality of evidence tends to bring the *Calopterygidæ* and *Agrionidæ* close together (the common character of the *absence of a long bridge* is very important), and to separate the *Lestidæ* out as a very distinct group of independent origin.

In now definitely rejecting Needham's explanation concerning the shifting of Rs over to M, I must lay the greatest stress on the ontogenetic evidence. If such a change as Needham pictured had ever taken place, *it is almost inconceivable that not the slightest record of it should now be left in the ontogenetic stages of the larval wing*. On the other hand, if such evidence can be found, the new theory must give way to Needham's original supposition, or some other theory in accord with the ontogenetic evidence.

If we now accept the Theory of the Unbranched Radius, four main consequences arise :—

(i.). Handlirsch's Suborder *Anisozygoptera* becomes untenable, and must be merged into the *Zygoptera*. The *Heterophlebiinæ* become *Lestidæ*, all the rest of the forms *Calopterygidæ*.

(ii.). The crossing of Rs over $M_{1\cdot 2}$ is no longer a character separating the *Odonata* from all known insects, but only separates the *Anisoptera* from the *Zygoptera*.

(iii.). The dichotomy between *Anisoptera* and *Zygoptera* becomes far more pronounced than heretofore. Consequently, the possibility of finding such structures as, for instance, reduced rectal gills in *Calopterygidæ*, must be regarded not only as very remote, but, if the theory is strictly true, they should not be expected to occur at all.

(iv.). A name and a notation are required for the extra branch of the media in *Zygoptera*. Counting the distal end of the main stem, there are five separate branches of the media. We cannot name these M_1, M_2, etc., to M_5 without destroying the obvious homologies of M_4 and M_2 in the *Anisoptera* with the most basal and most distal branches of M respectively in the *Zygoptera*. A name that would suggest the *analogy* of the extra branch with Rs in the *Anisoptera* would be the most suitable. I, therefore, propose the special term *Zygopterid Sector*, with the notation Ms. This notation is clearly the most suitable one, since it allows of the preservation of the homologies of the other branches, and suggests the analogy with Rs which this sector undoubtedly possesses. It is adopted in the figures accompanying this paper.

As it is of all things the most necessary, both for systematic and biological workers, that the notation for *Odonate* wing-venation should be speedily and finally settled, the new departure, here instituted, should be criticised at once, and any possible evidence against the new theory should be immediately brought forward. We do not desire change for the sake of change. But we refuse to remain bound to a notation which is clearly both incorrect and misleading, such as the use of Rs in *Zygoptera* when there is no Rs. In this connection, those who have the opportunity of examining the larval wings of other *Zygopterid* (and particularly *Calopterygid*) genera should do so at once, to see whether they add weight to the new theory or disprove it.

In North America, the study of all possible ontogenetic stages of *Hetaerina* and *Archilestes* would be of great value.

B. *The Problem of the Anal Vein.*

In my previous paper (*loc. cit.*), I showed that the anal vein of imaginal *Odonata* was secondarily developed by a backward growth from Ac, and I named it the "secondary anal vein," A′. Dr. Calvert (*in litt.*) objects to the term "secondary," and suggests "recurrent" as a better term. I am quite willing to accept his suggestion, though I fail to see the objection to the term "secondary." A glance at Fig.6 shows how this vein can be actually seen developing backwards in *Diphlebia*, during larval cuticularisation. In any case, A′ remains as the notation for this vein.

As regards the "anal bridge," Ab, Mr. Herbert Campion tells me that Dr. Ris has already employed (apart from tracheational studies) the notation A* for this vein. Dr. Ris's notation should take priority over mine, but for the fact that the use of the asterisk in notation is an innovation much to be deplored, and, as a matter of fact, "preoccupied" by the general consent and use of centuries. A* in any printed work (including scientific publications) means "A (see reference below)." To illustrate the impossibility of accepting such a notation, I need only remark that the next author who wanted to use it, and at the same time to refer the reader to the place where Dr. Ris originated it, would have to print the absurdity A** (unless he were lucky enough to get A*†!). Surely such signs as *, †, ||, need not be dragged into our notation at all. They should all be considered preoccupied, by general consent. Concerning the structure of Ab in the *Calopterygidæ*, we see (Figs.2, 3B, 4) that it really is formed along A_1 in the older forms, as I previously stated. In *Anisoptera*, A_1 reaches Cu_2; in *Calopterygidæ*, it just fails to do so; in *Agrionidæ* and *Lestidæ*, only a remnant of A_1 is left. We may, therefore, fairly retain Ab as a unit in the *Zygoptera*, and define it as "the vein which runs from the posterior end of Ac up to Cu_2."

There remains the curious formation Ac′ in *Calopteryx*(Fig.3B). This seems to be introduced simply because, in the larva, Ac lies some distance from the base, and there is a wide anal wing-space left between it and the base without tracheal supply. In the imago, it seems to be represented by the *first* cubito-anal cross-vein, Ac being the *third*, which is often seen to be slightly oblique (Fig.4).

C. *Supplementary Bridges in Calopterygidæ.*

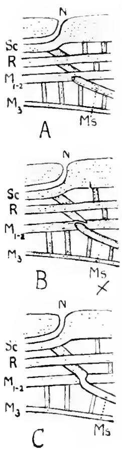
In *Diphlebia*, and probably also in *Philoganga*, the long supplement, lying between M_1 and M_2, is fed by a trachea which drops from M_1, and supplies weak distal and proximal branches to the developing supplement. In the imago, this condition is reproduced by an oblique vein, representing the stem of the descending trachea, and a short "bridge," which is, in reality, only the proximal portion of the supplement. Anyone who will examine the formation of Mspl and Rspl in *Anisoptera*, particularly in *Æschninæ*, will see a similar method of tracheal supply carried to excess. In *Æschna brevistyla*, I have sometimes seen as many as *three* depending tracheæ, all supplying the supplement. As, however, they are all of more than one cell's length, they do not get mistaken for "oblique veins" in the imago. But they are homologous with the latter, and the proximal parts of the supplements are the homologues of "bridge-veins."

A similar short "bridge-formation" is observable (apparently) extending Ms very slightly proximad in *Chalcopteryx* and *Rhinocypha*. This simply shows us that, in the *Calopterygidæ*, the wing required extra support in the region just distal from the arculus. In some forms, Ms did not arise sufficiently close to M_3 to give the necessary support, so a short "bridge" was developed to supply the deficiency. In others (*Calopteryginæ*), extra support was gained by a fusion with the radius.

Thus we see that short "bridges" and "oblique veins" may be developed in connection with almost any sector or supplement which requires strengthening basally. The "bridge" of *Anisoptera* and the "long bridge" of *Lestidæ* are the only two, out of probably very many attempts of this kind, which have attained real systematic importance, by attaining a definite structure and constancy throughout a whole group of genera.

D. *Cuticularisation of the Larval Wing* (Pl. xxxiii., figs.2-3; Text-figs.5-6).

The wings of *Diphlebia* larvæ well advanced in the last instar show a condition not hitherto recorded in any works known to me., viz., *a definite cuticularisation of the larval wing, outlining, but distinct from, the future venation of the imago.* This condition caused me considerable trouble, since I found (in the larva examined at Wentworth Falls by camera-lucida drawings) what appeared to be all stages in the development of a basal stem connecting Ms with R. At first, I believed that it was actually *trachea* Ms which was growing back on to R (how much the wish was father to the thought !). Dr. Ris, however, with characteristic insight, at once gave it as his opinion, on seeing the photographs taken from the second specimen, that here was a cuticularisation of the larval wing taking place, preparatory to the development of the imaginal venation within. This is clearly correct. We have all seen, of course, the pattern of the imaginal venation left behind on the larval wing-case in the exuviæ, but I do not think the actual formation of this pattern, as apart from the formation of the true venation, has ever been noted or figured. A point of interest in this cuticularisation is that it seems to take place somewhat unevenly.

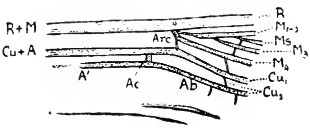


Text-fig.5.*

Thus in Pl. xxxiii., fig.3, we see the extreme base of M_{1-3} still unaffected, the transparent trachea plainly showing through as a narrow stalk. The bases of M_3 and Ms have only a little cuticularisation. In the case of A′, in one of the Wentworth Falls specimens, the process of gradual backward growth was beautifully shown (Fig.6). Again, in the case of Ms, as the

* *Diphlebia lestoïdes* Selys. Last larval instar. To show progressive stages in the cuticularisation of Ms and its connection with R.—A, in right hindwing of first larva—B, in right forewing of first larva—C, in right forewing of second larva. (Camera-lucida drawings made from the *under side* of the wing-case). Compare Pl. xxxiii., fig.2.

cuticularisation gradually overspread the base of the trachea, it continued to grow out *under* the main stem of M, and finally became united with a strong, slanting cross-vein from R, below the subnodus, thus forming a veritable *radial sector* on the wing-case itself, though the trachea Ms remained attached to M. Three stages in this growth are shown in Fig.5. These were drawn from the two Wentworth Falls larvæ in the last instar. It is important to note that the connection with R was effected on the *underside* of the wing-case, since this seems to show an obvious difference of level between tracheæ R and M in the larval wing, and helps us to understand how, in *Anisoptera*, Rs was able to pass below M_{1-2} without becoming strangled by the pressure of these overlying tracheæ.



Text-fig. 6.*

In conclusion, I offer an amended dichotomous table for the classification of the *Zygoptera*, based on venational characters, with particular reference to the points mentioned in this paper:—

1. { R once-branched. M with three posterior branches. Discoidal cell divided into triangle + supertriangle.........Suborder ANISOPTERA.
   R unbranched. M with four posterior branches. Discoidal cell a simple quadrilateral ....Suborder ZYGOPTERA (2).

2. { Ms arising from M_2; a long bridge developed backwards from this point.. Family LESTIDÆ (3).
   Ms arising from the main stem of M. No long bridge .... 4.

3. { The long bridge runs back to meet M_{1-2}.................................. 5.
   The long bridge runs back to meet M_3.................................. 6.

4. { M_3 and Ms close to arculus; M_2 at subnodus. More than two antenodals .... Family CALOPTERYGIDÆ†(7).
   M_3 and Ms close to subnodus (one of them usually directly under it), M_2 distally placed from subnodus. Normally two antenodals, rarely more (*Thaumatoneura*, fossils, and occasional anomalies)... ....Family AGRIONIDÆ (8).

* *Diphlebia lestoïdes* Selys. Last larval instar. To show method of cuticularisation of A′ backwards from Ac towards base of wing. (Camera-lucida drawing.) Compare Pl. xxxiii., fig.3.

† Fossil forms of this family are omitted.

5. Robust forms with many antenodals. Quadrilateral of hindwing much wider than that of forewing........Subfamily *Epiophlebiinæ*.
Slender forms with two (rarely three) antenodals. Quadrilaterals of both wings narrow, with sharply acute distal angle.................. ....Subfamily *Lestinæ*.

6. Robust forms with many antenodals. Quadrilateral wide, irregular. ....(Extinct). Subfamily *Heterophlebiinæ*.
Slender forms with two (rarely three) antenodals. Quadrilaterals of both wings narrow, with sharply acute distal angles.................. ....Subfamily *Synlestinæ*.

7. Sectors of the arculus attached to R. Hence, quadrilateral very wide basally. ....Subfamily *Thorinæ*.
Sectors of the arculus not attached to R .... 9.

8. Nodus very close to wing-base, at about one-seventh of the total wing-length. Numerous postnodals........Subfamily *Pseudostigmatinæ*.
Nodus at from one-fourth to less than one-half of the total wing-length .... 10.

9. Sectors of arculus arising at or a little above middle of arculus. No upward arching of $M_{1\text{-}3}$. Pterostigma normal............ ....Subfamily *Epallaginæ*.
Sectors of arculus arising below middle of arculus. $M_{1\text{-}3}$ arched strongly up to re-fuse with R. Pterostigma false or absent......... ....Subfamily *Calopteryginæ*.

10. Main veins diverging distally; intercalated sectors present besides the postnodal sector ....Subfamily *Megapodagrioninæ*.
Main veins not diverging; no intercalated sectors except the post-nodal...................................... .... 11.

11. Cu_2 reduced to a cross-vein ....Subfamily *Protoneurinæ*.
Cu_2 normal .... 12.

12. Quadrilateral regular.... ....Subfamily *Platycneminæ*.
Quadrilateral irregular, usually with distal angle sharply acute........ ....Subfamily *Agrioninæ*.

EXPLANATION OF PLATES XXXII.-XXXIV.

Plate xxxii. (Photomicrographs).

Diphlebia lestoïdes Selys.

Fig. 1.—Penultimate larval instar. Middle portion of wing; (×60).
Fig. 2.—Penultimate larval instar. Basal portion of wing; (×60).
Fig. 3.—Antepenultimate larval instar. Whole wing; (×25).

Plate xxxiii. (Photomicrographs).

Diphlebia lestoïdes Selys.

Fig. 1.—Penultimate larval instar. Basal two-thirds of wing; (× 25).

Fig. 2.—Last larval instar. Cuticularisation. Middle portion of wing; (× 60).

Fig. 3.—Last larval instar. Cuticularisation. Basal portion of wing; (× 60).

Plate xxxiv. (Photomicrographs by Dr. F. Ris).

Calopteryx splendens Harris.

Fig. 1.—Last larval instar; (× 25).

Fig. 2 —Last larval instar. Base of wing; (× 60).

Fig. 3.—Penultimate larval instar. Basal half of wing; (× 60).

THE TEMPERATURE OF *ECHIDNA ACULEATA*.*

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(With eight Text-figures.)

Introduction.—The study of the morphology of Echidna has led to its being classified with the most primitive of mammals. This fact has, perhaps, given rise to the supposition that the functional activities of the animal would share the primitive characters of its structure; and, indeed, Chapman(**4**) has shown that the behaviour of the muscle of the Echidna towards stimuli resembles more that of the muscle of cold-blooded animals such as the frog, than that of typical mammalian muscle. The observations which had, up to the present, been made of the temperature of Echidna were interpreted as further justifying this supposition.

The temperatures of reptiles lie within a few tenths of a degree of that of the surrounding air [Pembrey(**10**), Richet(**11**), Soetbeer(**14**)]. They vary, therefore, from day to day with the changes of the external temperature.

The temperatures of birds and of nearly all mammals (including marsupials) are subject to little variation (Pembrey, Richet, *loc. cit.*), and are maintained at levels (36°-45°C.), above which, in most parts of Australia, the temperature of the air rises only during a short season of the year [Hunt(**5**)].

The temperature of Echidna, however, was found to be considerably lower and more variable than that of other mammals. N. de Miklouho-Maclay(**9**), who appears to have been the first to observe the temperature of this animal (1879), found the cloacal

* The work, of which this paper is an account, was carried out in the year 1914, during the author's tenure of a Science Research Scholarship at the University of Sydney.

temperatures of two specimens to be 28·3° and 26·95°C. R. von Lendenfeld(6) gives the ordinary blood-temperature of the animal as 28°C., although he says it may rise as high as 35°C. Semon(13) found that the cloacal temperatures of the seven Echidnas, which he was able to observe, ranged from 26·5° to 34·0°C., whilst Sutherland(15), observing fourteen animals, found temperatures ranging from 22° to 36°C. The two latter observers recorded the temperatures of the air as well as those of the animals. The only conclusions to be drawn from the above small number of observations seem to be those expressed by Semon, that Echidna is not strictly to be classed either with poikilothermal or with homoiothermal animals; it has a body-temperature which stands in no direct relation to the temperature of the external air, but which undergoes uncommonly large variations.

Later, C. J. Martin(7) studied the behaviour of the temperature of Echidna, when the external temperature was rapidly varied in a definite and regular manner. Under these circumstances, it was shown that the temperature of Echidna undoubtedly depended on that of the surroundings. In experiments on three animals, for example, when the temperature of the surroundings rose from 5° to 35° in 6-7 hours, the temperature of the Echidnas rose from 25·5° to 34·8°, or 9·3°C., from 27·6° to 40·0°, or 12·4°C., and from 29·1° to 37·1°, or 8·0°C., respectively. It must be noted, however, that under circumstances such as these even the temperatures of higher mammals showed a degree of dependence on the external temperature much greater than usual. In the case of a rabbit, when the air-temperature fell from 40° to 5°, or 35°C., in about five hours, the temperature of the animal fell from 41·6° to 37·5°, or 4·1°C., in the same time. In the case of a cat, when the same fall in the external temperature occurred in an equal time, the temperature of the animal fell from 39·9° to 38·5°, or 1·4°C. The variations of the temperatures of reptiles (blue-tongued lizards) in similar experiments followed exactly those of the temperature of the surrounding air.

Under the conditions of these experiments, therefore, Echidna behaved in a manner intermediate, with regard to the regulation of its temperature, between that of reptiles and that of mammals;

and Martin concluded that Echidna is the lowest on the scale of warm-blooded animals.

But there is a class of mammals whose temperatures are at times subject to very great variations— the class of hibernants. The members of this class are not confined to any one group of animals, and among them is to be numbered Echidna (N. de Miklouho-Maclay, Martin, *loc. cit.*). During the winter-months, animals of this class allow their temperatures to sink towards that of the external air, and behave like cold-blooded animals for periods of varying duration.

As to the temperatures of these animals outside of the periods of hibernation, the data available are rather few in number, and different observers are not unanimous in their opinions. Pembrey (*loc. cit.*) states that, with regard to temperature, the behaviour of hibernants in their waking-state is practically the same as that of other warm-blooded animals. Merzbacher(**8**), on the other hand, is of the opinion that the temperature of hibernants in their waking-state is rather lower than that of other mammals, and is subject to much greater variations. He cites his own observations and those of Saissy(**12**), who gives the waking-temperature of the bat as 31°C; Berthold(**3**), who states that the normal waking-temperature of the dormouse is 29·7°C.; Barkow(**2**), who observed temperatures ranging from 25° to 35°C. in the case of a waking hedgehog; and of several other investigators in support of this view. A quotation from Barkow may be given as summarising their position: "Obgleich die Tiere ausserhalb des Winterschlafes zu den Warmblütigen gehören, so zeigt die Lebenswärme doch bei verminderter allgemeiner Tätigkeit, wie während des gewöhnlichen Schlafes, bei Abmagerung, oder sonstiger Krankheit, *grosse Neigung zum Sinken.*" Athanasiu(**1**), however, while admitting that the waking-temperatures of hibernants are perhaps slightly lower than those of other mammals, throws doubts on the reliability of the low figures given by some of the above observers, and points out how extremely limited is our knowledge of the temperatures of hibernants in their active state, and how necessary are new investigations to give us satisfactory information on this question.

In view of this incomplete state of our knowledge of the waking-temperatures of other hibernants, therefore, the conclusion that Echidna is the lowest on the scale of warm-blooded animals seems hardly justified. Anatomically, Echidna is indeed the most primitive of mammals, but between the anatomical classification of animals and their physiological functions there is not necessarily a direct relation. With regard to temperature, for example, this is well illustrated by a comparison of birds with reptiles and with mammals. As far as their structure is concerned, birds are much more closely related to reptiles than to mammals, and yet their behaviour with regard to temperature is quite different from that of reptiles, and very similar to that of mammals.

The aim of the present work has been to collect a series of observations of the body-temperature of Echidna under conditions which, although they can hardly be called natural, yet underwent no arbitrary, regular variations. The endeavour has also been made, by collecting a large number of data over fairly long periods and at different times of the year, to obtain material from which a more comprehensive idea of the behaviour of Echidna, with regard to temperature, might be gathered.

It may be stated here (i.) that the Echidnas under my observation hibernated only for very short periods at a time during the winter, (ii.) that, outside the periods of hibernation, their temperature kept in the neighbourhood of a value (30°C.) which is considerably lower than that of the average temperature of the majority of mammals, and (iii.) that the temperature of the animals was subject to comparatively large variations, and seemed to be affected, to some extent, by the temperature of the air.

Methods.—The observations recorded in this paper were made upon ten Echidnas, all males, and varying in weight from about 600 to about 2000 gms. The animals were kept in a shed of fibro-cement, the floor of the shed being of concrete, and having upon it a layer of sawdust about 5 cm. thick. For the first three weeks during which observations were made, the animals were fed upon bread and milk; for the remainder of the time, upon eggs beaten up with milk to which a little sodium citrate had been added to hinder coagulation. These animals are apt to so gorge themselves upon milk (they are able to drink as much as 30% of their body-weight of it) that, if clotting be allowed to take place unhindered, a solid mass, which digests very slowly, is formed in the stomach and eventually causes death.

Of the ten Echidnas under observation, Nos.1-7 were caught in Autumn, Nos.8-10 in Spring. These animals survived for varying lengths of time, after coming under observation, as set forth in tabular form below.

Caught in Autumn (April) 1914.	Caught in Spring (October) 1914.
No.1 lived for 37 days.	No.8 lived for 10 days.
No.2 lived for 75 days.	No.9 lived for 18 days.
No.3 lived for 61 days.	No.10 lived for 32 days.
No.4 lived for 32 days.	
No.5 lived for 103 days.	
No.6 still living.	
No.7 lived for 97 days.	

It will be noticed that the animals captured in Autumn lived, on the average, much longer than those taken in Spring. No.6 had been living in captivity for about twelve months at the time of writing. The death of one of the animals was due to acute peritonitis. What caused the death of the others is not known, although *post mortem* examinations showed the presence of infarcts in the liver in several cases. The animals were all rather emaciated before they died.

The body-temperatures of the animals were observed by inserting the bulb of a thermometer, graduated in tenths of a degree Centigrade, through the cloaca into the rectum, and reading off the temperature *in situ* to the nearest tenth of a degree after the lapse of two minutes, the time required for the mercury to become steady. The errors of the thermometers used were determined by reference to standard instruments, and the necessary corrections made to the readings. The animals were held up by a hind leg while the temperature was being observed. Difficulty was experienced at first in getting the thermometer into the rectum, owing to the rolling-up of the animals, but they soon became accustomed to handling, and then offered little resistance.

The temperatures of the animals were observed during two periods of the day, in the morning between 10 a.m. and 11 a.m., and in the afternoon between 2 p.m. and 3 p.m. The temperature of the air in the animals' shed, at a height of about 120 cm. from the floor, was always read just before taking the temperature of the animals. It should be remarked that the temperature of the air above the animals may be considerably different from that of the sawdust covering the floor of the shed. On one hot day, for example, the temperature of the air was 37·4°C., whilst that of the sawdust was only 21·9°C.

Results —The following is a tabular record of the observations made.

TABLE I.

Autumn and winter temperatures of Echidna.

Date.	Time.	Air-temp.	Temperature of Echidna						
			No.1.	No.2.	No.3.	No.4.	No.5.	No.6.	No.7.
30/4	10.15	20·2	30·8	29·8	31·6	29·1	31·6	28·3	28·5
	3.10	23·7	32·5	31·8	34·0	33·7	34·2	—	32·9
1/5	10.30	20·2	29·3	29·5	30·3	26·5	29·4	30·0	—
	2.30	22·2	31·8	32·4	33·3	30·9	33·4	32·0	33·0
4/5	11.0	20·2	30·0	31·9	30·1	25·9	30·3	29·9	30·2
	2.15	20·7	32·2	30·9	32·7	30·4	33·4	32·7	32·7
5/5	10.30	18·4	29·0	32·1	28·9	25·6	30·5	29·3	29·8
	2.30	20·4	31·6	31·3	32·7	30·2	33·7	30·8	32·9
6/5	10.30	18·6	27·7	30·7	31·2	23·2	29·7	29·0	29·8
	2.30	20·8	31·2	31·8	32·5	28·7	33·4	31·6	33·1
7/5	10.30	18·6	27·4	30·5	29·7	23·8	30·4	29·1	28·8
	2.0	19·8	29·8	32·9	33·2	29·4	33·3	30·3	32·5
8/5	10.15	20·3	26·8	30·3	30·4	25·1	29·3	29·3	29·4
	2.15	20·7	27·6	33·2	33·4	29·9	33·4	32·0	33·2
11/5	10.15	17·7	28·2	29·4	29·1	24·1	30·0	29·0	28·2
	2.30	19·9	31·4	32·9	33·4	29·0	33·3	32·0	—
12/5	10.30	17·6	29·2	30·0	27·4	25·0	29·4	28·6	29·9
	2.45	20·2	32·1	33·2	32·7	28·9	33·6	32·2	32·8
14/5	10.45	18·7	27·6	29·8	30·2	23·8	30·3	30·9	29·9
	3.15	19·7	32·1	33·4	32·8	29·0	33·5	33·5	33·3
15/5	10.45	17·2	28·8	30·5	26·1	24·9	29·3	29·7	29·5
	2.45	19·7	31·9	31·8	31·9	28·2	31·6	32·5	—
18/5	11.0	19·3	27·4	31·2	31·8	19·6	31·0	30·3	Lost
	3.0	18·3	31·0	32·4	33·2	21·5	33·1	32·5	
19/5	10.45	16·5	21·5	30·3	—	16·4	31·2	29·7	
	3.15	18·2	27·6	33·1	—	17·4	32·8	32·4	
20/5	10.30	17·3	21·5	30·0	26·9	16·6	29·6	28·6	20·0
	2.30	17·8	26·6	33·0	31·8	17·1	32·8	32·3	31·2
21/5	11.0	15·3	25·1	30·0	27·2	16·4	29·2	28·9	23·4
	2.45	17·0	28·9	32·6	32·0	22·8	32·0	32·1	29·2

TABLE i.—*Continued.*

Date.	Time.	Air-temp.	Temperature of Echidna No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
22/5	10.30	16·4	26·6	29·0	27·0	24·6	31·5	29·6	26·1
	2.45	17·2	30·9	33·1	32·4	28·8	33·6	32·6	32·1
25/5	10.15	14·8	15·0	29·2	19·2	14·8	26·8	30·0	14·8
	2.30	—		33·2	30·6		32·7	32·3	
26/5	10.30	16·1	Hibernating, not disturbed.	29·3	26·2	Hibernating, not disturbed.	29·6	27·1	Hibernating, not disturbed.
	—	—		—			—	—	
27/5	10.30	13·2		25·1	Hibernating, not disturbed.		18·0	25·3	
	3.0	14·1		32·5			31·1	Hurt, not disturbed.	
28/5	10.30	11·9		28·5			25·3		
	2.15	15·9		32·8			32·2		
29/5	10.30	13·7		26·1			18·3		
	—	16·6		32·9			—		
1/6	11.15	14·8	23·6	30·6	22·8	dead	29·5	22·2	28·8
	2.45	16·3	23·5	32·4	27·8	...	27·2	29·9	32·6
2/6	10.15	12·9	15·7	25·2	15·8	...	17·1	30·0	31·7
	2.45	17·2	16·2	32·5	19·1	...	16·9	30·4	33·0
3/6	10.15	12·8	13·5	25·5	14·8	...	12·8	23·8	21·9
	2.30	16·2	15·2	32·5	18·8	...	14·7	31·0	31·7
4/6	10.30	11·2	12·4	19·4	13·9	...	11·1	18·3	15·1
	2.45	16·0	14·5	31·8	21·7	...	13·9	29·5	18·9
5/6	10.30	13·3	dead	20·2	20·3	...	25·7	29·1	17·2
	2.45	16·9	...	30·8	32·1	...	32·0	31·5	31·0
9/6	11.0	13·7	...	20·9	17·9	...	19·6	17·7	19·4
	2.15	17·2	...	30·9	22·0	...	29·0	22·3	20·7
10/6	10.45	13·4	...	26·1	14·9	...	16·5	17·2	16·1
	2.30	16·5	...	32·5	15·8	...	29·1	29·5	15·8
11/6	10.15	13·2	...	30·4	13·5	...	25·3	29·6	13·8
	2.15	15·5	...	33·1	14·8	...	26·5	32·0	26·8
12/6	10.15	11·8	...	29·6	12·4	...	25·3	23·4	30·0
	2.15	15·4	...	32·7	14·7	...	27·8	30·5	32·0
15/6	10.30	12·0	..	14·8	11·9	...	28·8	13·5	13·3
	2.30	15·5	...	21·9	14·7	...	31·2	25·5	14·6
16/6	10.45	12·9	...	28·9	13·3	...	30·6	29·8	32·4
	2.30	14·3	...	33·1	14·3	...	31·5	31·6	32·1
17/6	10.30	12·9	...	20·9	13·2	...	29·7	14·4	20·6
	2.15	13·6	...	19·7	13·5	...	32·0	14·0	18·1
18/6	10.45	13·7	...	14·9	13·4	...	28·9	14·3	13·9
	2.15	14·8	...	15·2	18·2	...	31·6	25·1	14·8
19/6	10.45	13·7	...	24·1	20·2	...	30·6	28·8	13·8
	—	—	...	—	—	...	—	—	—
22/6	10.30	12·5	...	18·1	13·3	...	30·2	28·1	12·4
	2.0	13·8	...	29·5	15·3	...	32·6	32·0	13·7
23/6	10.15	10·9	...	24·3	13·0	...	30·3	28·7	31·9
	2.30	15·3	...	32·2	16·4	...	32·9	32·3	32·7
24/6	10.30	12·1	...	27·4	17·5	...	20·6	25·0	18·4
	2.30	15·9	...	33·0	16·6	...	32·8	31·5	15·9
25/6	10.45	13·6	...	28·8	14·6	...	29·6	27·7	13·5
	2.30	15·5	..	32·9	14·9	...	32·5	31·7	14·6
26/6	10.45	15·5	..	30·8	15·1	...	30·2	28·4	14·3
	2.30	16·2	...	30·5	15·7	...	32·6	30·1	15·2

TABLE i.—*Continued.*

Date.	Time.	Air-temp.	Temperature of Echidna No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
30/6	10.15	16·5	...	25·3	dead	...	31·6	28·5	14·9
	2.30	16·0	...	28·8	...	...	29·3	31·3	19·0
1/7	10.45	14·2	...	19·8	...	...	28·3	21·1	29·5
	—	—	...	—		...	—	—	—
2/7	10.45	14·8		18·9	...	...	29·6	14·8	23·8
	2.15	14·5	...	19·9	...	...	33·0	15·9	21·2
3/7	10.30	15·5		20·0	...		30·3	31·6	18·9
	2 30	16·4	...	21·4		.	33·0	32·7	17·9
6/7	10.30	14·8	...	24·7	...	...	30·0	29·2	13·6
	2.0	15·9		25·0	...		32·6	32·1	14·7
7/7	10.15	13·8		18·1	...	...	29·7	28·5	13·9
	2.1	15·8	...	17·1	...	..	31·7	31·3	14·3
8/7	10.30	10·6	..	10·9	...	...	30·0	13·3	11·8
	2.15	12·4	.	11·5	..		32·9	18·5	11·6
9/7	10 30	12·1	...	11·4	...	...	28·6	16·3	11·1
	2.0	14·0	...	13·3		...	32·3	31·3	12·4
10/7	10.30	10·6		10·4	...		28·2	24·7	10·1
	2.30	12·5	...	11·3	...		31·9	29·0	10·9
13/7	10.30	9·9	.	dead	...	...	29·3	10·7	32·0
	2.45	12·2	...		...		32·4	11·2	32·4
14/7	10.15	10·6	...	...	...	...	28·4	9·9	18·8
	2.15	13·0	...	...	...	...	29·4	11·3	15·5
15/7	10.45	12·0	...	...	...	...	25·1	9·9	10·2
	—	13·1	..	...		...	27·0	11·5	12·0
16/7	10.0	8·4	...	...	...	...	29·5	28·3	8·9
	2.0	11·3	...		...	..	32·3	31·3	9·9
17/7	10.15	10·1	...	..			27·8	25·8	15·0
	2.15	11·9	...	..	...	...	30·1	29·8	13·3
20/7	11.0	11·6	...	...	...	.	30·6	12·1	12·1
	2.30	13·1	..	...		...	32·4	12·3	12·6
21/7	10.45	12·0	...	..	...	.	19·2	12·7	11·3
	2.30	13·4	...	...	...		29·4	13·3	12·1
22/7	10.30	12·1	..	...		...	30·3	11·7	12·1
	2.30	13·6	...	...	...	..	31·7	13·7	24·8
23/7	10.30	9·8	...	...	..	...	29·4	30·6	31·4
	2.30	13·7	...		...	...	32·5	31·7	32·6
24/7	11.0	12·1	...	..	...	...	30·7	27·3	30·6
	2.0	13·9	.	...			32·7	31·9	32·5
27/7	10.15	11·1	..	...		...	21·5	26·2	11·2
	2.45	13·8	...		...	...	31·3	30·1	13·6
28/7	10.15	10·6	..	...	...	...	28·4	20·8	10·8
	2.15	14·8	...	...	...	.	30·8	30·0	12·6
29/7	10.30	13·1	...	..	..	...	29·2	29·6	12·1
	2 30	15·5	..	...		...	32·6	31·8	13·3
30/7	10.30	12·4	...	...		.	26·4	26·8	11·5
	2.30	15·9	...	...			31·3	32·2	13·8
31/7	10.15	12·7	..	...	...	...	29·1	25·8	12·4
	2.15	15·1		..			31·1	30·2	13·8
4/8	10.15	13·3	...	...	...	..	30·6	22·7	...
	2.15	17·0	...	..		...	31·8	30·5	..

TABLE i.—*Continued.*

Date.	Time.	Air-temp.	Temperature of Echidna. No.1.	No.2.	No.3.	No.4.	No.4.	No.6.	No.7.
5/8	10.30	12·9	..	...	...	...	28·4	28·8	...
	2.15	17·1	...	...		...	27·4	31·9	...
6/8	10.30	14·9	...	...		...	23·7	29·3	...
	2.45	16·1	...	...	...	.	23·9	29·1	
7/8	10.45	14·2	...	...	..	...	14·4	27·9	...
	2.15	17·3	...	..	...	...	16·1	31·8	
10/8	10.30	12·9	...	...	...	...	dead	23·9	...
	2.15	15·7	..	..		...	..	31·3	...
11/8	10.15	11·8	...		...	...	...	26·9	...
	2.15	16·4	...		.	...	...	30·7	...
12/8	10.45	14·1	.	..	...	...	...	27·4	...
	—	—	...	...	...	...	...	—	...
13/8	10.45	13·3	.	...	...	...	..	29·8	...

In the case of Echidna No.1, it will be seen that, between April 30th, and May 22nd, its morning-temperature varied between 30·8° and 25·1°, except on May 19th, and 20th, when very low body-temperatures were recorded; its afternoon-temperatures varied between 32·5° and 27·6°C. On May 25th, the first definite hibernation was noticed, the temperature of the animal being very close to that of the air. Observation of the animal's temperature was at once suspended in order not to disturb the hibernation, but a partial awakening occurred on June 1st. The animal was again torpid next day, and died three days later.

In the case of Echidna No.2, between April 30th and June 12th, with the exception of June 4th, 5th, and 9th, when low body-temperatures were observed, the morning-temperatures of the animal varied between 32·1° and 25·1°C., the afternoon-temperatures between 33·4° and 30·8°C. The hibernation of this animal was very erratic; the first definite signs of it were observed on June 15th. The animal was torpid on June 15th, June 18th, and from June 30th to July 2nd. The temperature rose somewhat on July 7th, but fell again next day, and remained almost at the level of the temperature of the air till the death of the animal on July 10th.

Between April 30th and June 22nd, Echidna No. 3 showed no signs of hibernation. During this period its morning-temperature varied between 31·8° and 26·1°C., its afternoon-temperature between 31·8° and 34·0°C. On June 22nd, the animal commenced to hibernate, and was left undisturbed. On June 26th, the animal began to wake up, however, but became torpid again on the 28th. It was again left undisturbed, but woke again on July 5th. From July 9th, till the time of its death on July 29th, the animal hibernated continuously. This is the longest period of continuous hibernation shown by any of the Echidnas under my observation.

The temperature of Echidna No.4 behaved, on the whole, in rather an erratic fashion. From April 30th, to May 15th, its morning-temperature varied between 29·1° to 23·2°C., its afternoon-temperatures between 33·7° and 28·2°C. From May 16th, to May 21st, the temperature of the animal approached towards that of the air, the animal meanwhile becoming more and more sluggish, and finally quite torpid. Next day, the temperature of the animal rose suddenly to 28·8°C., but immediately began to fall again almost as rapidly, reaching the level of the temperature of the air on May 25th. The animal became torpid again and remained in this condition until its death on June 1st. As this animal was in a poor state of health when it came under observation, its temperatures are not regarded as normal.

Echidna No.5 is peculiar, as it showed only one short period of hibernation during the Winter, from June 2nd, to June 4th. For the remainder of this period, with the exception of the mornings of May 27th, and 29th, June 9th, July 19th, and 27th, and the three days preceding its death, the morning-temperature of the animal varied between 31·6° and 25·3°C., the afternoon-temperatures between 34·2° and 26·5°C, although only on one or two occasions were the lower values reached.

The morning-temperatures of Echidna No.6 remained between 30·9° and 27·1°C., the afternoon-temperatures between 33·5° and 30·4°C., from April 30th, to May 26th. On June 16th, the first definite signs of hibernation were observed. This animal hibernated for a day or two on five separate occasions during the Winter. These occasions were June 17th, July 2nd, 9th, and 10th, July 14th, 15th, and 16th, July 20th, 21st, and 22nd. It will be noticed that, between the periods of hibernation, the temperature of the animal rose very sharply to its normal values in the vicinity of 30°C. This animal was injured on one occasion (May 27th) while inserting the thermometer, and was left undisturbed for a few days to recover. It was still alive and in good health at the end of the period of the observations.

Echidna No.7 showed the first signs of hibernation on May 20th. Before that date, its morning-temperature varied between 30·2° and 26·1°C., its afternoon-temperature between 33·3° and 29·2°C. The first period of hibernation began on May 25th; the animal was left undisturbed, but became active again on June 1st. This animal hibernated on eight successive occasions during the Winter, most of its time during that season being spent in the torpid condition. The periods of hibernation were May 25th-29th, June 4th, June 9th-11th, June 15th, June 17th-22nd, June 23rd-30th, July 3rd-10th, July 14th-21st, and, finally, from July 27th till the death of the animal on August 1st.

TABLE ii.

Spring and summer temperatures of Echidna.

Date.	Time.	Air-temp.	Echidna 6.		Echidna 8		Echidna 9.		Echidna 10.	
			temp.	wt.	temp.	wt.	temp.	wt.	temp.	wt.
22/9	10.30	18·1	28·5		30·3		...		...	
	2.0	21·7	32·7	1590	33·1	1175	..	...	...	...
23/9	10.0	18·0	29·5		30·4		...		...	
	2.30	26·6	33·8	1570	33·6	1150	...	...	...	...
24/9	10.15	17·4	27·8		29·9		...		...	
	2.30	23·5	33·3	1560	33·7	1120	...	...	...	...
25/9	10.0	14·1	25·8		28·8				...	
	2.15	19·9	32·2	1600	33·0	1090	...	...	...	...
26/9	10.0	13·8	27·9		25·9		...		...	
	—	—	—		—		...		...	
28/9	10.10	16·9	27·5		24·6		...		...	
	2.30	22·2	32·4	1550	32·0	1030	...	...	...	...
29/9	10.30	15·7	28·4		31·0		...		...	
	2.15	21·4	32·8	1570	33·6	990	...	...	...	...
30/9	9.45	17·3	31·2		30·6		...		...	
	2.15	22·0	32·9	1500	32·4	960		...	...	...
1/10	10.30	18·1	29·8		dead		...		...	
	2.40	23·2	32·4	1780	...	.	...	...	..	...
2/10	10.30	15·4	28·0				29·9		...	
	2.45	16·1	30·8	1760	...	..	30·8	1890	...	...
6/10	10.20	18·2	30·4		...		29·0		...	
	2.30	25·4	33·5	1590	...		30·0	1970	...	..

TABLE ii.—*Continued.*

Date.	Time.	Air-temp.	Echidna 6.		Echidna 8.		Echidna 9.		Echidna 10.	
			temp.	wt	temp.	wt.	temp.	wt.	temp.	wt.
7/10	10.15	18·9	30·2		...		30·0		...	
	2.30	25·3	33·2	1540	..	...	31·3	1980	...	...
8/10	10.30	20·3	30·3		..		30·8		.	
	2.30	21·2	32·6	1590	...	...	30·4	1930	...	...
9/10	10.30	23·4	29·5		..		30·2		...	
	2.30	29·6	33·5	—		...	31·5	—	...	...
12/10	...		...		...		...		...	
	2.55	21·6	33·2	1640	..	...	29·9	1850	...	...
13/10	10.25	18·8	29·6		...		30·3		.	
	2.20	24·2	33·5	1650	...	...	31·4	1800		...
14/10	10.30	22·6	31·1	1750	.		30·4	...	...	.
	2.25	22·3	33·1		.		29·7		...	
15/10	10.20	17·0	29·6		...		30·0		...	
	2.30	17·2	32·1	1740	...	...	32·0	1760	...	...
16/10	..	..	...		...		...		...	
	2.35	17·1	32 0	1800	...	..	30·4	1660	...	..
19/10	10.30	15·9	24·9		...		16 5		...	
	2.15	18·3	31·7	1650	...	...	17·2	1590	...	...
20/10	10.15	16·2	27·8		...		dead		...	
	2.30	17·6	32·2	1680	..	...	...	...	32·4	1680
21/10	10,25	18 2	29·4		.		.		29·9	
	2.10	22 5	33·2	1730	..	...	...	.	32·2	1640
22/10	10.30	19·6	29·4		...		.		29·0	
	2·15	36 8	32 5	1900		...	.	...	31·4	1610
23/10	10.0	19·9	28·3		...		...		26·7	
	2.10	26 8	33·2	1860	...	..	...	...	33·2	1570
26/10	10.30	28·9	31·9		...		..		29·8	
	2.20	30·4	34·0	1690	.		..	...	32·0	1560
27/10	10.15	22·8	29·8		...		...		28·3	
	2.20	27·9	33·5	1760	...	..	...	...	33·5	1630
28/10	10 30	19·3	29·2		...		...		28·4	
	2.30	20·2	32·3	1740	...	...	...	..	32·1	1570
29/10	10.30	21·2	—		...		...		30·3	
	2.15	24·9	33·3	1800	...	...	...	.	33·1	1590
30/10	10.25	27·4	30·9		...		..		31 5	
	1.45	34·2	33·9	1820	...	...	...	..	33·0	1620
2/11	10.20	20·5	31·1		..		...		25·6	
	2.15	21·9	32·7	1740				...	31·2	1530
3/11	10.30	22·3	30·9		...		.		24·4	
	2.25	23·7	33·1	1870	...	...	...	...	32·2	1560
4/11	10.10	20·9	29·8		...		...		29·3	
	2 25	25 6	33·4	1840	...	...	...	...	32·2	1550
5/11	10.15	23·8	30·7		..		...		29·6	
	2.10	28·4	34·0	1860	.	..	...	...	31·9	1530
6/11	10.20	22·9	30·2		...		...		29·4	
	2.40	24·4	33·7	1820	...	...	...	...	33·0	1490
9/11	10.35	25·0	32·4		...		...		31·6	
	2.30	22·2	33·3	1760	...	...	...	...	32·2	1420

TABLE ii. *Continued.*

Date.	Time.	Air-temp.	Echidna 6.		Echidna 8.		Echidna 9.		Echidna 10.	
			temp.	wt.	temp.	wt.	temp.	wt.	temp.	wt.
10/11	10.25	25·0	31·4		...		..		30·0	
	3.0	29·2	33·9	1900	..	.	..	...	32·7	1440
11/11	11.10	19·6	30·7		.		...		27·4	
	2.30	20·8	32·4	1950	...	..	...	..	30·6	1420
12/11	10.20	21·6	28·3		...		...		29·3	
	2.20	22·7	32·4	1860	..	..	...	...	31·2	1360
13/11	10.0	22·8	31·7		...		...		27·8	
	2.30	28·3	33·7	1850	..	...	...	...	32·2	1330
16/11	10.15	25·1	32·5		...		...		30·4	
	2.35	28·9	33·8	1810	..	...		...	31·7	1280
17/11	9.50	25·5	32·1		...		...		32·2	
	2.20	24·2	32·6	1950		...	...		31·9	1270
18/11	10.5	22·2	30·6				...		30·3	
	2.40	23·1	31·8	2000	.	...	...	..	30·9	1210
19/11	10.5	21·4	...		...		.		27·0	
	2.15	24·3	31·4	1910	...	.	...	..	28·6	1150
20/11	10.20	25·8	31·1		..		...		dead	
	2.25	27·4	34·0	1920	...	..	...	..	...	...
23/11	10.0	22·9	33·2		..		...		.	
	2.30	24·2	33·8	1760	.	...	...	...	...	...
24/11	10.5	24·2	31·8		...		...		...	
	2.25	28·3	33·7	—	...	...	...	...	...	...
25/11	9.55	24·3	31·1		.				..	
	—	—	—	1820	...	...	...		...	...
27/11	10.20	20·5	28·9		..		...		.	
	3.15	22·6	33·0	1910	...	...	...	...	...	...
30/11	—	—	—		...		...		...	
	2.0	21·6	33·0	1750	.	...	...	...	...	.
1/12	10.10	20·8	30·1		.		..		..	
	2.35	27·0	33·7	1820	..	...	...	...	...	...
2/12	10.0	22·3	28·7		..		...		...	
	2.35	26·5	33·5	1790	...	...	..	...	...	...
3/12	10.15	21·8	30·0		..		...			
	2.35	22·6	33·0	1820	...	...	...	...	...	..
4/12	10.35	21·2	29·4		...		...		..	
	2.15	28·3	33·5	1830	...	...	...	...	...	...
7/12	11.0	20·5	31·0		..		...		...	
	2.25	21·6	32·6	1730	...	...	...	...	..	...
8/12	10.40	19·7	28·7		...		...			
	2.35	23·9	31·9	1790	...	...	.	...	...	...
9/12	10.10	22·3	30·6		...				...	
	2.20	28·5	33·5	1770	...	...	...	...	...	..
10/12	10.35	22·9	30·5		...		..		...	
	2.30	24·9	33·9	1840	..	..	...	...	...	...
11/12	10.30	24·2	31·5		...		...		...	
	2.25	29·6	33·4	1850	..	...	...	...	...	...
14/12	9.45	23·4	31·1		...		...		..	
	3.30	25·4	33·7	—	...	...	...	..	...	...

Table ii.—*Continued.*

Date.	Time.	Air-temp.	Echidna 6.		Echidna 8.		Echidna 9.		Echidna 10.	
			temp.	wt.	temp.	wt.	temp.	wt.	temp.	wt.
15/12	10.40	27·3	32·7		..		...		...	
	2.35	34·1	33·9	2100	...	...		..	..	...
16/12	9.40	25·3	29·4		...		...		...	
	2.30	32·5	32·4	2010	..	...	...	...	...	..
17/12	10.10	24·8	31·9		...		...		...	
	2.30	30·2	33·1	1920	...	...	...		...	...
18/12	9.55	22·2	30·6		...		...			
	2.30	23·0	33·3	1900		...	...	...	...	...
21/12	9.50	20·8	29·1		...		..		...	
	3.0	20·6	31·7	...	...	...	...	...	..	...

In Table ii., a record of the weight of the animals has been added, so that some idea may be gathered of the general state of their health during this period of observation.

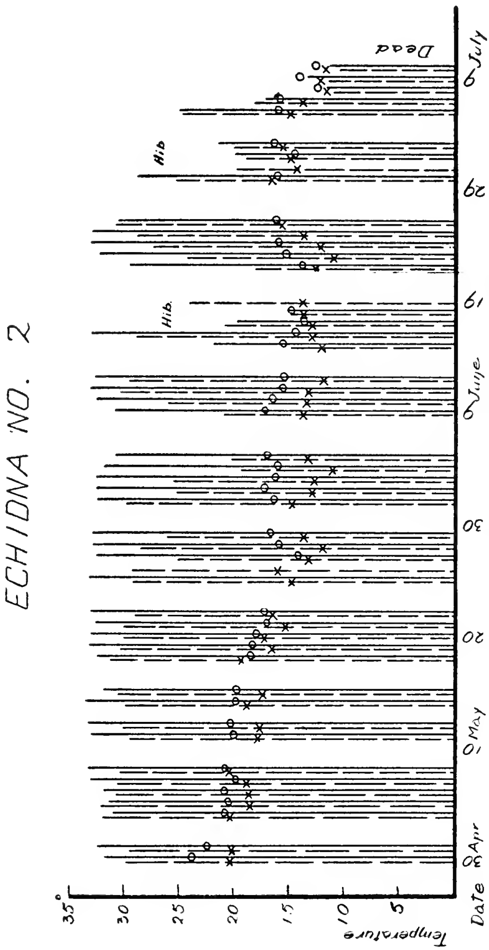
The morning-temperatures of Echidna No.6 will be seen, from the above Table, to have varied between 33·2° and 25·8°C., the afternoon-temperatures between 34·0° and 30·8°C. The weight of the animal also showed very large fluctuations, its lowest value being 1540 gms., its highest 2100 gms. The weight, on the whole, increased, however, and the animal was still living and in good health at the end of the period of observation.

Echidna No.8 lived only a short time while under observation. During this time, its weight steadily fell. Its morning-temperatures varied between 31·0° and 24·6°C., its afternoon-temperatures between 33·8 and 32·0°C.

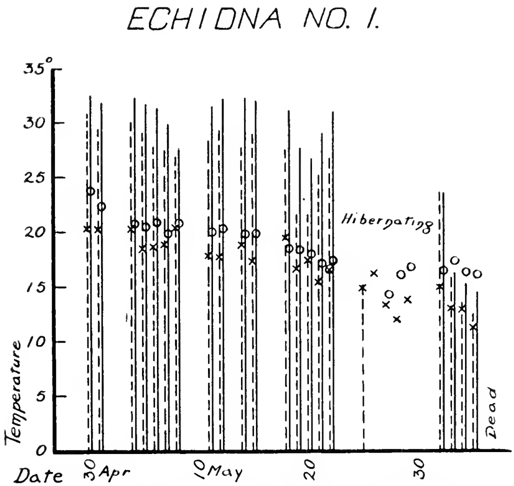
Echidna No.9 also did not live long, and its weight, too, steadily fell. Its morning-temperatures varied between 30·8° and 29·0°C., its afternoon-temperatures between 31·5° and 29·7°C., except on the last day, when the animal was dying, and its temperature was almost at the level of that of the air.

Echidna No.10 also decreased in weight during the period of observation, although it lived about thrice as long as Nos.8 and 9. Its morning-temperatures varied between 32·2° and 24·4°C., its afternoon-temperatures between 33·5° and 30·6°C.

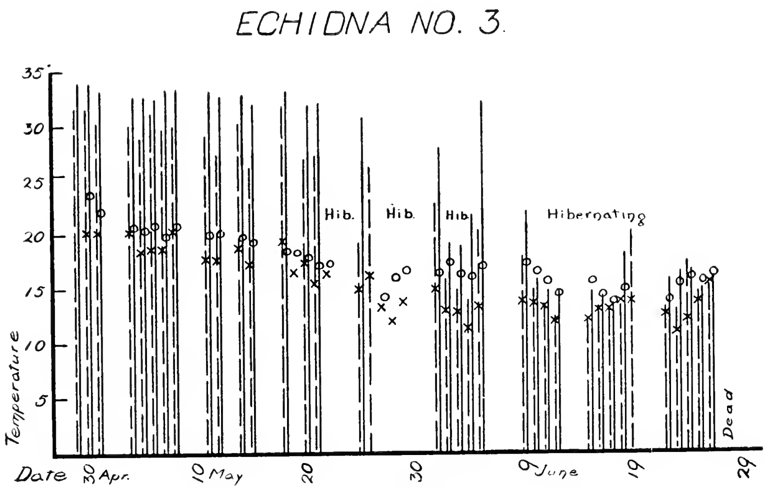
The observations recorded in the above Tables, with the exception of those made on Echidna No.4, have been plotted out graphically in order to render their meaning more evident. In the accompanying diagrams (Text-figs. 1-8), the temperatures are represented by vertical lines, the heights of which are proportional to the values of the corresponding temperatures. Morning-temperatures are represented by discontinuous lines, afternoon-temperatures by full lines. The points corresponding to the levels of the temperatures of the air are marked on the ordinates for the temperatures of the animals by crosses in the case of morning-temperatures, and by circles in the case of afternoon-temperatures.



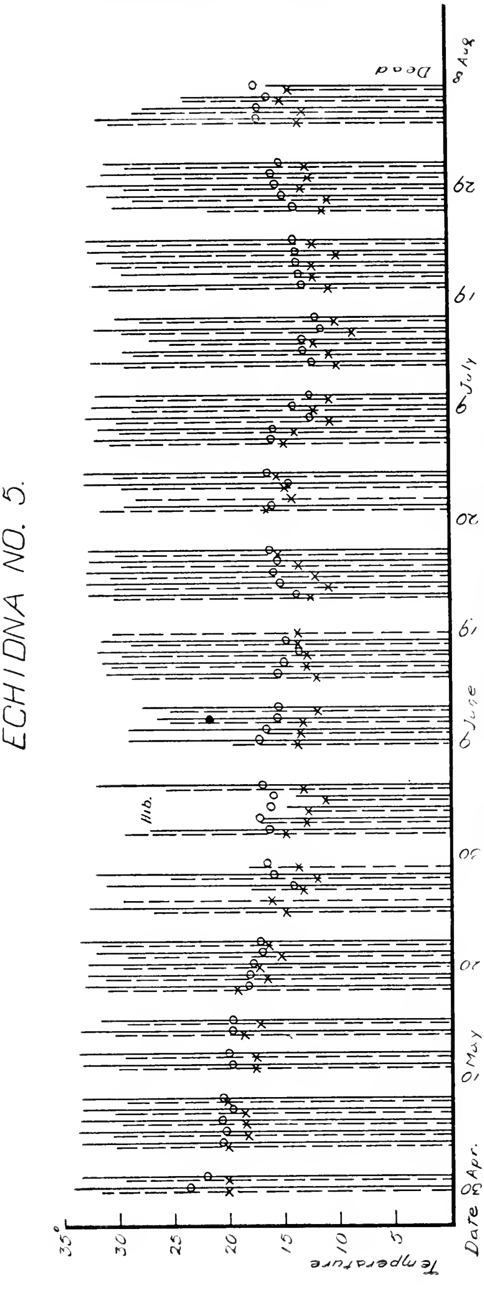
Text-fig. 2.—Autumn and Winter temperatures.



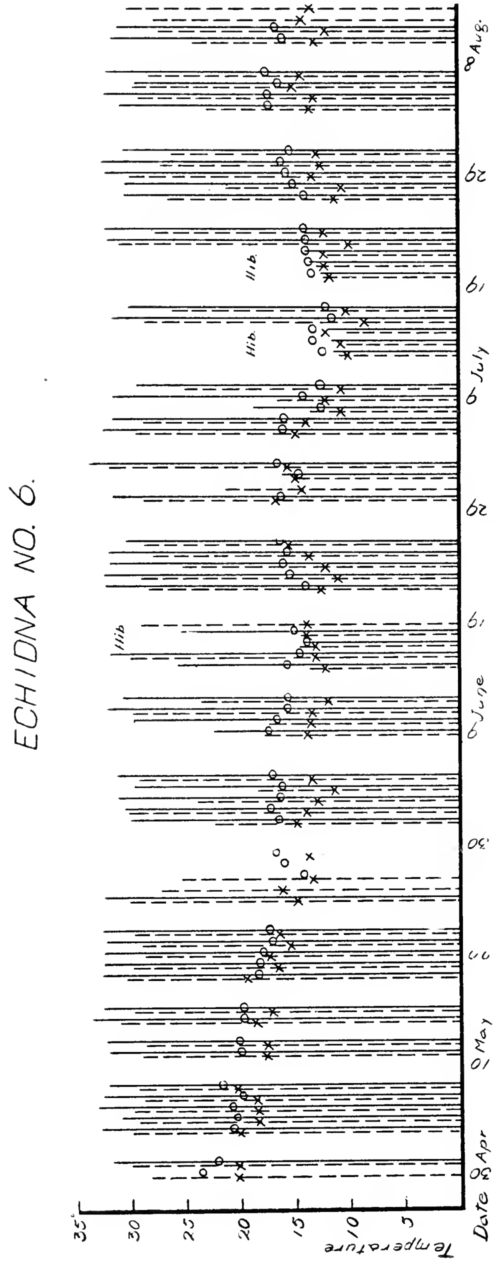
Text.fig.1.—Autumn and Winter temperatures.



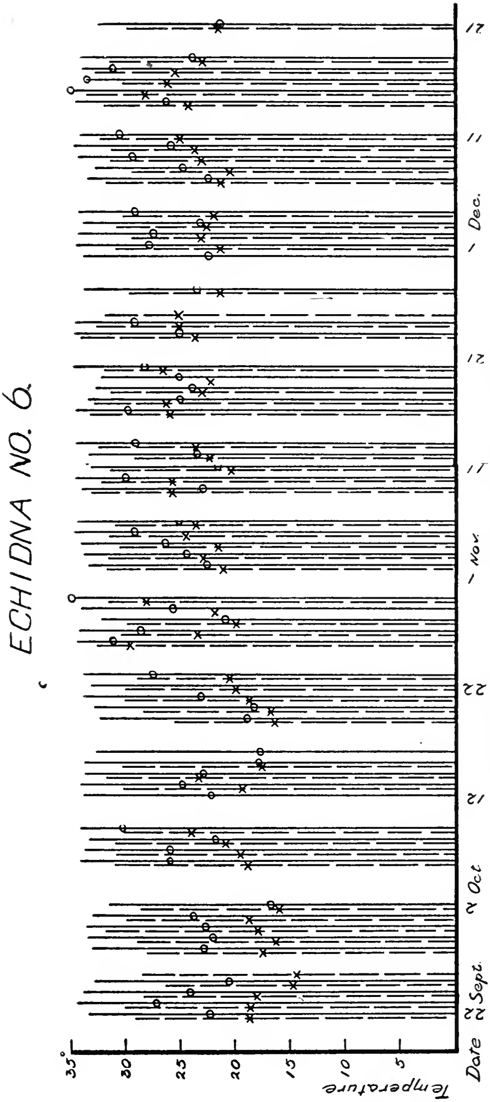
Text-fig.3.—Autumn and Winter temperatures.



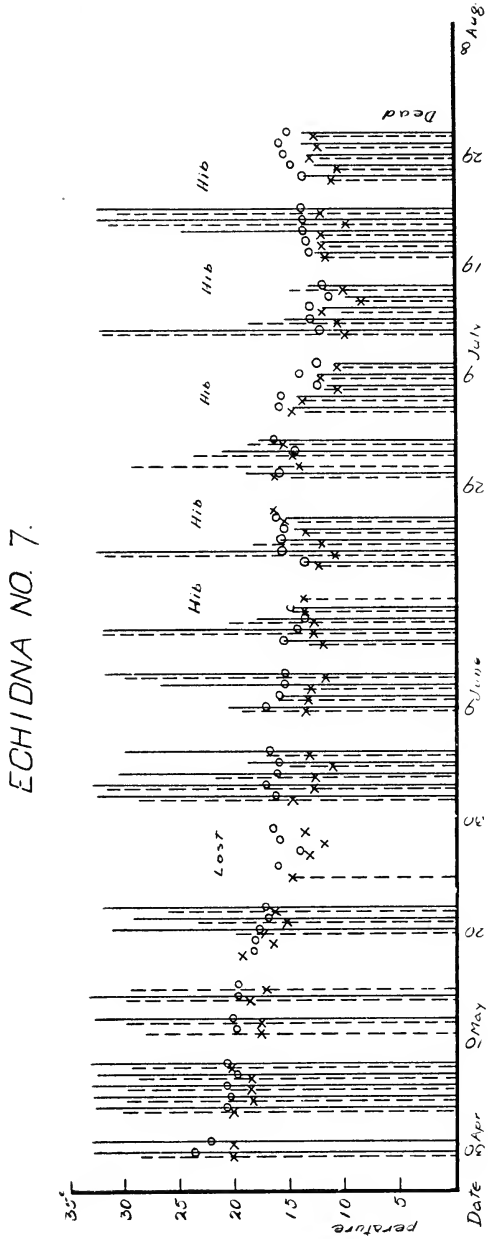
Text-fig. 4.—Autumn and Winter temperatures.



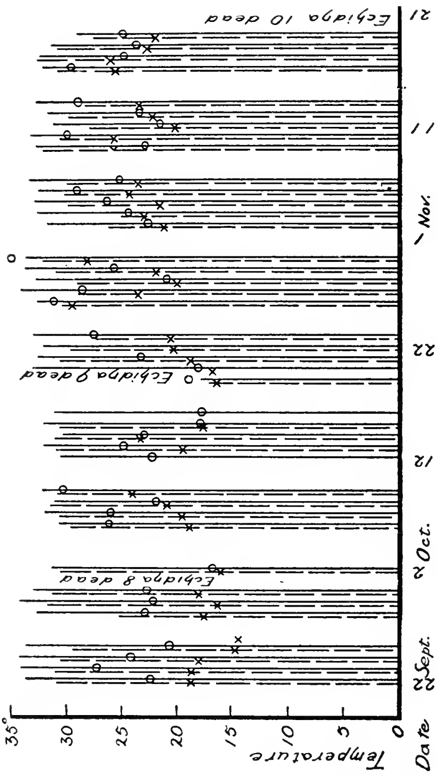
Text-fig. 5.—Autumn and Winter temperatures.



Text-fig. 6.—Spring and Summer temperatures.



Text-fig. 7.—Autumn and Winter temperatures.



Text-fig. 8.—Spring and Summer temperatures.

The above series of observations was made, as will be seen, during two periods of the year. The first period extended from April 30th to August 13th, 1914, 105 days, and comprised the end of Autumn and the greater part of Winter. The second period extended from September 22nd to December 21st, 1914, 90 days, and comprised the greater part of Spring and the beginning of Summer. For the first series of observations, Echidnas Nos. 1, 2, 3, 4, 5, 6, and 7 were used; for the second series, Nos. 6, 8, 9, and 10.

As the behaviour of the animals, with regard to their temperature, was considerably different in the winter-portion of the first period from that in the autumn-portion of it, and in the second period, it will be convenient to consider first the observations obtained during the Winter separately.

Hibernation of Echidna.—As previously stated, under the conditions under which I observed Echidna, its hibernation was of a very fitful nature. This fact is well exhibited by the sudden falls and rises of temperature shown in the diagrams giving the winter-temperatures. During the periods of hibernation, the temperatures of the animals remained only slightly higher than the external temperature, following the variation of this like the temperature of a cold-blooded animal. The instances in which the temperatures of Echidna are shown to be actually lower than the external temperatures are due to the occurrence of rises of the latter so rapid that the animals have not warmed-up quickly enough to follow them. The diagrams also show how great are the individual differences between the animals as to the extent to which they hibernate during Winter, the only common feature being the fact that none of them ever hibernated continuously for more than a few days at a time. The longest period of hibernation shown extended over about ten days; the average period, however, was only two or three days. During these periods, the animals lay inert while undisturbed, and showed no visible respiratory movements. If moved and placed in an awkward position, they very slowly readjusted themselves.

No doubt the unnatural conditions, under which the animals were living, had much to do with the intermittence of their hibernation. The taking of an animal's temperature, *per rectum*, twice a day, must have a rather disturbing effect, although specimens which were purposely left undisturbed, during periods of hibernation, did not remain torpid any longer than others whose temperatures were regularly taken.

The behaviour, during Winter, of the Echidnas under my observation was markedly different from that of the animals observed by Martin, who states that "during Winter, Echidna abandons all attempts at homœothermism and hibernates for four months." The fact that the Winter of Melbourne (where Martin's observations were made) is rather colder than that of Sydney, the average midwinter temperatures being 9·5° and

12·2°C., respectively (Hunt, *loc. cit.*), may account for the fact in part, but, apparently, not altogether, as an examination of the diagrams and tables will show that the animals were sometimes awake and active at temperatures lower than those at which they were, at other times, torpid. Temperature seems, therefore, not to be the only factor concerned in the bringing on and maintenance of hibernation, as has also been supposed in the case of European hibernants.

With regard to the rate at which the animals enter into or emerge from a state of hibernation, no very detailed information can be gained from the tables and diagrams, as the temperatures were not observed at frequent enough intervals. The large falls of temperature, indicating the entrance of an animal into a state of hibernation, generally occurred between an afternoon-observation of the temperature and the succeeding morning-observation. Falls of temperature of as much as 16°-17° occurred in this period of twenty hours, as in the case of Echidna No.6, on June 16th-17th, and of Echidna No. 7 on June 3rd-4th. Between the morning- and afternoon-observations, a period of about four hours, comparatively sudden rises of temperature occurred as the animals awoke from hibernation. For example, in the case of Echidna No.6, on June 15th, a rise of 12·0° occurred in the above interval of time; and, in the case of Echidna No.7, a rise of 13·8° occurred on June 5th, in the same period.

Relation between temperature of Echidna and temperature of air.—Let us consider now the temperature of Echidna during the periods in which no hibernation occurred, Autumn, Spring, and Summer. It will be seen that, during these periods of observation, firstly, the morning-temperature of the animals was, with only one or two exceptions, lower than the afternoon-temperature; and, secondly, that, although the morning- and afternoon-temperatures each showed variations considerably greater than are met with in the case of human beings, yet these variations seem to have occurred about a sort of mean value; and we may therefore speak of these temperatures as having certain average or mean values, always bearing in mind the very doubtful significance of any average or mean figure as applied to living organisms. In the following Table, the average morning- and afternoon-temperatures for several individual Echidnas, and for the whole number in the Table are given for the autumn-period, *i.e.*, the period before hibernation.

TABLE iii.

Average Autumn-temperatures of Echidna.

Echidna	Temperature Morning	Temperature Afternoon	No. of obs.
2	30·2°	32·5°	18
5	30·2°	33·2°	16
6	29·4°	32·1°	17
7	29·5°	32·9°	10
Average	29·9°	32·7°	61

It will be seen that the individual averages do not differ much from one another. Single observations, however, may differ as much as 3° from the average values. The average morning- and afternoon-temperatures from 61 observations distributed over four animals are shown to be 29·9° and 32·7°C. respectively. The average temperature of the air for this period was about 18°C.

In Table iv., are given the average morning- and afternoon-temperatures for individual Echidnas, and for the whole number in the Table for the Spring- and Summer- period, *i.e.*, after hibernation.

TABLE iv.

Average Spring- and Summer-temperatures of Echidna.

Echidna	Temperature Morning	Temperature Afternoon	No of obs.
6	30·1°	32·9°	60
8	28·9°	33·1°	8
9	30·1°	30·8°	9
10	29·0°	31·9°	23
Average	29·4°	32·2°	100

In this table, too, it will be seen that the individual averages do not differ greatly from one another, although the differences shown are greater than in Table iii. The collective average morning- and afternoon-temperatures, obtained from 100 observations distributed over four animals, are, in this case, 29·4° and 32·2°C., respectively, values slightly lower than those given in the preceding Table, although the average temperature of the air for this period was about 23°C., or 5° higher than in the autumn-period. The differences from the average values shown by single observations are rather greater than was the case with the autumn-temperatures, differences of about 5° occurring in a few cases. This may possibly be due, in part, to the fact that the health of the animals examined in Spring and Summer, with the exception of that of No.6, was not so good as that of those examined in Autumn. The former animals lived only 1-3 weeks while under observation, whereas the latter lived considerably longer, on the whole. It is to be noted, however, that the variations in the temperature of Echidna No.6, which has survived all the others, were as great during the spring-period as those of the animals which died.

It has been seen that, outside of the winter-period, the morning-temperature of Echidna was almost invariably lower than the afternoon-temperature; the average difference for the whole of the observations was 2·8°C., but there were considerable variations from this value. It will be seen, too, that, in the great majority of cases, the external temperature was also higher in the morning than in the afternoon. In spite of this general agreement in the direction of the changes of the temperature of the air and that of the changes of the temperature of the animals, the grounds do not seem sufficient for concluding immediately that the variations in the temperature of the animal are due to those of the temperature of the air. In the first place, there were several instances in which the temperatures of the air in the morning were greater than in the afternoon, and yet the temperatures of the animals increased towards the afternoon in the usual way. These instances are collected together in the following Table.

TABLE V.

Relation of temperature of Echidna to temperature of air.

Date.	Temperature of air		Temperature of air	
	Morning	Afternoon	Morning	Afternoon
18/5/14	19·3°	18·3°	27·4°	31·0°
			31·2°	32·0°
			31·8°	33·2°
			31·0°	33·1°
			30·3°	32 5°
30/6/14	16·5°	16·0°	29·3°	31·3°
			31·6°	29·3°
2/7/14	14·8°	14·5°	29·6°	33·0°
14/10/14	22·6°	22·3°	31·1°	33·1°
			30·4°	29·4°
9/11/14	25·0°	22·2°	32·4°	33·3°
			31·6°	32·2°

As will be seen from the above Table, there were only two occasions on which a reversal of the direction of change of the temperature of the air was accompanied by a similar reversal in the direction of variation of an animal's temperature, and, on each of these occasions, this reversal was shown only by one of two animals under observation.

In addition to these cases in which the temperature of the air fell, instead of rising, between morning- and afternoon-observations, there were many occasions on which the rise of the temperature of the air was less than that of the temperature of the animals. Further, there were four occasions on which, although the temperature of the air rose between morning and afternoon, that of an animal fell in the same interval of time; and these do not include those cases where erratic behaviour of the temperature of an animal was due either to the onset or to the close of a period of hibernation.

From the above facts, therefore, it seems that the daily variation of the temperature of Echidna does not entirely depend upon that of the temperature of the air, but is, in part, of the same nature as the daily variation observed in the case of other mammals (of man in particular), which is regarded as quite independent of the variations of the temperature of the air, and which, as in the case of Echidna, consists of an increase, though a much smaller one, between morning and afternoon. The magnitude and unevenness of the daily variation in the case of Echidna are quite in keeping with the general behaviour of its temperature. It must be remembered, too, that temperatures were observed only at two times of the day, and these may not have coincided with the extremes of variation of the animals' temperatures.

If one considers now the relation of a series of morning- or of afternoon-temperatures to the corresponding temperatures of the air, it will be found that the variations of the former sometimes take place in the same direction as those of the latter, and at other times in the opposite direction. The prevailing tendency is, however, for the variations of the air-temperatures and of the body-temperatures of the animals to be in the same direction, so that there seems to be some connection between the two. This view is further supported by the comparison of the mean autumn-temperatures of Echidna No.6, with the mean spring- and summer-temperatures of the same animal. The air-temperatures during Autumn were considerably lower than those during Spring and the beginning of Summer. The average temperatures of the animal were: Autumn, morning, 29·4°, afternoon, 32·1°; Spring and Summer, morning, 30·1°, afternoon, 32·9°C. Over these fairly long periods, then, higher temperatures of the animal were, as a rule, associated with higher air-temperatures, although the evidence of any causal connection between the two is not very strong. It will be remembered, however, that the average morning- and afternoon-temperatures of several animals (Tables iii. and iv.) were slightly higher in Autumn than in Spring.

Summary. —(1). During the winter-months, the Echidnas under observation hibernated intermittently, their temperatures approximating to those of the air during the periods of hibernation.

(2). Outside of the periods of hibernation, these Echidnas maintained a temperature which was fairly constant (30-33°C.), although lower than that of other mammals. Echidna, therefore, is a true homoiothermal animal.

(3). The temperature of these Echidnas showed a daily variation, which seemed to be, to some extent, independent of the variations of the external temperature.

(4). Apart from the bringing on of hibernation, there is an indication that change of the external temperature has an effect, although not a simple or immediate one, on the body-temperature of Echidna, as the average temperature of an animal in Spring was slightly higher than that of the same animal in Autumn.

In conclusion, I wish to express my indebtedness to Professor Sir Thomas Anderson Stuart, in whose laboratory this work was done, and to Assistant-Professor Chapman, for his helpful advice during the course of the work.

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NOTES ON, AND DESCRIPTIONS OF AUSTRALIAN FISHES.*

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(Plates xxxv.-xxxvii.)

The following notes and descriptions are based on specimens which have been forwarded to the Australian Museum from various sources.

Family APLOCHITONIDÆ.

Genus Lovettia, gen.nov.

Body elongate, naked. Dorsal with 8-9 rays, placed a little behind the ventrals, which are submedian in position and are composed of seven rays. Adipose fin large, longer than high. Anal rather long, with 19-20 rays. Pectorals elongate, rounded, with 11-12 rays. Caudal forked. Nostrils large, remote from one another. Eye of moderate size. Teeth comparatively large, in single rows on the jaws and palatines, and on each side of the tongue. Gill-openings wide, the membranes not attached to the isthmus; gill-rakers of the first arch long and slender. Pseudobranchiæ present. Urinogenital orifice produced into a large fleshy papilla which lies in a deep groove behind the vent.

This genus apparently only differs from *Aplochiton* Jenyns, in being much more slender, and in having the dorsal, anal, pectoral, and ventral fins differently shaped. The adipose fin is also much larger.

I associate with this genus the name of Mr. E. F. Lovett, of Hobart, to whom I am indebted for the beautifully preserved specimens described below, as well as many other interesting Tasmanian fishes.

* Contributions from the Australian Museum.

Lovettia sealii Johnston.

(Plate xxxv., fig.2.)

Haplochiton sealii Johnston, Proc. Roy. Soc. Tasm., 1882(1883), p.128; *Id.*, Macleay, Proc. Linn. Soc. N. S. Wales, ix., 1884, p.54.

D. 8-9; A. 19-20; P. 11-12; V. 7; C. 16. Head 4·7 in the length to the hypural. Eye 4·2-4·36, greatest depth 2 in the head.

Body elongate, compressed, and a little quadrilateral, the back and belly being somewhat flattened : it is naked, and there are about fifty-three myomeres between the operculum and the hypural. The lateral line is marked by a series of pores in a linear depression along the middle of the sides. The head is flat above, and the bony interorbital space is equal to about two-thirds the diameter of the eye. Snout as long as, or a little longer than the eye. Nostrils large, and placed on the supero-lateral angle of the snout; the first is in the middle of its length, the other nearer the eye. Maxillary reaching to the anterior third or fourth of the eye, and slightly expanded behind. Lower jaw projecting well beyond the upper. Lower preopercular border free, the hinder covered with skin. Operculum with a long skinny lobe which overlaps the base of the pectoral.

Teeth proportionately large, in single rows in each jaw. A large one on each side of the symphysis of the upper jaw, followed by much smaller ones which extend along the whole premaxillary border. They are larger in the lower jaw, and increase in size backwards. There are four very large, curved ones in a row on each side of the tongue. There is a stout tooth on the anterior part of each palatine, and two or three more a little farther back below the anterior part of the eye.

Origin of the ventrals behind the middle of the distance between the tip of the snout and the hypural, and their tips do not quite reach to the vent; all the rays are divided, and the third and fourth are the longest. Origin of the dorsal behind that of the ventrals, and the base of the last ray is above or in front of their tips; the two or three anterior rays are simple, and the third or fourth is the highest. The base of the anal is long, and there is a space between its front ray and the genital papilla; the anterior rays are simple, and the fourth is the longest, the following ones decreasing regularly in length. Pectoral with a strong fleshy base, the middle rays longest and reaching less than half their distance from the ventrals; the upper ray is not thicker than the others. Caudal deeply forked, the two outer rays broad and simple, the others divided. Adipose dorsal fin triangular, much longer than high, and placed above the hinder part of the anal.

Colour in formalin.—White, the back and upper part of the head closely speckled with minute blackish dots. A dot is present at the base of each anal ray, and there are two parallel rows on the belly which unite to form one below the pectorals. Other scattered dots are found on the sides of the body and the fins.

Described from six specimens, 49-65 mm. long, collected by Mr. Lovett in the Derwent River, Tasmania. They differ from Johnston's short description only in having the maxillary shorter, and not reaching backward to the middle of the eye. The largest example is figured.

Family SYNGNATHIDÆ.

Genus ICHTHYOCAMPUS Kaup.

ICHTHYOCAMPUS SCALARIS Günther.

(Plate xxxvi., fig.2.)

Ichthyocampus scalaris Günther, Brit. Mus. Cat. Fish., viii., 1870., p.177. *Id.*, Macleay, Proc. Linn. Soc. N. S. Wales, vi., 1881, p.292. *Id.*, Duncker, Faun. Südwest-Aust., ii., 1909, p.240.

Two specimens, 163-170mm. long, differ greatly in their colour-marking. One, a male, is brown, variegated with irregular bluish blotches which are largest on the back; the back is crossed by sixteen broad bars, and the sides of the abdomen are marked with curved lines of bluish dots.

The other, which is figured, is much lighter, and the cross-bands are less distinct; the sutures have a brown spot at each angle, and the abdomen is crossed by narrow brown bands. The sides and back are closely covered with reticulating brown lines, and the lower parts of the head and the breast bear numerous deep brown dots.

Loc.—Western Australia.

Genus Hippocampus Rafinesque.

Hippocampus breviceps Peters.

Hippocampus breviceps (Peters) Duncker, Faun. Südwest-Austr., ii., 1909, p.247, references. *Id.*, McCoy, Prodr. Zool. Vict., dec. vii., 1882, Pl. lxv., fig.2.

Hippocampus tuberculatus Castelnau, Res. Fish. Austr. (Vict. Offic. Rec. Philad. Exhib.), 1875, p.48.

Two specimens from Cottesloe Beach, near Perth, agree very well with Castelnau's brief description of *H. tuberculatus* from the Swan River. They are also very similar to Victorian examples of *H. breviceps*, differing only in the degree of development of the tubercles, which are usually more rounded in the Western Australian specimens. I therefore regard the two species as identical. Duncker has already recorded *H. breviceps* from Fremantle.

Family SERRANIDÆ.

Genus Therapon Cuvier.

Therapon bidyana Mitchell, young.

(Plate xxxvi., fig.1.)

Therapon ellipticus Richardson, Voy. "Erebus" and "Terror," Fishes, 1848, p.118, Pl. lii., figs.4-8. *Id.*, Stead, Ed. Fish. N. S. Wales, p.73, 1908, Pl. xlii.

Therapon bidyana McCulloch, Rec. Austr. Mus., ix., 1913, p.359.

D. xii./12; A. iii./8; P. 17; V. i./5; C. 17. L. lat. 59; scales 77. Depth 3·6 in the length from the snout to the hypural, and a little less than the length of the head, which is 3·3 in the same. Eye equal to the snout, and but little less than the interorbital width, 3·7 in the head. Fifth dorsal spine and second anal spine of equal length, 1·8 in the head; first dorsal ray 2·1 in the same. Caudal peduncle 3 in the head.

Body slender, deepest at the origin of the dorsal fin. Snout obtuse, rising rapidly to the level of the upper margin of the eye; the profile thence rises gradually to the first dorsal spine. Eye large, its greater portion in the upper half of the head, and in advance of the middle of its length. Mouth small, the maxillary not quite reaching the anterior margin of the eye. There are about seventy-seven rows of scales above the lateral line between the suprascapular and the hypural, but its tubules are widely spaced anteriorly, there being only about fifty-nine between the same points.

Colour.—Olive-green above, silvery below; the back and sides are closely mottled with irregular, anastomosing, darker bands, which tend to become longitudinal posteriorly. The dorsal and caudal have faint indications of darker markings, the other fins colourless. Eye pale golden, cheeks silvery.

Described and figured from a single small example, 95mm. long. It differs from the adult fish figured by Stead in having the body elongate instead of deep, the snout convex instead of pointed, and in its colour-marking. The eye is also much larger, and the proportions generally are very different, but an examination of the material available convinces me that all these features are merely juvenile characters.

I am indebted to Mr. H. K. Anderson for the opportunity of describing and figuring this specimen, which he collected in the Murrumbidgee River below the Berumbed Weir, on November 13th, 1914.

Family RACHYCENTRIDÆ.

Genus RACHYCENTRON Kaup.

RACHYCENTRON PONDICERIANUM Cuvier & Valenciennes.

Black Kingfish; Sergeant Fish.

Elacate pondiceriana Cuvier & Valenciennes, Hist. Nat. Poiss., viii., 1831, p.329.

Elacate nigra Day, Fish. India, 1878, p.256, Pl. lv., fig.2. *Id.*, Castelnau, Proc. Linn. Soc. N. S. Wales, iii., 1879, p.381. *Id.*, Macleay, Proc. Linn. Soc. N. S. Wales, v., 1881, p.560. *Id.*, Kent, "Gt. Barrier Reef," 1893, p.291.

Rachycentron canadus Stead, Ed. Fish. N. S. Wales, 1908, p.93.

The Australian Museum collection includes seven specimens of this species ranging from 356 to 1120 mm. in length. Of these, one is from Madras, and is part of the late Dr. Francis Day's collection; five others were captured in New South Wales waters, and one is from Moreton Bay, Queensland. The number of spines and rays in their dorsal fins varies as follows:—D. vii.-ix., 3-4/27-31; A. 2-3/23-26. The proportional measurements of three local examples are given in the following table.

Length	1120 mm.	1020 mm.	356 mm.
Head (measured obliquely from symphysis of upper jaw to end of opercular bone) into the length	4·1	4·2	4
Depth at last dorsal spine, into the length	5·7	5·1	6·7
Snout, from median symphysis to anterior margin of eye, into the head	2·3	—	2·5
Eye into head	8·4	8·8	6
Eye into snout	3·6	—	2·3
Interorbital width into head	2·3	—	2·8
Interocular width into head	1·9	—	2·2
Pectoral fin into head	1·2	1·1	1·3
Ventral fin into head	2·5	2·5	2·6
Highest dorsal ray into head	1·7	1·6	2
Highest anal ray into head	2·1	1·9	2·5
Depth of caudal peduncle into head	4·7	4·2	4·5

Colour.—In large specimens, the back and sides are deep brown, this colour being sharply defined below by a narrow silvery band; the junction of the two forms a straight line from the tip of the lower jaw to the middle of the caudal peduncle. Below the silver band, is another brown one, which sharply defines an oblong patch of orange colour on the abdomen between the ventral and anal fins. In young examples, there is a light band on the upper part of the sides also, which causes the brown below it to form a median stripe as is shown in Day's figure quoted above.

There is some doubt as to whether the Sergeant Fish, *R. canadum* Linnæus, is specifically identical with the Australian Black Kingfish, though a comparison of my specimens with Jordan and Evermann's figure* of the former reveals scarcely any important differences between them. My Madras specimen and another from New South Wales of about the same size, appear to be exactly alike in all their characters, and Day's

* Jordan & Evermann, Bull. U. S. Nat. Mus., No.47, iv. 1900, Pl.cxlviii., fig.401.

figure represents them very accurately in all but one detail; in all my specimens, the upper caudal lobe is distinctly longer than the lower, whereas he illustrates them as subequal, though he notes variations of this character in his description.

Very little is known of the habits and migrations of the Black Kingfish in Australian waters. It is probably not uncommon near the surface along the northern portion of the New South Wales coast and southern Queensland. Examples are occasionally forwarded to the Sydney markets among other fish, but they are generally of small size, though individuals four feet long are not unknown. The two large specimens referred to above were captured with the rod by Dr. Mark C. Lidwill and Mr. C. H. Gorrick in March and April, 1914, not far from the rocks off the south head of Port Stephens. They each took a garfish bait which was trolled at a speed of about five miles an hour, and they offered but little fight when hooked, diving straight to the bottom and stopping there.

Family LABRIDÆ.

Genus Hemigymnus Günther.

Hemigymnus Günther, Ann. Mag. Nat. Hist. (3), viii., 1861, p.386.

Cheilolabrus Alleyne & Macleay, Proc. Linn. Soc. N. S. Wales, i., 1877, p.345.

Alleyne and Macleay have counted the dorsal and anal fins of *Cheilolabrus* as 8/10 and 2/10 respectively, but four typical specimens of *C. magnilabris*, preserved in the Macleay Museum, have the normal 9/11 and 3/11, though the anterior anal spine is small and easily overlooked.

Hemigymnus melapterus Bloch.

Hemigymnus melapterus (Bloch) Bleeker, Atl. Ichth., i., 1864, p.142, Pl. xlv., figs.2-3.

Cheilolabrus magnilabris Alleyne & Macleay, Proc. Linn. Soc. N. S. Wales, i., 1877, p.345, Pl. xvi., fig.2.

Four specimens, which are the types of *C. magnilabris*, agree very well, both in form and colour, with Bleeker's figure of *Hemigymnus melapterus*; they also do not differ from others from Port

Moresby, which have been identified by Macleay as the latter species.

Family SCOMBRIDÆ.

Genus GRAMMATORYCNUS Gill.

Grammatorycnus Gill, Proc. Acad. Nat. Sci. Philad., 1862, p.125 (*Thynnus bilineatus* Rüppell).

Nesogrammus Evermann & Seale, Bull. U. S. Fish. Bur., xxvi., 1907, p.61 (*N. piersoni* Evermann & Seale).

Nesogrammus is apparently identical with *Grammatorycnus.* The former is said to have no corselet, whereas it is formed of somewhat enlarged scales in the latter. In the species described below, it is not very well defined, and is apparently intermediate between the two extremes.

GRAMMATORYCNUS BICARINATUS Quoy & Gaimard.

Large-scaled Tunny.

(Plate xxxv., fig.1.)

Thynnus bicarinatus Quoy and Gaimard, Voy. "Uranie" and "Physicienne," 1825, p.357, Pl. lxi., fig.1.

D. xii., 10,7; A. ii.,6; P. 24; V. i., 5; C. 17. Head 4·8, depth 4·4 in the length from the tip of the snout to the pit at the base of the caudal fin. Eye 5·9, snout 2·8, interorbital space 3·1, and depth of caudal peduncle 5·3 in the head. Pectoral 1·5, ventral 2·8, second dorsal spine 3·1, and second dorsal and anal rays 2 in the head.

Body rather elongate, fusiform, somewhat compressed laterally. Dorsal and ventral profiles evenly curved, the greatest depth being in the middle of the length. Head conical, rather flat above; the jaws are pointed, and the lower is the longer. Maxillary reaching to below the middle of the eye, not covered by the preorbital; it is expanded posteriorly. Interorbital space slightly convex. Posterior margin of preoperculum smooth, the angle produced a little backwards, and broadly rounded. Opercular margin somewhat excavate above. Eye in the upper half of the head, and a little in advance of the middle of its length; it is surrounded by a semitransparent lid.

Teeth uniform in size, compressed and arranged in a single row in each jaw. A small patch of microscopic teeth on the vomer, a larger one on each palatine, and another on the tongue.

The entire body, opercles, cheeks, and top of the head as far forward as the middle of the eye, are covered with cycloid scales, the margins of which are often broken into irregular lobes. They are larger than is usual in the family, the largest being on the cheeks, where they are arranged in about eleven rows. They are small on the lower half of the operculum, and the top of the head. The corselet is small and not very well defined. There are one hundred and seventy-five rows of scales above the lateral line between the corselet and the pit at the base of the caudal; there are twelve between the middle of the spinous dorsal and the first lateral line, and probably twenty-seven more to the lower lateral line. The upper lateral line commences behind the corselet, and follows the curve of the back to the caudal peduncle; a branch descends from it a little behind the verticle of the middle of the pectoral, which is at first almost upright, then very oblique, and finally follows the curve of the ventral profile till it joins the upper line again in front of the caudal peduncle. The second dorsal, anal, and pectoral, are entirely covered with small scales, as is a space on the middle of the caudal fin.

Caudal peduncle with a strong median keel, and two smaller oblique ones on either side of it at the base of the tail. A minute pit is also present on the upper and lower surfaces before the insertion of the caudal fin.

Second dorsal spine longest, the others decreasing gradually to the last; the spines can be received into a groove in the back. Second dorsal and anal similar in form, their anterior rays forming falcate lobes. Pectorals rather short and somewhat falcate, situated a little below the median line of the body. Ventrals inserted behind the verticle of the pectorals but before that of the first dorsal spine; they are short, and can be received into grooves in the abdomen. Finlets well developed. Caudal lunate.

Colour.—Silvery in formalin, the back tinged with olive-green; a number of large dark spots are present on the belly. The fins are dark olive-green, the anterior rays of each being darker than the others, When fresh, the fish was particularly brilliant, being shot with opalescent-blue above, and gold below. The back was faintly marbled with olive-green, and there were spots of the same colour along each side. The abdominal spots were brown, and the fins green.

Described from a specimen 925 mm. long from the snout to the end of the middle caudal rays, and weighing eighteen and three-quarter pounds; its girth is twenty inches. It is closely allied to *G. bilineatus* Rüppel,* but differs in having seven instead of six dorsal finlets, and the lateral line branches at the verticle of the middle of the pectoral instead of behind that fin. It is evidently identical with *Thynnus bicarinatus* Quoy & Gaimard, which was apparently described from a very imperfect drawing of a fish captured in Shark Bay, West Australia. The illustration published by these authors is very crude, the upper jaw being shown as longer than the lower, and the pectorals and ventrals are elongate, while no attempt has been made to preserve the structural details of the other fins. The presence of two lateral lines and seven dorsal finlets, however, suggests that the drawing represents the same species as is described above, while the fact that the original was captured in Australian waters strengthens this view.

Loc.—For the opportunity of describing and figuring this rare fish, I am indebted to Mr. C. H. Gorrick, who caught it early in June, 1914, off Cook Island, a few miles from the Tweed River Heads, New South Wales. It took a garfish bait which was being trolled at about three or four miles per hour, and was apparently one of many of the same kind, since it was hooked in the midst of a large school of feeding fish. It did not fight as hard as an ordinary Tunny does, nor did it make the long runs of a Spanish Mackerel. The water where it was hooked was about eight fathoms deep, with a bottom of rocky reefs.

The fish described and figured as *Nesogrammus piersoni*† is evidently very similar to my specimen, differing principally in

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* Rüppel, Neue Wirbelth. Faun. Abyssin., 1835-40, p.39, Pl. xii., fig.2.

† Evermann & Seale, Bull. U. S. Fish. Bur., xxvi., 1907, p.61, fig.3.

having seven instead of six anal finlets and higher anterior dorsal spines.

Family LEPTOSCOPIDÆ.

Genus Crapatalus Günther.

Crapatalus Günther, Ann. Mag. Nat. Hist., (3), vii., 1861, p.86.

According to Günther's definition of this genus, there are no teeth on the palate, and the cleft of the mouth approaches the vertical line. Mr. C. Tate Regan has very kindly re-examined the type of *C. novæ-zelandiæ* for me, however, and informs me that both the vomer and palatine bear teeth, and that when the head is in position and the mouth closed, the cleft of the latter is not nearly vertical.

Crapatalus arenarius, sp.nov.

(Plate xxxvii., fig.1.)

Leptoscopus macropygus Ogilby, Mem. Qld. Mus., i., 1912, p.57 (not of Richardson).

Br. 6. D.34; A. 37; P. 21; V. i., 5; C. 10. L.lat.47; l.tr. 5/1/5. Head, to end of opercular lobe, 3·5 in the length from the tip of the lower jaw to the hypural; depth at vent 7·4 in the same, and 2·1 in the head. Eye equal to the interorbital space, and about as long as its distance from the tip of the upper jaw, 7 in the head. Depth of caudal peduncle a little greater than the eye, 5·2 in the head. Seventh dorsal ray equal to that of the anal, 3·3 in the head. Longest pectoral ray 1·1, fourth ventral ray 2·3, and caudal fin 1·9 in the head.

Body elongate, head and shoulders depressed, the remainder compressed. Head entirely naked. Body covered with large cycloid scales extending forward to above the operculum on the back, and to behind the pectoral and ventral fins on the lower surface; they are smallest in front of the dorsal fin, and encroach on the bases of the caudal rays. Lateral line almost straight from the suprascapular along the middle of the body to the base of the caudal. Breast armed with two small spines anteriorly which project forward. Urinogenital apertures immediately in front of the origin of the anal fin, with a minute papilla protected by an overhanging sheath.

Lower jaw longer than the upper. Mouth a little oblique, the maxillary reaching backward to just behind the verticle of the eye; each lip closely covered with a row of flattened cirri. Similar cirri fringe the upper portion of the operculum. Nostrils in short tubes, in a slightly depressed area in front of the upper portion of the eye; the anterior pair somewhat closer together than the posterior. Eyes supero-lateral, covered with thick, loose skin. Interorbital space very slightly concave. Preopercular margin rounded, entire, with series of pores on its border, which extend forward on the lower jaw. Operculum without spines, thickened above, membranaceous below.

Teeth minute, cardiform, depressible: they are arranged in two or three rows on the jaws. A short, single row of similar teeth on either side of the vomer, separated by a rather wide interspace; anterior portion of each palatine similarly denticulated. Pharyngeal bones closely covered with villiform teeth.

Dorsal fin commencing above the middle of the pectorals, composed entirely of simple rays of which the tips are free; anterior rays increasing in length to about the seventh, the posterior ones becoming somewhat shorter, and the last connected with the caudal peduncle by membrane. Anal of similar form, but longer, commencing below the anterior third of the pectoral. Pectoral large: the eighth ray longest, those above it becoming abruptly shorter, while below it they decrease gradually in length; upper ray simple, the next six or seven bifurcate, and the re-remainder trifurcate, their tips free. Ventrals thoracic, well in advance of the pectorals, and extending almost horizontally outwards; the rays similar to those of the pectorals Caudal subtruncate; the upper ray slightly produced, simple, the others branched.

Colour.—Whitish in formalin, with vermiculating brown lines and spots on the upper portion of the head and back. Fins colourless. In life, the colour of the fish harmonised with that of the sand in which it was found, being marbled with light reddish-brown above, and pearly-white below.

Described and figured from a specimen 85 mm. long from Narrabeen, near Sydney. Two others in the Australian Museum scarcely differ, though the maxillary does not reach quite so far back; the much larger and less numerous scales distinguish this species from *C. novæ-zelandiæ.*

This interesting little fish was captured alive by Mr. R. J. Kinghorn on 26th January, 1915. He discovered it while digging for "Pippies" in moist sand which was washed by the waves, but above the actual tide-level. It escaped when first disturbed, and after swimming rapidly over a most erratic course, buried itself in some loose sand. It was found a second time, and was placed in a bottle with some sand, into which it disappeared so suddenly that it was supposed to have been again lost, until its slightly projecting eyes and snout were detected. Mr. Kinghorn observed that it lay flat upon the sand when burrowing, and, with a small wriggling movement, buried itself in a fraction of a second. The fringes of cirri covering the mouth and upper portions of the gill-openings doubtless serve to prevent the entry of sand into these apertures, while the lower parts of the gill-openings can be completely closed by the overlying membranes of the operculum and branchiostegals.

Locs.—Narrabeen, near Sydney; Maroubra Bay, near Sydney; Point Lookout, Stradbroke Island, Queensland. The specimen in the Australian Museum from the latter locality is one of those recorded by Ogilby as *Leptoscopus macropygus.*

Family GOBIIDÆ.

Genus CALLOGOBIUS Bleeker.

Callogobius Bleeker, Arch. Neerl. Sc. Nat., ix., 1874, p.318 (*Eleotris hasseltii* Bleeker). *Id.*, Weber, Siboga Exped., lvii., Fische, 1913, p.479.

Mucogobius McCulloch, Rec. W. Austr. Mus., i., 1912, p.93 (*Gobius mucosus* Günther).

Weber having suggested that *Gobius mucosus* belonged to the genus *Callogobius*, I have compared specimens with his figure of *C. hasseltii* (*loc. cit.*, p.480, fig.98), and find that the two species are very similar, and their generic characters identical. My name *Mucogobius*, proposed for *G. mucosus*, therefore becomes a synonym.

Family APLOACTIDÆ.

Genus PARAPLOACTIS Bleeker.

PARAPLOACTIS TRACHYDERMA Bleeker.

Paraploactis trachyderma Bleeker, Nederl. Tijdschr. Dierkunde, ii., 1865, p.169.

Aploactis lichen de Vis, Proc. Linn. Soc. N. S. Wales, ix., 1884, p.460.

Two specimens received from the Qneensland Museum as *Aploactis lichen* de Vis, do not differ from Bleeker's description of *P. trachyderma.* De Vis' type came from Moreton Bay, Queensland, and the Australian Museum specimens were obtained at the same locality.

Genus APLOACTIS Schlegel.

Aploactis Schlegel, Fauna Japonica, Poiss., 1843, p.51 (*A. aspera* Richardson).

Aploactisoma Castelnau, Proc. Zool. Soc. Vict., ii., 1873, p.63 (*A. schomburgkii* Castelnau).

Castelnau separated his genus *Aploactisoma* from *Aploactis* on account of supposed differences in the dentition. He described the palatines of the typical species, *A. schomburgkii*, as covered with minute teeth, whereas they are toothless in *Aploactis*; he also found a longitudinal ridge at the symphysis of the upper jaw bearing two teeth anteriorly. I have examined several South Australian specimens which are supposed to be *A. schomburgkii*,* but find no palatine teeth in any, while the longitudinal ridge is represented only by a fleshy, toothless tubercle

I have further compared them with a Japanese example of *Aploactis aspera*, with which they appear to be congeneric; the external cephalic structures are somewhat differently formed in the two species, but this is probably only of specific importance.

APLOACTIS MILESII Richardson.

Aploactis milesii Richardson, Proc. Zool. Soc., 1850, p.60, Pl. i., figs.1-2.

Aploactisoma schomburgkii Castelnau, Proc. Zool. Soc. Vict., ii., 1873, p.64.

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* See footnote, p.273.

Castelnau distinguished *Aploactisoma schomburgkii* from *Aploactis milesii* on account of differences in their dentition and fin-formulæ, though he noted that the two species were possibly identical. If the specimens referred to below* are correctly identified as *A. schomburgkii*, as I believe, these differences do not exist, as they have no palatine teeth, and the fin-formula is variable. I count eight specimens as follows:—D 28-29(xiii.-xiv./14-15; A.12-13(i./11-12); the length of the anterior dorsal spines is variable, the second being from half to two-thirds as long as the head.

Locs.—The Australian Museum collection includes specimens from Port Jackson, New South Wales; South Australia; and Western Australia.

Family BLENNIIDÆ.

Genus CLINUS Cuvier.

CLINUS JOHNSTONI Kent.

(Plate xxxvii., fig.2.)

Clinus johnstoni Kent, Rept. Fish. Dept. Tasmania, 1886, p.13. *Id.*, Johnston, Proc. Roy. Soc. Tasm., 1890(1891), p.33.

D.2-3, 32-33/5; A.2/25-26; P.15; V.3; C.10. Length from snout to end of bony operculum 3·7-3·9, depth at origin of anal 4·1-4·6 in the length to the hypural. Eye 5·2-6·1, snout 4·6-4·7 in the head. Interorbital width 1·2-1·4 in the eye. Second dorsal spine 3-4, first dorsal ray 2, fourth last anal ray 2-2·1 in the head. Median rays of the pectoral 1·6, ventral 1·6-1·9, and caudal 1·5 in the head.

Body moderately deep and robust. Maxillary reaching beyond the hinder margin of the eye. Tentacle of anterior nostril form-

* One of these is in the old collection of the Australian Museum, and is entered in the register as a type of the species; it was purchased together with a type of *Kurtus gullivieri* Castelnau, but the vendor's name is not given, though it was possibly Castelnau himself. The other two have been received on loan from Mr. Edgar R. Waite, Director of the South Australian Museum, and belong to the old collection of that Institution. They agree with the description of *Aploactisoma schomburgkii* in all details except the dentition, which suggests that this character has been incorrectly described by Castelnau.

ing a short tube, terminated by six long cylindrical filaments, which overhang the mouth. Orbital tentacle large, with more or less numerous lobes. Head with several series of muciferous canals and open pores surrounding the eye, and extending along the margin of the preorbital and preoperculum, and the lower jaw; others cross the nape and join the lateral line. Teeth consisting of a single row of larger canines on the upper jaw, followed by two patches of villiform teeth anteriorly. They are similarly arranged on the lower jaw, but the lateral canines are much stronger, and the villiform patches smaller. Two broad patches of villiform teeth on the vomer which are united on the median line. Palatines toothless.

Body covered with minute rudimentary scales which extend forward to the base of the first dorsal spine; head naked. Lateral line nearly straight from the operculum to a point above the end of the pectoral; thence it curves downward to the middle of the body, and extends to the base of the tail. Anteriorly, the tubes and pores are large and close together, but they become smaller and widely spaced behind.

First dorsal situated about midway between the eye and the posterior margin of the preoperculum, or a little nearer the latter; its spines are subequal, and the membrane from the last extends about one-third up the first spine of the second dorsal. The latter is inserted above the hinder end of the operculum, and is about two-thirds as long as the second spine of the first dorsal; the following spines increase gradually in length to the last, which is much shorter than the rays. Rays equally spaced, the last united to the caudal peduncle or the base of the caudal rays. Anal similar in form to the dorsal, but the membrane deeply excised between the rays; the last is not connected with the caudal peduncle. Pectoral broadly rounded; the ninth ray longest, reaching the verticle of the first anal spine or not so far. Ventrals with three simple rays, the median one the longest. Caudal rounded.

Colour.—Pale yellow, with or without nine more or less distinct cross-bars, the first of which largely covers the head, and the last is on the caudal fin. These are wholly lost in one specimen, and very distinct in another, according to the medium of preservation.

Described from two specimens, 227-341 mm. long, in the Australian Museum collection. The smaller one is figured, but its anterior dorsal fin being malformed, this is corrected from the larger example.

I have also examined a still larger specimen in the Tasmanian Museum, which is possibly the type of the species. Kent's notes only refer to the great development of the rostral tentacle and the size of the specimen—15 inches, but Johnston later recorded the number of spines and rays in the dorsal and anal fins.

Loc.—Tamar River, Tasmania.

Genus PETRAITES Ogilby.

PETRAITES INCERTUS, sp.nov.

(Plate xxxvii., fig.3.)

D.3, 29/4; A.2/23-24; P.11; V.3; C.9. Head 3·8-4·06, depth before the anal 4·3-4·9 in the length to the hypural. Eye 5-5·1, snout 3·7-3·8 in the head. Interorbital space 1·8-2·1 in the eye. First dorsal spine 1·6-1·9, first dorsal ray 1·6, and fourth last anal ray 1·4-1·9 in the head. Median pectoral ray 1·3, median ventral ray 1·4-1·5, and median caudal rays 1·3-1·6 in the head.

Body moderately elevated, snout pointed. Maxillary reaching to below hinder margin of the eye. Tentacle of anterior nostril minute; orbital tentacle well developed, with a few small lobes. Head with several series of muciferous canals and minute pores surrounding the eyes, and extending along the margin of the preorbital and preoperculum, and beneath the lower jaw; others cross the nape and join the lateral line.

Cardiform teeth in a single row on the upper jaw, followed by two patches of villiform teeth anteriorly. They are similar in the lower jaw, but the villiform patches are smaller. Vomer with two bands of villiform teeth which are united on the median line Palatines toothless.

Body covered with minute rudimentary scales which extend forward to the third dorsal spine; head naked. Lateral line almost straight from the operculum to a point above the end of the pectoral; thence it curves downward to the middle of the body and extends to the base of the tail. Anteriorly, it is well developed, but the tubes become smaller and widely spaced posteriorly.

First dorsal spine situated a little behind the verticle of the posterior orbital border; it is a little longer than the second, and much longer than the third. The latter is connected with the nape or the extreme base of the first spine of the second dorsal. Origin of the second dorsal above the posterior part of the operculum; the spines increase gradually in length to the last, which is much shorter than the rays. Dorsal rays widely separated but uniformly spaced; the last is united to the end of the caudal peduncle, or the base of the upper caudal ray. Anal similar in form to the dorsal, but its membrane deeply excised between the rays; the last ray is partially connected with the caudal peduncle by membrane. Pectoral rounded, the seventh ray longest, scarcely reaching the verticle of the vent. Ventrals with three simple rays, of which the median is the longest. Caudal rounded.

Colour.—Uniform yellowish in formalin, with very indefinite traces of the usual darker cross-bars.

Described from two specimens 205-216 mm. long; the larger of the two is the specimen figured I propose a new name for them with great hesitation, they being clearly closely related to several of the many imperfectly known species already described. They do not wholly agree with any of the descriptions, however, so I give a detailed description and figure which will enable them to be compared with the typical specimens of other species when the latter are available.

Loc.—Tamar River, Tasmania.

Genus Lepidoblennius Steindachner.

Lepidoblennius haplodactylus Steindachner.

Lepidoblennius haplodactylus Steindachner, Sitzb. Akad. Wiss. Wien, lv. i., 1867, p.11, Pl. i., figs.2-3.

Lepidoblennius geminatus Macleay, Proc. Linn. Soc. N. S. Wales, vi., 1881, p.13.

A comparison of specimens of *L. geminatus* Macleay, from near Sydney, with Steindachner's description and figure of *L. haplodactylus* proves the two to be synonymous. The species is very abundant in rock-pools along the coast near Sydney, and has the curious habit of leaving the water to bask in the sun on damp, weed-covered rocks. When approached, it skips rapidly into the water, and hides among the coralline sea-weeds, which it closely resembles in its colour-marking. It is extremely active in the water, and is commonly known as Jumping Joey or the Basking Blenny.

Mr. J. D. Ogilby informs me that the species occurs in Moreton Bay, Queensland, and that he has examined specimens from Cape Moreton.

Family ANTENNARIIDÆ.

Genus TATHICARPUS Ogilby.

TATHICARPUS MUSCOSUS Ogilby.

(Plate xxxvii., fig.4.)

Tathicarpus muscosus Ogilby, Proc. Roy. Soc. Q'land, xx., 1907, p.22, and Mem. Q'land Mus., i., 1912, p.64.

Three specimens in the Australian Museum do not differ from each other either structurally or in colour-marking. One was forwarded to Mr. Ogilby for comparison with his *T. muscosus*, and he informs me that there is no doubt of its identity with that species; the typical specimen is unfortunately lost, but a second example from Wide Bay, Queensland, is preserved in the Queensland Museum.

The accompanying figure represents a specimen 80 mm. long, which was collected at Shark Bay, Western Australia. The other two are from north-western Australia.

EXPLANATION OF PLATES XXXV.-XXXVII.

Plate xxxv.

Fig.1.—*Grammatorycnus bicarinatus* Quoy & Gaim.
Fig.2.—*Lovettia sealii* Johnston.

Plate xxxvi.

Fig.1.—*Therapon bidyana* Mitchell (young).
Fig.2.—*Ichthyocampus scalaris* Gthr.

Plate xxxvii.

Fig.1.—*Crapatalus arenarius*, sp.n.
Fig.2.—*Clinus johnstoni* Kent.
Fig.3.—*Petraites incertus*, sp.n.
Fig.4.—*Tathicarpus muscosus* Ogilby.

ON *MOREAUIA MIRABILIS*, gen. et sp.nov., A REMARKABLE TREMATODE PARASITIC IN *ORNITHORHYNCHUS*.

By S. J. Johnston, B.A., D.Sc., Department of Zoology, University of Sydney.

(Plates xxxviii.-xxxix.)

The worms forming the subject of this paper were found by Mr. S. J. H. Moreau, who, in January of this year, accompanied me on a collecting trip to the Fish River district, on the western side of the Blue Mountains. Six specimens of Ornithorhynchus were shot on this expedition, and the two which harboured the trematodes under consideration were found in the Duckmaloi, a tributary of the Fish River.

About the end of March, from two specimens of Platypus out of the same river, twenty-one of these trematodes were obtained. The worms lie in the intestine transversely, almost, or sometimes quite hidden by the transverse folds of the mucous membrane. They occur in the region beginning at the pyloric constriction and reaching backwards for twelve or fifteen inches. They lie so well hidden, that a careful search is necessary in order to bring them to light. They cling very tightly, and some effort is required to displace them by means of a camel's hair brush.

With this remarkable trematode from the Platypus, which he was instrumental in bringing to light, I wish to associate the name of Mr. Moreau, a student of Sydney University, and a very energetic and able collector of zoological and embryological material, to whom I am indebted for a considerable number of Entozoa. Hence the generic name.

The occurrence of a second trematode in the Platypus, so different from the already known *Mehlisia ornithorhynchi*, which I have previously described from that host(**3,4**), seems to be of special interest.

At first sight, the worms looked like the free posterior segments of a tape-worm of the Phyllobothrium-type, and of that nature I supposed them to be until I had made a microscopic examination.

This new find differs so much from known Trematodes, that I must propose for it a new genus and subfamily.

MOREAUIINÆ, new subfamily.

MOREAUIA MIRABILIS, gen. et sp.n.

Diagnosis.—Middle-sized worms, with weak musculature, and small suckers near one another. Body flattened, *rectangular in shape, with the long axis of the rectangle representing the breadth of the worm.* Integument thin, devoid of spines. Pharynx and œsophagus well marked; intestinal limbs reaching to the posterior end. Excretory vesicle Y-shaped. Genital opening on the *left border* near its middle, copulatory organs present; muscular cirrus-sac *surrounding the large vesicula seminalis, well-marked pars prostatica,* and cirrus. *Cirrus spiny.* Testes large and deeply lobed, with their *long axes in a straight line,* and the lobed *ovary between.* Laurer's canal elongated, receptaculum seminis wanting. Uterus *fairly long,* running from right to left, with a capacious receptaculum-seminis-uterinum. Yolk-glands intensively developed, filling up the region of the body outside the intestinal limbs. Eggs few in number, large, oval, thin-shelled, with operculum.

Parasitic in *Ornithorhynchus anatinus,* in the small intestine.

Type-specimen in the Australian Museum, Sydney, No.W.407.

External Characters.—These worms are mainly rectangular in shape, flat and thin dorsoventrally, with the long axis of the rectangle representing the breadth of the worm, while the short axis represents the length. While in some of the specimens the anterior and posterior edges are comparatively straight, in others the lateral wings are drawn forwards a little so as to form a shallow double concavity in front, with a slight projection in the middle, between the two, and a corresponding double convexity behind(Fig.1). The oral sucker is situated on the ventral aspect, near the middle of the anterior border.

The excretory opening is placed in the middle of the posterior border, while the common genital opening is situated in a depression on the middle of the left lateral border.

The size is moderately large, about 2 mm. long by rather less than 10 mm. broad. The average length of eight specimens measured was 1·94 mm., and the breadth 9·49 mm The largest specimen measured 2·09 mm. long by 10·78 mm. broad. The cuticle is thin and smooth, and devoid of spines.

The suckers are small, shallow, and circular, and are very nearly equal in size, the ventral being slightly smaller than the oral. The average diameter of the oral, measured in eight specimens, is 0·213 mm., that of the ventral 0·21 mm. In half the specimens measured, the two suckers are exactly equal in diameter, while in the largest specimen the diameter of the oral is 0·232 mm., that of the ventral 0·223 mm. Distance between the suckers 0·475 mm.

Alimentary Canal.—The globular pharynx lies partly dorsal and partly posterior to the oral sucker, and is somewhat smaller in size, its diameter being 0·141 mm. There is no prepharynx, the pharynx being very closely applied to the oral sucker, and in part fused with it. The œsophagus is short (0·174 mm.) but distinct. Diverging from the posterior end of the œsophagus, the two intestinal limbs run out to the lateral aspects of the body, following the contour of the anterior, lateral, and posterior borders, to end near one another, one on either side of the excretory vesicle. Each limb, therefore, is U-shaped (Fig. 1). The left loop of the intestine passes the common genital chamber on its dorsal aspect.

Excretory System.—The excretory pore opens on the middle of the posterior border, and leads into a short, rather narrow passage which opens anteriorly into two more spacious chambers. The latter, which are somewhat pear-shaped but flattened on their median sides, run forwards, to end in the region just behind the ventral sucker. The three chambers together constitute an essentially Y-shaped excretory vesicle, in which the main stem, however, is short. Each of the upper arms of the Y gives off three main branches on its outer side. The hindmost of these passes off from the postero-lateral corner, and may be traced outwards across half the length of the posterior border of the worm, and close to it (Fig.1). The second passes off from the middle of the same limb of the vesicle, and runs parallel and just posterior to the terminal part of the intestinal limb; while the anterior branch, which is much shorter than the others, comes off near the anterior end of the vesicle. From all three lateral branches, numerous capillary vessels are given off, those from the posterior lateral branch especially forming a close network of vessels that extends over the whole of the posterior region of the body, lying just beneath the cuticle.

Nervous System.—A pair of cerebral ganglia, consisting of a considerable number of nerve-cells, lie one on either side of the œsophagus, a little behind the pharynx. They are connected by a thick band of nerve-fibres passing dorsal to the œsophagus, but no ventral commissural fibres are to be found. From each cerebral ganglion (Fig.1), a thick nerve-trunk passes outwards and backwards in an oblique direction to the posterior border of the body, passing on the mesial side of the ovary, on the one hand, and of the cirrus-sac, on the other. Each of these nerve-trunks, in the region just in front of the point where it passes the anterior loop of the intestinal limb, gives off a large branch, only a little smaller than the main trunk, which runs outwards parallel and close to the anterior loop of the intestine and in front of it. From the cerebral ganglia also arise four or five fine nerve-fibres on each side, which run forwards and are distributed to the anterior sucker and pharynx, and the region in front of the sucker. Numerous nerve-fibres pass off to various parts of the body from the main lateral trunks, and from the two main branches into which each main trunk divides. The nervous system cannot be made out in whole specimens, but has been drawn in on Fig.1 from a series of horizontal sections.

Genitalia.—The genital aperture, which lies in a depression in the middle of the left lateral border, leads into a comparatively spacious common genital chamber. The gonads are of large size, and lie in the other side of the body, that is, on the right of the middle line. They lie in the space formed by the U-shaped intestinal limb, almost completely filling it. The testes are large, transversely elongated, fairly deeply lobed bodies, each exhibiting ten or twelve lobes. They are nearly equal in size, in some cases the outer, in other cases the inner being slightly the larger.

In the eight specimens measured, the average length of the outer is 1·83, of the inner 1·84 mm., or about one-fifth of the whole breadth of the body. The ovary, which lies between the two testes, is three- or four-lobed, and much smaller than the testes, its longest diameter being 0·59 mm. The ovary occupies practically the whole space between the two testes. The vas deferens of the inner testis leaves it on its anterior aspect near its outer border, quite near the ovary: that of the outer testis, however, begins near its inner border, and the two vessels run along, side by side, in a wavy course between the gonads and the anterior limb of the right intestinal loop, passing dorsal to the ventral sucker, and joining one another, at last, just as they enter the cirrus-sac The cirrus-sac is very large and muscular. It is 2·72 mm. in length, *i.e.*, nearly one-third of the longest diameter of the whole body. The vesicula seminalis is a conspicuous structure lying within the inner end of the cirrus-sac, generally exhibiting two or three constrictions or twists. The pars prostatica and the prostate-glands are also very conspicuously developed (Fig.4), lying, along with the seminal vesicle, in a well developed mass of parenchyma, within the walls of the cirrus-sac. The male organ of copulation is a cirrus rather than a penis, consisting of an eversible tube. This structure forms one of the most remarkable features of the worm under consideration. The inner wall of the eversible part of the tube, in its involuted or withdrawn state, is densely covered with large, thick, somewhat pointed and recurved chitinoid spines (Figs.1*b* and 3). In the everted position of the organ, these spines are, of course, on its outer surface.

The oviduct leaves the ovary near its anterior-inner corner. The outer end of the inner testis is smaller than the rest of it, and in the space thus left, between it and the anterior loop of the intestine, the ootype, the small yolk-reservoir, and the comparatively large "shell-gland" lie. Laurer's canal is long, coursing along beside the inner testis, right up to the middle line of the body, where it opens on the dorsal surface.

The uterus, a comparatively narrow tube, runs to the left in a series of small waves, in front of the inner testis, behind the ventral sucker and behind the cirrus-sac, between that organ and the posterior loop of the left intestinal limb. In the middle part of its course, it is considerably dilated to form the receptaculum-seminis-uterinum, which, in most of the specimens, is filled with considerable masses of spermatozoa. There is no "receptaculum seminis." The vagina opens into the posterior side of the common genital chamber, just near the male opening. The follicles of the yolk-glands vary from pear-shaped to tubular, and average 0·051 mm. in width. These glands are very extensively developed and widely distributed over the body, filling up the space between the intestinal limbs and the various borders of the body. The region round the suckers, however, is comparatively clear of them, and so also is the region near the genital opening.

The follicles also extend inwards beyond the intestinal limbs to a slight extent, especially behind the cirrus-sac, and on the extreme right of the body, where, to the right of the outer testis, they spread over the whole field. The yolk-ducts from the left side run close to the loops of the intestinal limb, gradually converging after passing the cirrus-sac, and joining to form a large common duct a little to the left of the ventral sucker. This common duct is joined near the yolk-reservoir, on the one hand, by a duct which runs along from the right near the anterior limb of the right intestinal limb, and, on the other hand, by a duct which is itself formed by the confluence of two ducts coursing along near the posterior loop of that intestinal limb, from the right and left (Fig.1, Y.d).

The eggs are comparatively few in number, oval in shape (Fig. 1a), thin-shelled, of large size, 0·105 × 0·077 mm. They vary somewhat in size, the smallest being 0·096 × 0·069 mm., while the largest was 0·111 × 0·079. The operculum is situated at the narrower end.

Relationships.—Amongst known Trematodes, *Hapalotrema* Looss(**5, 6**), and *Liolope* Cohn(**2, 8**), seem to approach most nearly to *Moreauia* in the essentials of their structure, in spite of the great difference in form and general appearance. The main differences in the form and position of the various organs, which are of primary importance in deciding the relationships of those two genera on the one hand, and *Moreauia* on the other, are, after all, mainly due to the remarkable extent to which the body of *Moreauia* is broadened out at the expense of its length.

In *Hapalotrema* (Fig.2), we have a worm with large testes (divided up into a number of separate lobes) placed in a line, one behind the other, with the ovary between. The yolk-glands, consisting of a large number of comparatively small follicles, occupy the whole lateral field behind the ventral sucker and outside the intestinal limbs, encroaching also to a slight extent on the space to the inner side of those limbs. The genital opening, with the cirrus-sac and vagina, is on the left side. The excretory vesicle is essentially Y-shaped. Now, if we imagine a worm like *Hapalotrema* to begin to extend laterally, right and left, the excretory vesicle and pore remaining in the middle of the posterior end, and the genital opening remaining near the middle of the left side till a shape of body similar to *Moreauia* is reached, we should have a worm very like *Moreauia* in its external features, provided that the lateral extension on the right side took place in such a way that the testes remained in a line parallel with their long axes, with the ovary between. And in such a spreading out, in order that room might be found for two such large bodies as these testes, this would naturally have to be the case.

After such a transformation in shape, we should have a worm in which the configuration of the intestine would be essentially the same as that present in *Moreauia*; the excretory vesicle would be very similar, the lateral stretching producing the slight dilatation of the upper limb of the Y seen in *Moreauia*; the large, elongated, very deeply lobed testes, with the ovary between, would correspond with those of *Moreauia* in form and position, though the testes of the latter are less deeply lobed; the genital opening, cirrus, and cirrus-sac would occupy similar positions; the configuration and extension of the yolk-glands and yolk-ducts would be practically the same. Such an alteration in the shape of *Hapalotrema*, with the simple alteration of the position of the internal organs, an obvious consequence of this alteration in shape, would produce a worm strikingly similar to *Moreauia*. Other similarities would be found in the form of the suckers, and in their position, not only in regard to one another, but also in regard to the other organs of the body; in the thin character of the integument and the absence of spines, complete in *Moreauia*, and almost complete in *Hapalotrema*. Important differences are the absence of the pharynx in the latter, and the very much more strongly developed cirrus-sac and the conspicuous pars prostatica in the former. The systematic position of *Hapalotrema* has been variously estimated by different writers on this group of animals. Looss(**4**) considers it closely related to *Bilharzia* (*Schistosomum*), mainly on the grounds of a similarity of certain external features (integument and suckers), the conformation of the alimentary tract, and the miracidia. Pratt(**11**) places it with the Clinostominæ, while Odhner(**8**) places it, along with *Liolope*, in a subfamily Liolopinæ. The last arrangement, I consider the most satisfactory. *Moreauia* shows so many distinctive features, that it can hardly be placed in the Liolopinæ, but must be considered the representative of a new subfamily, MOREAUIINÆ, which has close affinities with the Liolopinæ. The chief differences between the two groups, besides those concerned with the unique shape of *Moreauia* and the consequent rearrangement of the relative positions of some of the organs, are the presence of a very marked pars prostatica in *Moreauia*, and a very strong cirrus-sac, within which the vesicula seminalis is also included (it lies quite outside the relatively small cirrus-sac in *Hapalotrema*) [**5**, Fig.73].

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REFERENCE LETTERS.

C., cirrus—C.g., cerebral ganglion—C.s., cirrus-sac—E., excretory vessels—Ex.p., excretory pore—Ex.v., Excretory vesicle—G.p., genital aperture—G.c., common genital chamber—Int., intestinal limbs—L.c., Laurer's canal—Lt., lateral nerve-trunk—Œs., œsophagus—O.s., oral sucker—O., ovary—O.d., oviduct—oot., ootype—Ph., pharynx—Pr., prostate—P.Pr., pars prostatica—R.s.u., receptaculum-seminis-uterinum—T., testes—ut., uterus—Vag., vagina—V.d., vas deferens—V.s., vesicula seminalis—V.sk., ventral sucker—Y.d., yolk-duct—Y.g., yolk-gland.

EXPLANATION OF PLATES XXXVIII.-XXXIX.

Plate xxxviii.

Moreauia mirabilis (except Fig.2).

Fig. 1.—Drawing of a whole mount (× 15). A portion of the right lateral border is turned over. The excretory and nervous systems have been drawn in from a series of horizontal sections. The rest of the drawing has been made with the camera lucida.

Fig. 1a.—Two eggs of Moreauia.

Fig. 1b.—Surface-view of the spines on the cirrus.

Fig. 2.—*Hapalotrema constrictum* Leared (after Looss).

Plate xxxix.

Moreauia mirabilis.

Fig. 3.—Microphotograph of a section through the genital chamber and spiny part of the cirrus, not quite in the middle of the cirrus, but showing the method of eversion of the cirrus through the genital chamber (× 108).

Fig. 4.—Microphotograph of a section through the middle of the cirrus-sac, showing the spines on the surface of the inverted cirrus, the well marked pars prostatica, etc. (× 125).

NOTES AND EXHIBITS,

Mr. Fred Turner gave some particulars, from American records, (Mohr's "Plant-life of Alabama"; and Vasey's "Monograph of the Grasses of the United States and British America") of the occurrence and distribution of *Panicum glabrum* Gaud., in the United States—an introduced plant now acclimatised in Australia. He also communicated, from an unpublished source, the late Mr. F. M. Bailey's views on *P. globoideum* Domin.

Mr. A. A. Hamilton showed an additional series of introduced or indigenous plants exhibiting teratological developments; and others illustrating leaf-variation, from the National Herbarium, Sydney, namely—*Antirrhinum majus* Linn., Hort., showing fasciation, spiral torsion, and frondescence. An example in the early stage (W. M. Carne; Sydney Botanic Gardens; November, 1914) shows the fused stems only slightly contorted, the upper portion branching laterally. Some of the flowers are organically perfect, but exhibit the customary attenuation due to malnutrition, and a considerable reduction in size in the floral leaves. The fruit-capsules are, in the first place, normal in size, and fertile, but become attenuated as the trouble advances, and finally abortive. In an example at a more advanced stage (Rev. J. W. Dwyer; Temora; November, 1914) the contortion of the fused stems has become more pronounced, the leaves and shoots on the upper portion are twisted, and finally reversed; and the flowers are represented by tufts of leaves.—*Rosa*, Hort. var., "The Bride" (E. Cheel; Penshurst; May, 1911), showing phyllody of the floral organs, accompanied by axial spiral torsion. The axis of the flower is prolonged beyond the abortive ovary, and spirally contorted; the filaments of the stamens are leafy and dilated, the anthers becoming petaloid; and the petals exhibit phyllody, and are much attenuated. Owing to its contortion, the stamens and petals are interlaced spirally on the elongated axis.—*Casuarina glauca* Sieb., (A. A. Hamilton; Duck River Clyde; May, 1915), showing arrested growth caused by larval activity. A series of branchlets have become conglomerated by the action of intruding insect-larvæ, the true leaves (which are degenerate, and represented by minute teeth), normally in regular whorls, have been thrown into confusion, their bases becoming swollen and dilated. The branchlets not subjected to the attack exhibit attenuation.—*Hakea pugioniformis* Cav., (A. A. Hamilton; Maroubra Bay; August, 1914), showing leaf-variation, resultant from environment. Example (1), with short, crowded leaves (1 to above 2 cm. long) was found growing in a shallow basin, without drainage, (on a bench of otherwise bare rock) containing a small quantity of soil and débris. Example (2), with longer and more distant leaves (from above 1 to 5 cm.), was growing on the slope of the hill, with good drainage but insufficient moisture. Example (3), with comparatively luxuriant foliage (3 to above 8 cm.), grew in fairly deep soil, well drained, and adjacent to a watercourse. Examples of this species from Newnes Junction (A. A. Hamilton; September, 1914) were also exhibited, showing the similarity of the xerophytic effect on the habit and foliage, brought about by the apparently dissimilar environments of the dry ridge and the swamp.—*Helichrysum semipapposum* DC., (A. A. Hamilton; Blackheath; November, 1914), showing alteration of a xerophytic adaptation. An old bush of this species was noted, surrounded by a colony of younger ones, evidently its progeny. The leaves and branches of the young bushes were heavily clothed with a woolly vestiture (a common device to reduce transpiration). The parent-bush had discarded, for the greater part, the woolly coat, and had adopted instead a measure of viscidity as a protective agency.—*Xylomelum pyriforme* Sm., (A. A. Hamilton; Cook's River; August, 1914), showing leaf-variation. The juvenile leaves are falcate, lanceolate, oblong, elliptical, to almost rhomboidal; their apices acute, acuminate, apiculate, obtuse, truncate, to emarginate; and their margins from finely to coarsely toothed, or lobed. The adult leaves exhibit little variation in shape, and have the usual entire (or nearly entire) margins.—*Myrsine variabilis* R.Br., (A. A. Hamilton; Cook's River; July, 1914). Apart from the well known distinction between the juvenile and adult leaves (the former with toothed, and the latter with entire margins), the variation noted is inconspicuous.

Mr. E. Cheel exhibited, and offered observations on fresh specimens of Red Clover (*Trifolium pratense-perenne*) infested with a Rust [*Uromyces trifolii* (Alb. & Schw.) Wint.; or *U. fallens* of some authors]. This plant was originally exhibited at a Meeting of the Society [These Proceedings, 1913, pp.171, 397]; when it was shown that a plant which was infested with Rust at Hill Top, was able to resist the attack of the fungus when grown in better soil at Sydney. The plant exhibited at the July Meeting of 1913 was divided into two; one portion was planted in good soil at Ashfield; and the other transferred again to Hill Top. Both plants made fairly vigorous growth; and, so far, the Ashfield plant showed no signs of Rust; whilst the plant transferred to Hill Top had again developed Rust very badly. Mr. Cheel also exhibited specimens of—*Erechtites mixta* DC., which he had collected at Nethercote Road, Eden, Twofold Bay, in December, 1903; and at Hill Top, Southern Line, in April, 1914. This species has previously been recorded only from Piper's Hill (in the interior?) by Bentham (Fl. Aust., iii., 659); and from the Blue Mountains (Moore & Betche's Handbk. Fl. N.S.W., p.298). —*Dysphania littoralis* R.Br., (Syn. ? *D. myriocephalus* Benth.); Penshurst (E. Cheel; October, 1911). Attention has recently been drawn to this plant as containing hydrocyanic acid, and, therefore, to be regarded as a virulent stock-poison (Queensland Agricultural Journal, June, 1915, p.264).—*Erythræa Centaurium* Linn. Specimens of this species, collected at Chatham, Kent (England), in July, 1905, together with specimens of plants collected at Penshurst, near Sydney, in November, 1898, were exhibited. These appeared to the exhibitor to be identical. This species seems to be widely spread, chiefly in the coastal districts of this State, extendiug to the Blue Mountains on the Western Line, and to Goulburn on the Southern Line. It has evidently been mistaken for *E. australis* R.Br., which seems scarcely distinct from *E. spicata* Pers. The latter is being further investigated.

Dr. H. G. Chapman communicated some results obtained, by a number of investigators, in the physiological laboratory, on the tension of carbon dioxide in expired air. The tension was found increasing continuously during the passage of the expired air from the respiratory tract. The last portion of the expired air, therefore, contained the greatest quantity of carbon dioxide.

Mr. North, with the sanction of the Curator of the Australian Museum, exhibited a series of the eggs of 18 species of sea-birds showing considerable variation in shape and size, selected from the Australian Museum collection, procured by members of the Mawson "Australasian Antarctic Expedition" in 1911-14. The eggs of the following species were obtained in Antarctica:—*Megalestris maccormicki*, *Oceanites oceanicus*, *Thalassœca antarctica*, *Priocella glacialoides*, *Pagodroma nivea*, *Daption capensis*, *Pygoscelis adeliæ*. On Macquarie Island, *Larus dominicanus*, *Megalestris antarctica*, *Puffinus griseus*, *Æstrelata lessoni*, *Macronectes giganteus*, *Phœbetria cornicoides*, *Phalacrocorax traversi*, *Aptenodytes patagonica*, *Pygoscelis papua*, *Catarrhactes pachyrhynchus*, and *C. schlegeli*. The egg of *Phœbetria cornicoides* is elongate-oval in form, the shell being comparatively close-grained, dull white, much nest-stained, and lustreless; on the larger end are some scattered indistinct spots and blotches of faint reddish-brown. Length 3·87 × 2·55 inches. The eggs of *Phalacrocorax traversi* vary from oval to elongate-oval in form, and are of a faint bluish or greenish-white colour, which is almost concealed with a white calcareous coating slightly nest-stained. Three average-sized specimens measure: Length (A) 2·5 × 1·6; (B) 2·42 × 1·55; (C) 2·63 × 1·5 inches. The oological results of the Expedition, as evidenced by the quota of the collection assigned to the Trustees of the Australian Museum, may be briefly summarised as follows:—the eggs of two species of Skua, one Gull, eight Petrels, one Albatross, one Cormorant, and five Penguins. Attention was drawn to the dull and sombre hues of the specimens forming this exhibit, broken only by the olive, brown, and black tints of the eggs of *Larus* and *Megalestris*. Undoubtedly, they resembled their environment, a desolate and uninhabited great Southern land of ice, snows, and blizzards.

SPECIAL GENERAL MEETING.

June 30th, 1915.

Mr. A. G. Hamilton, President, in the Chair.

Business: the Hon. Treasurer to move—"That the Annual Subscriptions of all Ordinary Members of the Society serving with the Australian Expeditionary Forces be remitted during their term of service."

The Hon. Treasurer moved the Resolution, of which due notice had been given. On being put to the Meeting, it was carried unanimously.

ORDINARY MONTHLY MEETING.

July 28th, 1915.

Mr. A. G. Hamilton, President, in the Chair.

The President read, to the Meeting, a letter from Mr. J. F. Bailey, of Brisbane, returning thanks to Members for sympathy in bereavement.

The Donations and Exchanges received since the previous Monthly Meeting (30th June, 1915), amounting to 15 Vols., 72 Parts or Nos., 28 Bulletins, 2 Reports, and 6 Pamphlets, received from 48 Societies, etc., and one author, were laid upon the table.

SPECIAL GENERAL MEETING.

July 28th, 1915.

Mr. A. G. Hamilton, President, in the Chair.

On the motion of Mr. J. H. Campbell, Hon. Treasurer, it was resolved unanimously that the Resolution passed at the Special General Meeting held on 30th June, 1915 [That the Annual Subscriptions of all Ordinary Members of the Society serving with the Australian Expeditionary Forces be remitted during their term of service] be confirmed.

PETROLOGICAL NOTES. No. i. IGNEOUS ROCKS AND TUFF FROM THE CARBONIFEROUS OF NEW SOUTH WALES.

By M. Aurousseau, B.Sc., Deas-Thomson Mineralogy Scholar, University of Sydney; Assistant Lecturer in Geology, University of Western Australia.

(Plate xl.)

Introduction.—The study of the genetic and tectonic relationships of the Carboniferous igneous rocks of New South Wales is a work of pressing importance in Australian petrology, and one which I had planned to take up, but my removal to Western Australia has caused its abandonment, at any rate for some years.

The following notes represent a small amount of preliminary collecting and study. The field-relations of the rocks dealt with have not yet been worked out, but are indicated to some extent on Professor David's maps (David, 1907).

The igneous rocks are interbedded with littoral sedimentaries and tuffs belonging to the upper part of the Lower Carboniferous (Benson, 1913, Pt. i.), but, owing to the absence of persistent horizons in the sedimentaries (Jaquet, 1901), correlation will depend largely on the igneous rocks. For this reason, and as the rocks described will have to be identified in the field as mapping proceeds, the descriptions have been made fairly detailed.

The rocks to be described are from Martin's Creek, near Paterson; and Eelah, Hudson's Peak and Knockfin, near Gosforth, in the Hunter River Valley, N.S.W.

Martin's Creek, Paterson.

(108) *Pyroxene-amphibole-mica andesite.*—A handsome greenish to brownish-grey rock with occasional red patches; porphy-

ritic with numerous white felspars and subordinate hornblendes up to 3 mm. long; the felspars frequently appear to invest a ferromagnesian kernel; the fracture is smooth and subconchoidal.

Microscopically, the primary minerals developed are plagioclase, hornblende, biotite, rhombic pyroxene, magnetite, apatite, and zircon.

The plagioclase is an oligoclase-andesine, with a maximum symmetrical extinction of 16°. It is of subequant habit, twinned on the Carlsbad, albite, and pericline laws, and is appreciably zoned, though the variations in composition are but slight; the kernels are acidic, and sharply separated from the more basic outer zones. The felspar has a peculiar spangled appearance, due to the formation of resorbtion-cavities, and the development of cleavage- and fracture-cracks and sericite-scales. The acidic kernels are often completely replaced by pseudomorphs of a blue-green chlorite, rather strongly pleochroic and weakly birefringent, with a fibrous, spherulitic habit. The boundaries of these aggregates are quite sharp, and concentric with the zoning of the felspar. Zircon is the only mineral included.

Common hornblende is greatly subordinate in amount to plagioclase. Its pleochroism and absorbtion are, $\mathfrak{a}$ pale greenish-yellow, $\mathfrak{b}$ yellow-green, $\mathfrak{c}$ green, with $\mathfrak{a}<\mathfrak{b}<\mathfrak{c}$. It includes zircon, magnetite, and apatite, and patches of exceedingly minute rods lying parallel to C in the (110) cleavage-planes. It is surrounded by reaction-rings of moderate depth, the pyroxene of which has altered to a grass-green, strongly pleochroic chlorite with a birefringence equal to that of quartz, while the magnetite-granules are passing into limonite.

Biotite occurs in thin, bent flakes, much altered, and so strongly resorbed as to be represented, at times, by a mere string of magnetite-granules.

Rhombic pyroxene is very scarce, and almost completely altered. It is a pale, feebly pleochroic hypersthene, passing into pseudomorphic aggregates of blue-green chlorite, and brown, pleochroic anthophyllite. Alteration proceeded with the paramorphic formation of anthophyllite inwards from the sides and transverse fractures, while chlorite formed internally.

Zircon is comparatively abundant, as is magnetite, which includes apatite, and is passing peripherally into limonite. Apatite is scarce, but is peculiar in showing prismatic cleavage.

The groundmass is pale brownish in colour, with a slightly fluidal fabric in places, and is thickly dusted with magnetite, limonite, and chlorite. In ordinary light, it has the appearance of a typical glass. It consists, however, of a very fine-grained mosaic of untwinned plagioclase, more acid than the phenocrysts. The separate grains are independent of flow-lines or inclusions in their orientation. The mosaic, hence, represents a devitrified plagioclase-glass. Small nests of granular quartz, perhaps secondary, occur occasionally. (Pl. xl., fig.3).

This rock has been extensively quarried for use as ballast on the North Coast Railway.

Eelah.

(113) *Hypersthene-andesite.*—A very dark brown, heavy rock, with a rough, uneven fracture, and granular appearance; porphyritic with numerous, yellow, glassy felspars up to 3 mm. long, which weather to a brown colour. The rock, as a whole, develops an earthy crust on weathered surfaces, on which the felspars stand out in slight relief.

Plagioclase, hypersthene, magnetite, apatite, and zircon are developed. (Pl. xl., fig.4).

The plagioclase is a basic labradorite, with a maximum symmetrical extinction of 35°, twinned on the Carlsbad, albite, and pericline laws; habit idiomorphic, subequant, with slightly rounded outlines, distinctly corroded by the groundmass in places. Zoning is well marked, but the variations in composition are only slight, and are not progressive. Generally, there is an even basic core, followed by several oscillations, with a well marked acidic outer shell. Stony inclusions tend to concentrate in the zones of oscillating composition. The felspar is generally fresh and unaltered, though fractured. Limonite has been deposited in the cracks. Small grains of hypersthene are included.

Hypersthene forms stout columnar crystals of rounded outline, and is not very abundant. The colour is fairly deep; pleochroism and absorbtion are as follows :—$\mathfrak{a}$ brownish-pink, $\mathfrak{b}$ brownish-yellow, $\mathfrak{c}$ greenish-grey; $\mathfrak{a}>\mathfrak{b}\geqq\mathfrak{c}$. Multiple twinning is common. Magnetite is often, but felspar seldom, included. Aggregates of irregularly intergrown hypersthene and felspar occur, and large felspars are sometimes moulded on to large hypersthenes. Evidently, the crystallisation of hypersthene commenced slightly before felspar; the periods overlapped, but hypersthene finished first. Alteration to bastite is taking place.

Magnetite is fairly abundant in rounded grains passing into limonite. Apatite and zircon are very rare.

The groundmass consists of minute felspar and hypersthene individuals set in a preponderant glass. It is partly replaced by limonite and bastite.

(103) *Pyroxene-andesite.*—A compact, dark green, serpentinous rock, porphyritic with numerous indistinct, greenish felspars up to 4 mm. long, which become white on exposure, and finally weather out; exposed surfaces, thus, have a rough, pitted appearance, and are dark brown in colour; fracture fairly smooth.

Phenocrysts and groundmass are in about equal proportions. The minerals developed are plagioclase, pyroxene, magnetite, and apatite.

The plagioclase is a basic labradorite, with a maximum symmetrical extinction of 31°, tabular-prismatic in habit, with wide albite lamellæ, and an occasional pericline-set. Zoning is present, with slight oscillatory changes in composition as in (113). The general change is from a basic centre to a more acid margin, but there are often one or two zones more acid than the outer shell. The felspar is sometimes moulded on to pyroxene-pseudomorphs, and includes magnetite. Minute stony inclusions are zonally distributed. The crystals are much fractured and, at times, recemented. The fractures are filled with yellow-green clinochlore, which also occurs sporadically in the crystals, but shows a marked preference for pseudomorphic replacement of the acid zones. The centres of small crystals are entirely replaced, whereas in larger ones there are one or two ragged zones of chlorite, concentric with those of the felspar. Irregular carbonate-replacements also occur.

Pyroxene is represented by idiomorphic pseudomorphs of clinochlore and carbonate, in which traces of original cleavage and fracture are preserved. Magnetite and apatite are included. The original pyroxene appears to have been rhombic, and was considerably less in amount than felspar. Alteration proceeded inwards from the sides of the fractures, and outwards from scattered centres in the crystals.

Magnetite is moderately abundant, and is passing into limonite. Apatite is quite rare.

The chlorite of the rock (clinochlore) is in ragged plates and fibrous spherulitic aggregates, yellow-green in colour, weakly pleochroic, with a birefringence equal to that of quartz.

The groundmass is of normal appearance in ordinary light, thickly dusted with magnetite, limonite, and chlorite, and here and there replaced by chlorite; a few tiny patches are clear, and free from inclusions. It is holocrystalline, being a mosaic of interlocking, untwinned plagioclase-grains, more acid than the phenocrysts. As in (108), it is a devitrified plagioclase-glass, but here the grainsize is much coarser, averaging 0·3 mm. (Pl.xl., figs.1-2). The clear patches, in ordinary light, are nests of quartz.

The order of crystallisation was normal.

(105) *Pyroxene-amphibole-mica andesite.*—A dirty puce-coloured rock, porphyritic with numerous white felspars up to 3 mm. long, and subordinate hornblendes of similar size. The felspars often invest a ferromagnesian kernel. The groundmass is replaced in patches by chlorite. The rock is soft, and evidently much weathered, and tends to split in definite directions; fracture smooth.

Plagioclase, hornblende, biotite, pyroxene, magnetite, zircon, apatite, and quartz are developed (cf.108).

The plagioclase is an oligoclase-andesine, with a maximum symmetrical extinction of 15°. It resembles that of (108) exactly, in both primary and secondary characters, even to the replacement of the kernels by chlorite (here clinochlore) [Pl. xl., fig.5].

Common hornblende, subordinate in amount to felspar, is like that of (108) in pleochroism and absorbtion. The reaction-rings are slightly deeper, however, and all trace of their secondary pyroxene has been removed, while the granular magnetite is greatly decomposed. Apatite and primary magnetite are included; in one case, hornblende appears to have grown in parallel position with pyroxene (represented by a pseudomorph).

Biotite is in about the same amount as hornblende, and has suffered greatly by resorbtion.

Pyroxene is represented entirely by pseudomorphs. These are generally of clinochlore, carbonate, and quartz, but in three cases, grains of acid plagioclase, with undulose extinction, enter into their composition. Magnetite and apatite are included.

Magnetite includes apatite, and is passing into limonite. Zircon is comparatively abundant, but apatite is scarce.

One minute, rounded grain of quartz was observed. It is undoubtedly primary, being corroded by the groundmass.

The groundmass is greatly clouded by limonite and chlorite, and is, in patches, entirely replaced by chlorite. Fluidal fabric is feebly developed. As in (108), it is a holocrystalline, fine-grained mosaic of plagioclase more acid than the phenocrysts.

In all its primary, and most of its secondary characters, this rock is the exact counterpart of (108). The differences are of degree, rather than of kind.

In a more weathered specimen of the same rock, hornblende is represented by pseudomorphs of allotriomorphic plagioclase which approaches albite in composition, all indices of refraction being lower than Canada balsam. The extinction of the grains is sometimes undulose, and they enclose strings and patches of very finely granular epidote, as well as the apatite-inclusions of the original hornblende. The entire aggregates are surrounded by the reaction-rings of magnetite, which express the characteristic outlines of the hornblende.

In the same specimen, the larger biotites enclose numerous grains of secondary albite, in poikilitic fashion.

A slide of this rock was treated with hydrochloric acid in order to remove limonite; the chlorite-pseudomorphs of pyroxene were noticed to have lost colour, contracted, and become almost isotropic, after the treatment.

Fluidal fabric is better developed in the groundmass of (105) than in that of (108), and the scale of devitrification is somewhat finer in the former than in the latter.

(112) *Biotite-dacite.*—A puce-coloured rock not unlike (105) in appearance, but of rough fracture, and possessing free quartz. Phenocrysts of quartz up to 3 mm., felspar up to 2·5 mm., and biotite are discernible. Felspar preponderates slightly over quartz, while biotite is quite subordinate in amount. The rock resembles the dacite of Rigel, Kohlbach, Hungary, in appearance (Krantz Coll.).

Quartz, orthoclase, plagioclase, biotite, hornblende, magnetite, ilmenite, zircon, and apatite occur.

The quartz is in subidiomorphic to rounded grains, with abundant inclusions and inlets of the groundmass. It contains many, fine, stony inclusions, and large inclusions of glass, each containing a gas-bubble. Strain about the inclusion has been relieved by cracking of the quartz, as in the rhyolite of Eureka, Nev.(Iddings, 1911, p.70, fig.37), and the quartz-porphyry of Dossenheim(Rosenbusch-Iddings, 1905, pp.14-18, Pl. vi.).

Orthoclase is more abundant than plagioclase, and forms idiomorphic, tabular-prismatic crystals, with inclusions of sericite, epidote, and carbonate.

The plagioclase is a calcic oligoclase, with a maximum symmetrical extinction of 7°. It is slightly zoned, the basic kernels being fairly well marked-off from the acid outer shells. Carlsbad-albite twins occur, and the crystals are equant, with rounded corners. They are often spangled by resorbtion-cavities, cracks, and sericite-scales, and are partly replaced by carbonate. Magnetite is included.

The biotite is in strongly absorbtive, bent flakes, surrounded by narrow reaction-rims of granular magnetite. It includes zircon, iron-ores, and apatite.

One piece of chloritised hornblende was observed, surrounded by a narrow reaction-rim.

Judging from their decomposition-products, magnetite and ilmenite coexist; magnetite is in excess, and both include zircon and apatite.

Zircon is plentiful in small, stout grains, while apatite is rare. The groundmass is fluidal in places, elsewhere imperfectly spherulitic. It is greatly clouded by secondary products (limonite, leucoxene, epidote, and chlorite), and is completely devitrified to a fine mosaic of felspar and quartz.

(104) *Oligoclase-biotite rhyolite.*—A light, tough rock, creamy to pink in colour, weathering to a yellow-brown. Scattered, hexagonal flakes of biotite occur. The fracture is very irregular and rough.

Plagioclase, quartz, biotite, and magnetite occur as phenocrysts, all very sparingly.

The groundmass is fluidal, and is completely devitrified, consisting of a microcrystalline mosaic of quartz and felspar, with imperfect felspar-spherulites. It includes numerous margarites. The felspar has a refractive index sometimes greater, sometimes less than that of quartz, and the arms of the extinction-crosses of the spherulites are parallel to the cross-wires. It is, hence, an oligoclase. The phenocrysts of plagioclase are more basic, but do not exhibit twinning. The scanty quartz-phenocrysts are strongly corroded. The biotite is in bent flakes, and is strongly absorbtive. The pleochroism and absorbtion are, $\mathfrak{a}$ pale yellow, $\mathfrak{b}$ black, $\mathfrak{c}$ black; $\mathfrak{a} < \mathfrak{b} = \mathfrak{c}$. The magnetite is passing into limonite.

(114) *Tuffaceous, porphyritic rhyolite.*—A compact, yellow-brown rock, porphyritic with fairly numerous quartzes and white felspars up to 3·5 mm. in diameter. The fracture is rough, and weathered surfaces are a dirty-grey. The rock has the appearance of a typical quartz-porphyry.

Quartz, orthoclase, plagioclase, biotite, hornblende, iron-ore, and zircon are developed.

The quartz is, in all respects, like that in (112).

Orthoclase is next in abundance, forming stout, tabular-prismatic grains, slightly resorbed.

The plagioclase is in small, equant crystals, and is not abundant. It is a slightly calcic oligoclase, with a maximum symmetrical extinction of 4°. Carlsbad, albite, and pericline twins occur. It has the spangled appearance before-mentioned, and includes zircon. Some crystals are broken and recemented, others are rounded.

Biotite is scanty and much altered. It resembles that of (104). The plates are sometimes bent.

Hornblende is represented by rare chlorite-pseudomorphs.

The magnetite, surrounded by yellowish earthy haloes, is apparently titaniferous. Zircon is common, and is included in magnetite.

The subfluidal groundmass is rendered yellow by limonite, chlorite, and epidote particles. Suitable illumination reveals innumerable little cuspate bodies, exactly like the collapsed bubbles of many tuffs. The rock is not a tuff, as the groundmass distinctly corroded the quartz and felspar; but these bodies undoubtedly represent an intermixture of tuffaceous material. They have been filled with quartz, and their felspathic walls have devitrified along with the groundmass, which is a microcrystalline mosaic of quartz and felspar; they are, hence, not apparent between crossed nicols.

(117) *Porphyroid tuff* (Pl. xl., fig. 6).—A very tough, compact rock of dark red colour, consisting of scattered grains of quartz and felspar up to 2·5 mm. in diameter, in an even, aphanitic matrix containing occasional, soft, brown patches, which effervesce strongly with acids; even the harder, red part effervesces to a degree. The fracture is smooth but splintery. In hand-specimens, the rock would be taken for a quartz-felspar porphyry. It develops a thin, brown, earthy crust on weathering.

The individualised matter consists of grains and fragments of quartz, orthoclase, calcic oligoclase, bent and ragged flakes of biotite, and grains of magnetite, precisely similar to those in the associated igneous rocks.

The matrix consists of minute, close set, cuspate bodies of exceedingly fantastic forms, representing the collapsed bubbles of a dispersed pumice. They have been subsequently filled with clear quartz, and their walls have devitrified, giving, at first, the false impression that the matrix consists essentially of cuspate quartz-splinters, of extraordinary and impossible forms. The interstices between the bubbles are filled with granular felspar, quartz, and carbonate, in variable proportions, carbonate becoming dominant in some patches. The interstitial material is very thickly clouded with limonite-dust, which gives the rock its red colour. Consolidation has evidently been brought about by the introduction of quartz and carbonate.

Texturally, the rock bears a close resemblance to the porphyroid tuff of Steimel, near Schameder, Westphalia (Lossen, 1883), and to the andesitic tuff from the Old Red of Inverinan, Argyllshire (Kynaston, 1901), but differs from both in several important respects.

HUDSON'S PEAK.

(390) *Porphyritic pitchstone.*—A black aphanite, with a pitch-like lustre, and a very rough, subconchoidal to hackly fracture; extremely brittle.

Plagioclase, hypersthene, biotite, magnetite, zircon, and apatite occur.

The plagioclase is strongly zoned, and appears to change from labradorite within to andesine without. There was one well-marked change, followed by several minor oscillations. There are cavities and inclusions in the outer zones. Carlsbad, albite, and pericline twins occur, as well as complex aggregates. Apatite, zircon, biotite, hypersthene, and magnetite are included.

The hypersthene is in rounded grains, of very weak colour and pleochroism, but of negative sign. It includes zircon, apatite, and small felspars, and is partly moulded on, but mostly includes magnetite.

Biotite is strongly pleochroic, includes zircon and apatite, and is moulded on to magnetite.

Magnetite, zircon, and apatite are not remarkable.

The groundmass is very strongly fluidal, consisting of alternating streaks of yellow-brown, and colourless glass differing in their refractive indices, and, seemingly, representing a residuum in the act of splitting into two immiscible fractions. It contains fragments of a foreign, trachytic rock.

The rock is interesting in that it shows the order of crystallisation, which is :—

Apatite }
Zircon }
Magnetite
Hypersthene
Biotite
Plagioclase

The position of biotite is uncertain.

The fragmentary evidence afforded by the other rocks agrees with this order.

(162) *Felspathic andesite.*—A fresh-looking, yellowish to reddish-brown rock, porphyritic with numerous, glassy yellow felspars up to 2 mm. long; fracture fairly smooth, but splintery. The specimen studied contains a small fragment of a foreign, black, cherty rock.

Plagioclase, magnetite, zircon, and apatite are developed. Femic minerals are represented by occasional doubtful pseudomorphs.

The plagioclase is an andesine, twinned on the Carlsbad, albite, and pericline laws. It is well zoned, passing from a basic kernel, through several oscillations, to an acid margin. It is slightly spangled by resorbtion-cavities, and the centres of some crystals are partly replaced by chlorite, epidote, and sericite. Some of the crystals are broken and recemented. Magnetite, zircon, apatite, and, in one place, vestigial hornblende(?) are included. Corrosion by the groundmass is very slight.

Scanty pseudomorphic aggregates of quartz, chlorite, and epidote, are the sole representatives of pyroxene or amphibole.

Biotite is completely altered and very rare. One piece is represented by a mosaic of secondary quartz and chlorite, through which run thin parallel strings of minute stony inclusions, indicating the original biotite-cleavages.

Magnetite includes zircon and apatite. Zircon is more abundant than apatite.

The groundmass is greatly clouded with limonite, epidote, and chlorite, but a fluidal fabric is still recognisable. It consists, like that of (108), (103), and (105), of a fine mosaic of untwinned plagioclase, more acid than the phenocrysts, and contains small fragments of a foreign trachytic rock (cf.390).

I am indebted to Professor Woolnough for calling my attention to this rock.

KNOCKFIN.

(391) *Porphyritic rhyolite.*—A very fresh, light pinkish-brown rock, porphyritic with fairly plentiful quartzes and pink felspars up to 2·75 mm. in diameter. The fracture is smooth, but irregular and splintery, and small fragments are milky and translucent on thin edges. In hand-specimens, the rock would be classed as a quartz-porphyry.

Quartz, felspar, biotite, magnetite, and zircon occur.

The quartz is strongly corroded, and has many inclusions and inlets of the groundmass.

Two felspars are developed, but twinning is only feebly expressed, and suitable comparisons of refractive index were not obtained. One is optically negative, and forms simple Carlsbad-twins. It is, doubtless, orthoclase. The other is optically positive, multiply twinned, with low symmetrical extinction-angles, and seems to be albite-oligoclase. It is slightly spangled. Carbonate-replacement occasionally occurs.

Biotite is exceedingly rare.

A few grains of zircon are present, while magnetite is scarce.

The groundmass is fresh-looking, slightly cloudy, and strongly fluidal. It has devitrified to a fine, quartz-felspar mosaic. The felspar preponderates over quartz, has a refractive index lower than that of quartz, and is in fibrous aggregates, sometimes spherulitic, but more often forming long strings with the fibres transverse to the lines of flow. The slight cloudiness of the felspar reveals the fluidal fabric. In some respects, this rock resembles (114).

Review and Conclusions.—Viewed collectively, the igneous rocks above-described present many features of interest.

The question of the mode of origin of these rocks is one on which little can be said. From internal evidence, the writer was disposed to think them all to be volcanic, but Professor David states, "recently I have examined further sections in the neighbourhood of Wallarobba (between Martin's Creek and Dungog), and found, close to the Wallarobba Station, a most interesting section showing Martin's Creek Andesite strongly intrusive, as a sill, into the Carboniferous sedimentary rocks. Since seeing this section, I have now no doubt whatever that, at Martin's Creek also, the rock is strongly intrusive. . . . . . There can be no doubt, I think, that sill-structure is much more extensively developed in the Carboniferous rocks than we had previously any idea of."*

Mr. W. N. Benson also writes to me, concerning the hypocrystalline hypersthene-andesite of Duri Peak, near Currabubula, "I believe it to be part of a great sill of several miles in extent, and several hundred feet in width, but I have not finished field-work thereon."†

In the face of this evidence, it is unsafe to make any assertions based on microscopical information, unsupported by field-relations. Nevertheless, the frequent occurrence of tuffs and tuffaceous sedimentaries, renders the occurrence of lavas also in the highest degree probable.

This uncertainty of origin introduces difficulties of nomenclature. For the sake of uniformity, however, it has been thought of advantage to adhere to the volcanic names hitherto used for these rocks. Greater precision can be attained only with increased knowledge of field-relations.

The rocks are all subalkalic in character.

The proportion of ferromagnesian to salic minerals in the phenocrysts is small, except in (113): and where devitrification has revealed the nature of the groundmass, the proportion in the whole rock is seen to be much smaller. This poverty in femic material has been noticed in the Pokolbin rocks (Browne and

* Letter to author, February 23rd, 1915.

† Letter dated March 26th, 1915.

Walkom, 1911), and in those of the Bingara-Barraba district (Benson, 1913, Pt. iii.).

The effects of physical instability in the magma (Harker, 1909, Ch. ix.) are widespread in the rocks described, but have not been noted elsewhere in the series, except in the quartzes of Pokolbin. The corrosion of the quartzes and felspars was probably due to the sudden change from plutonic conditions on eruption, but the resorbtion of the hornblendes and biotites, and the zoning of the felspars were undoubtedly intratelluric.

In four rocks, from three localities, *the groundmass has the exact composition of a felspar, being a devitrified felspar-glass.* A similar feature has been observed in a devitrified obsidian from Mount Alford, Queensland, (Wearne and Woolnough, 1911, p.154) but I am unable to find record of the phenomenon elsewhere.

Combined with the low ferro-magnesian content of the rocks under consideration, it indicates that *they are trachytic in composition, though andesitic in habit.* Trachytes are notably absent from the collection studied, though present in the similar assemblages of Pokolbin (Browne and Walkom, 1911), and Tangorin (Walkom, 1913).

According to the criteria established by Iddings, the quartz of all the acid rocks crystallised rapidly

The accessories are interesting; the iron-ore is probably all titaniferous (Walkom, 1913; Jaquet, 1901). Zircon is remarkably abundant (cf. Benson, 1913, Pt. iii.), while apatite is exceedingly rare, except in (390).

The felspars are all comparatively fresh, and singularly free from the ordinary types of alteration. On the whole, they are more acid than those in the Pokolbin rocks.

The pyroxene-amphibole-mica àndesites of Martin's Creek, Paterson, and Eelah, are so exactly alike, except in their degrees of weathering and the consequences thereof, that I have no hesitation in stating that they are derived from the same magma-fraction. The similarity of the resorbtion-effects in both rocks makes it highly probable that they were erupted at the same time.

In the rocks from Eelah, the extent of intratelluric crystallisation, represented by the proportion of phenocrysts to groundmass, was moderately great in the basic members, greater in the intermediate, and slight in the acid. In the basic rocks, centres of crystallisation were few, but the crystals large; in the intermediates, centres were numerous, but the crystals small.

In conclusion, I wish to express my thanks to Professors David and Woolnough for advice and assistance in my work. I would also urge that the mapping already carried out in the Clarencetown district (Jaquet, 1901) be extended to the Hudson's Peak-Eelah district, as much depends on the relation between these two areas. The North Coast Railway should also be traversed while the cuttings are yet fresh. Excellent sections are exposed, especially around Paterson, and between Stroud Road and Dingadee.

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* *Fide* Harker. † *Fide* Rosenbusch.

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(Very little geological literature is obtainable in Perth as yet.)

EXPLANATION OF PLATE XL.

Fig. 1.—Pyroxene-andesite; Eelah, (103); crossed nicols, showing coarsely devitrified plagioclase-groundmass; (×24).

Fig. 2.—Same rock; ordinary light; (×24).

Fig. 3.—Pyroxene-amphibole-mica andesite; Martin's Creek, Paterson, (108); crossed nicols; showing finely devitrified plagioclase-groundmass; (×24).

Fig. 4.—Hypersthene-andesite; Eelah, (113); ordinary light; (×24).

Fig. 5.—Plagioclase (oligoclase-andesine) with kernel replaced by chlorite in (105); ordinary light; (×28).

Fig. 6.—Porphyroid tuff; Eelah, (117); ordinary light; (×24).

FRESHWATER ALGÆ OF THE LISMORE DISTRICT: WITH AN APPENDIX ON THE ALGAL FUNGI AND SCHIZOMYCETES.

By G. I. Playfair, Science Research Scholar of the University of Sydney in Hydrobiology and Plankton.

(Plates xli.-xlvi.; and 11 figures in the text.)

In a previous paper,* I gave some account of the freshwater algæ and algal fungi of the Richmond River at Lismore. The following pages are concerned with forms found on land.† The majority of the latter were collected, during 1914, from lagoons, swamps, rainwater-pools, and roadside-ditches almost entirely within the boundaries of the city of Lismore. The following Table shows the general character and composition of the alga-flora of these swamp-waters compared with that of the River.

Algæ.	Land.	River.	Additional.	Total.
Phæophyceæ	7	—	7	7
Chlorophyceæ....... ...	82	57	62	119
Desmidiaceæ	116	57	99	156
Heterokontæ	2	—	2	2
Bacillarieæ..............	36	134	14	148
Myxophyceæ	30	38	11	49
	273	286	195	481
Algal Fungi.				
Chytridiaceæ	12	6	9	15
Schizomycetes	13	13	3	16
	308	305	207	512

The first column gives the total number of forms observed on land, the second the total from the river (*l.c.*, p.95). Records

* "Contributions to a Knowledge of the Biology of the Richmond River," These Proceedings, 1914.

† Six additional forms, four new, are included from the River.

for the district additional to those from the river occupy the third column, and the fourth shows the totality of the forms recorded from the Lismore district. As the latter, for the purposes of this paper at any rate, is all included within a circle two miles in diameter, I think the grand total of 512 may be considered indicative of a very rich area.

Samples.—Nos.176-178, 186-188, 190-193, 195-197, 201, 225, are out of weeds in the river or creeks; 185, 240, swamp on Woodlawn Road; 223, 241, 260, 261, lagoon behind Foley's; 227, ditto at Woodburn; 236, 237, 259, ditto near North Lismore Station; 238, 254, 255, 258, ditto near Cemetery, Goolmangar Road; 233, rainwater pools, Woodlawn Road; 242, 243, ditto near Girard's Hill; 244, 246, 251, ditto near Drill Hall; 245, 247, ditto in Conway Street; 248, 249, ditto on Wyrallah Road; 250, ditto near Convent; 253, ditto North Lismore. The following are in the form of mucous strata: 202, river-bank, Coraki; 199, 208, open drain, Keen Street; 206, on curbstone at Nisbet's; 207, open drain near Cathedral; 211, 221, 228, 229, 232, ditto in Carrington Street; 226, ditto in Terania Street; 231, 252, ditto near Presbyterian Church; 210, on zinc-footwasher; 205, 209, horse-trough near Post Office; 212, ditch in Conway Street; 213, 230, ditch in Magellan Street; 256, 257, on rocks, New Cut.*

Chlorophyceæ.—There is the same extraordinary dearth of *Protococcaceæ* in the swamps and lagoons of the district as in the river-system, in striking contrast to their prevalence round Sydney, where I have obtained them in such quantities as to make the water, in which they were, quite gelatinous. All the usual genera, however, were observed. On the other hand, the *Volvocaceæ* are well represented and plentiful (in the rainy season especially), as was the case also with the green flagellate infusoria. Out of a total of 82 forms of *Chlorophyceæ* noted, no less than 31 (or nearly 40%) belong to the *Volvocaceæ*, representing nine genera, viz., *Carteria*, *Chlamydomonas*, *Phacotus*, *Pteromonas*, *Gonium*, *Pandorina*, *Eudorina*, *Volvulina* gen.nov., and *Volvox*. Indeed, the predominance of the green flagellates (both

* The numbers, 176 to 261, correspond to samples preserved in the National Herbarium, Botanic Gardens, Sydney.

algal and infusorial) is characteristic of the district, just as the predominance of the diatoms is of the river. Not a sign of the *Phytheliece* was seen, though repeated gatherings were made from shallow meres on grassland, which are said to be their favourite haunt. Out of a total of 119 forms of *Chlorophyceæ* from swamp and river, only 20 were common to both.

Phæophyceæ.—The absence of *Dinobryon*, which was remarked in the river, is noticeable also in the swamp-waters. Only two small fragments were observed. *Synura* was plentiful. *Chloromonas*, as usual, frequently present in gatherings but always sparsely discributed. The most interesting item in this Class, however, is the discovery* of a large and handsome flagellate resembling *Volvox*, but corresponding in structure and characteristics more to my new genus *Volvulina* in the *Volvocaceæ*. To receive this form, it has been necessary to propose a new genus of *Syngeneticæ*, to which I have given the name *Tessella*.

Desmidiaceæ.—The desmids attain to the respectable total of 156 for the whole district, including the river; but, in no case, were they found in abundance. I am inclined to attribute this, as also the deficiency of *Protococcaceæ*, to the character of the soil, which is a fine loam, very deep, so that water does not lie very easily, and the surface dries very rapidly. Most promising lagoons here yield next to nothing in the way of desmids, while in the Parramatta district and the coastal district of Sydney (Botany, Coogee, Centennial Park) where the soil is clay, or sand with rock underlying at no great depth, little patches of swampy ground, where water lies regularly after rain, will often yield a certain set of desmids in profusion. It is noteworthy that the desmids of the river are almost entirely different from those found on land. Out of 156 forms, only 17 are common to both, and of these 11 are varieties of *Closterium*, a genus whose forms seem to flourish equally well in almost any habitat. The 116 forms noted on land represent 13 genera, but only the very commonest. *Netrium*, *Tetmemorus*, *Sphærozosma*, *Phymatodocis*, and *Triploceras* even were not observed. The absence of the last is re-

* Or rather re-discovery, for I noted it first in Sydney, on August 1st 1909.

markable, as its forms are frequent round Sydney, and *Phymatodosis* also is found there locally. As in the river, forms of *Closterium* (29) and *Cosmarium* (30) form the bulk of the desmid-flora, accounting for exactly half, *Euastrum* and *Staurastrum* (11 each), *Penium* and *Xanthidium* (7 each), *Docidium* (6), *Micrasterias* (5), and *Gonatozygon* (4) make up the bulk of the remainder.

Bacillarieæ.—It is strange that the swamp-waters should be so poor in diatoms (plentiful enough round Sydney), especially considering that they bulk so largely in the river. Only 36 forms were met with, representing 13 genera, as against 134 in the river, with 27 genera. Only 22 were common to both, viz., *Pinnularia* (5), *Nitzschia* (4), *Vanheurckia* (3), *Gomphonema* (3), *Cocconema* (2), *Navicula*, *Achnanthes*, *Synedra*, *Stenopterobia*, and *Hantzschia* (1 each). It is curious and interesting to note that, out of 21 forms of *Navicula* (including *Diadesmis*), only one, *Nav. mutica* var. *Göppertiana*, is common to both land and river.

Myxophyceæ. – The township of Lismore is rich in these, chiefly forms of *Oscillatoriaceæ*. In roadside-ditches and concrete water-tables, and wherever there is a regular dribble of water, mucilaginous strata are sure to form. Enmeshed in them may be found certain diatoms in some quantity, sometimes, indeed, in such abundance as to give to the stratum their own distinctive yellow-brown colour. In general also, while consisting principally of one species, they contain others in lesser quantities, *e.g.*:

(26).*L. Lismorensis*, *L. Kützingii* var. *distincta*, *O. formosa*, *O. splendida* var. *amylacea*, and var. *limnetica*, *Ph. tenue*, *Spirulina laxissima*.

Nitzschia palea var. *debilis*, *N. vermicularis* var. *vialis*, and var. *minuta*.

Nav. lanceolata, with var. *curta* and var. *arenaria*.

(27).*Spirulina major*, *O. formosa*, *O. Corakiana*, *O. acuminata*, *O. splendida* var. *amylacea*, and var. *limnetica*, [*O.*] *amphibia* (*Spirillum* filament), *Spirillum volutans*, *Spirulina Corakiana*, *Nitzschia obtusa* var. *scalpelliformis*.

(30). *Phorm. corium*, *Ph. tenue*, *Plect. nostocorum*, *L. Lismorensis*, and var. *nigra*, *Calothrix Braunii*, *Nitzschia subtilis*, and var. *palacea*, *Syn. ulna*.

The first-named, in each case, is the prevailing form.

New forms.—In the following notes, two new genera have been proposed, and 17 species, 33 variations, and 8 forms (58 in all) have been described as previously unrecorded. These are allocated as follows, Algæ(53):—*Phæophyceæ* 5, *Chlorophyceæ* 20 (all but one are *Volvocaceæ*), *Desmidiaceæ* 18, *Bacillarieæ* 4, *Myxophyceæ* 6. Algal fungi (5):—*Chytridiaceæ* 4, *Schizomycetes* 1.

PHÆOPHYCEÆ.

Genus SYNURA Ehr.

SYNURA UVELLA Ehr. (Pl. xlv., f.1, 2.)

Cell. long. 22, lat. 11 μ.

Lismore (242); Wyrallah.

Lemmermann, Plankt. Schwed. Gewass., p.119, describes the test of *Synura uvella* Ehr., as membranous ("membran hautartig") which implies that it is smooth. I have restricted the name, therefore, to such specimens.

SYNURA GRANULOSA, n.sp. (Pl. xlv., f.3.)

Testæ ovato-claviformes, fronte rotundatæ, a tergo attenuatæ; granulis minutis sparsis ornatis.

Cœn. diam. 55-100; cell. long. 35, lat. 10 μ.

Lismore (223, 241, 249, 260, 261).

Synura granulosa is the common *Synura* of this country. The test shows as a granulate hyaline border even in living specimens. In all our forms of *Synura*, setæ are very rarely present. G. S. West, Br. Frw. Alg., p.46, gives the colour of the chromatophores as brownish-green in European specimens of *Synura*, but here they are yellow-brown.

Var. PUSILLA, n.var.

Testæ subglobosæ, minute granulatæ. Cœnobia parva, cellulis paucis.

Lismore (260).

This is a young form of the species, the cœnobia being smaller, the cells few and suborbicular. The cœnobia are formed, of course, by the self-division of (originally) a single individual. It is not uncommon to find specimens consisting merely of two cells tail to tail. In such, the subglobose shape is very distinct; as the cœnobia become larger, the cells become more fusiform.

SYNURA AUSTRALIENSIS, n.sp. (Pl. xlv., f.4, 5.)

Testæ fusiformes, fronte truncatæ, membrana tenui glabra.

Cœn. diam. 70-140: cell. long. 45, lat. 5-8, ap. $2\frac{1}{2}$-3 μ.

Lismore (260, 261).

A very beautiful and distinct species; some magnificent clusters were noted. The membrane is thin and quite smooth; the test does not show as a hyaline border. No marginal setæ, apparently two contractile vesicles on each side below the centre.

Genus DINOBRYON Ehr.

DINOBRYON SERTULARIA Ehr.

Dinobryon is very rare in this district; after over two years' thorough search, I have noted two isolated sprays.

Wyrallah, lagoon.

Var. CONICUM, nom.nov.

Testæ hyalinæ, conicæ, inferne acuminatæ, lateribus leviter arcuatis, ore non everso.

Lismore (260).

Syn., *Dinobryon sertularia* Ehr., forma, Plankt. Syd. Water, p.515, Pl.57, f.5.

TESSELLA, gen.nov.

Character idem ac speciei.

TESSELLA VOLVOCINA, n.sp. (Pl. xlv., f.6, 7.)

Cœnobium molle, mucosum, sphæricum, cavum; e strata unica cellularum exstructum, integumento mucoso, minute granuloso, investitum. Cellulæ (ut videtur) pulviniformes, a vertice visæ inæqualiter circulatæ vel polygoniæ, pæne contingentes; a latere depressæ, flagellis binis præditæ. Chloroplastides binæ(?), aut singulæ genuflexæ(?), luteo-fuscescentes vel luteo-virides, granulis magnis (pyrenoidibus ?) aliquot plerumque 3, vesiculis contractilibus aliquot (3-5 ?), instructæ. Stigma rubrum non vidi.

Cœn. diam. 30-170; integ. crass. 4; cell. diam. 10 μ.

Lismore (260).

This interesting Volvox-like flagellate, all the more interesting because it does not seem to belong to the green algæ, is found in lagoons. I first noted it many years ago, at Pott's Hill, near Auburn, but it is distinctly rare. The cœnobium is hollow and flaccid; even when revolving freely, it cannot retain the spherical shape, but gets dented in here and there. It is formed of a single layer of large, cushion-shaped cells, irregularly circular or polygonal when seen from above, and nearly touching. The chloroplasts are yellow-brown or yellow-green in colour, as in *Synura*, in company with which it is often found. The protoplasmic contents of the cells are homogeneous and refractive, and I have never been able to make certain of the shape of the chloroplasts. From above, the cell shows a central clear strip with a parietal chloroplast, or fold of a chloroplast, on each side. There are several large granules present, acting, perhaps, as pyrenoids. A number of rather large pulsating vesicles were observed in each cell; the cystole and diastole are both very slow and gradual. Two flagella noted, but no stigma. I have arranged this form near *Synura* on account of the colour of the chloroplasts.

CHLOROPHYCEÆ.

Fam. ZYGNEMACEÆ.

Genus Zygnema Ag.

Zygnema pectinatum (Vauch.) Ag., forma.

Fil. diam. 26; cell. alt. 60 μ.

Lismore (240).

A form in which the outer sheathing membrane has been ruptured, and the cells are merely adherent by the apices. It seems to throw some light upon the formation of *Debarya*. I have noted the same form from Kogarah (diam. 24, cell. alt. 50-70 μ). The broken sheath may be seen at the angle of one of the cells (Pl. xlii., f. 1).

Genus Spirogyra Link.

Spirogyra crassa Kütz.

Cell. veg. diam. 160-180, alt. plerumque 120-190, interdum 50; membr. crass. 2 μ.

Lismore (249).

Six, narrow, smooth chloroplasts making one turn each. Pyrenoids very numerous, large for the size of the chloroplast, taking up the full breadth or a little more.

Spirogyra Grevilleana var. **australis**, n.var. (Pl. xlii., f.2.)

Forma zygosporis ellipticis acuminatis, præ longitudine valde latioribus.

Cell. veg. diam 30, alt. 160-230. Zygo. long. 75, lat. 50 μ.

Lismore (248).

Cf. *Sp. Grevilleana* (Hass.) Kütz. in Petit, Spir. d. Paris, p.10 Pl. ii., f.1-6, (fig.6 has pointed zygospores); also Borge, Zygnemales, in Pascher, Süssw. Fl. Deutschl., p.17, f.4. The chloroplasts of the vegetative cells are sometimes single, making 5 to 7 turns, sometimes double, making only 2½ turns, the edges scalloped, and pyrenoids very small. Ends of cell reflexed. The zygospores are elliptic with pointed ends, not oval, and much broader in proportion than in the type. Sporangial cells very much swollen.

DESMIDIACEÆ.

Genus Gonatozygon DeBary.

Gonatozygon monotænium DeBy.

Long. 101-144, lat. centr. 11-12, ap. 12 μ.

Lismore (223, 254, 260).

Var. **tenue**, n.var. (Pl. xli., f 1.)

Cellulæ quam forma typica angustiores; apicibus haud expansis in cellulis liberis arcuatis nec planis.

Long. 80-150, lat. centr. 8, ap. 8 μ.

Lismore (223).

The dimensions agree with the lowest of those given by W. & G. S. West, Monog. i., p.30, but the shape of the cells is unusual, the diameter the same from centre to apices, the extreme ends in free cells not flat and incrassate but strongly arcuate and thin-walled as in loose cells of *Mougeotia*. This is most unusual in *Gonatozygon*, and is probably the result of rapidly repeated division.

GONATOZYGON BREBISSONII var. MINUTUM W. & G. S. West.

(Pl. xli., f.2.)

Long. 65, lat. 4, ap. 3 μ.

Lismore (261).

Cf. W. & G. S. West, Br. Desm., i., p.33, Pl. i., f.15. The type also noted. Pl. i., f.16 of the Monograph should be placed under var. *Kjellmanni*(Wille) Rac.; (*Gon. Kjellmanni* Wille, *l.c.*).

Genus PENIUM Bréb.

PEN. MARGARITACEUM var. PULVERULENTUM, n.var. (Pl. xli., f.3.)

Forma puncta-granulis minutissimis sparsis nec in seriebus ordinatis ornata.

Long. 147, lat. 21, isth. 20, subap. 18 μ.

Lismore (185).

The type, with small but distinct granules in longitudinal series, is very rare in this country; I have seen it only once. Var. *irregularius* W. & G. S. West, Alg. fr. Orkneys and Shetlands, p.14, Pl.i., f.23 (by clerical error, var. *irregulare* in G. S. West, Alg. Yan Yean Res., p.53) has larger granules irregularly disposed. In this form, on the other hand, the granules are minute, indeed hardly noticeable at the edges. Membrane very faintly rufescent, almost hyaline.

Var. INDIVISUM, n.var. (Pl. xli., f.4, 5.)

Forma haud constricta, isthmo nullo, polos versus leviter attenuata; lateribus planis parallelis, vel levissime arcuatis, apicibus rotundatis subtruncatis; membrana puncta-granulis minutissimis sparsis ornata, dilutissime luteola vel hyalina; chloroplastidibus in medio interruptis.

Long. 74, lat. 20, ap. 17 μ.

Lismore (185). Cum priori.

This form is the result of repeated self-division. A specimen is figured with one end expanded.

PEN. CUCURBITINUM var. SUBPOLYMORPHUM f. CRASSIOR, n.f.

Forma paullo major quam forma typica, præ longitudine paullo latior; apicibus rotundatis nec subtruncatis.

Long. 25, lat. 50 μ.

Lismore (185).

A form somewhat larger and slightly broader than Nordstedt's type, Frw. Alg. N.Z., p.71, Pl.7, f.20. For a length of 95 μ, his figure gives a breadth of $42\frac{1}{2}$ μ, which agrees with specimens gathered by Lütkemüller in Austria (Desm. d. Attersees, p.8). The latter gives long. 96-100, lat. 40-42, lat. constr. 36 μ. In the very slight constriction, however, our form resembles the type. (Pl. xli., f.6.)

Genus CLOSTERIUM Nitzsch.

CLOSTERIUM SPETSBERGENSE var. PALUSTRE, n.var. (Pl. xli., f.7.)

Forma gracilior, juxta polos acutior; latere dorsali plano pæne usque ad polos, quam levissime recurvato in extremis; latere ventrali arcuato polos versus pæne recto; apicibus truncatis incrassatis; membrana hyalina, glabra, punctis nullis nec striis.

Long. 275, lat. 34, ap. 7-8 μ.

Lismore (185).

Cf. *Cl. Spetsbergense* Borge, Süssw. Alg. Spets., p.8, fig.5, of which the author remarks that a very closely connected form is *Cl. lanceolatum β coloratum* (Klebs) Playf., Some Syd. Desm., p.604 Pl. xi., f.1. From the figures in W. & G. S. West, Brit. Desm., i., however, it is evident that the latter is not *Cl. lunula β coloratum* Klebs, which it was supposed to represent. It might stand, therefore, as *Cl. Spetzbergense* var. *australe* mihi. For the type, Borge gives: Crass. cell. 40-46 μ, crass. apic. 6-7 μ, crassitudine 5-6·5-plo longius. The Sydney specimen figured, *l.c.*, measured 270 × 45, ap. 7-8 μ. Cf. *Cl. lanceolatum* Kütz.(?) in Cleve, Sveriges Söttv. Alg., T. iv, f.7.

CLOSTERIUM ACEROSUM var. CASINOENSE Playf.

Long. 440, lat. 40 μ. Membrana dilute luteola, obscure striata.

Lismore (248).

Cf. Biol. Richm. River, these Proceedings, 1914, p.101, Pl. iii., f.5.

CLOSTERIUM GRACILE Bréb.

Long. 166, lat. 6, ap. 2 μ.

Lismore (254, 260); Wyrallah.

The breadth of our specimens of *Cl. gracile* is nearly always 6 μ, occasionally 7 μ. It is evident from Brébisson's note (Liste, p.155) that the generally accepted type of this species is not what its author had in view. He says "peu attenué aux sommets qui sont légèrement courbés et obtus." The blunt-ended form, therefore, is, strictly speaking, Brébisson's type, and this accounts for the curious shape of the apices in his figures. This point, however, is not mentioned in the Latin description.

Var. ELONGATUM W. & G. S. West.

Long. 300, lat.7, ap.2 μ.

Lismore (223).

Cf. Monog., i., p.168; the authors give lat. 3-4 μ, but, in this country, its breadth ranges from 5 to 8 μ.

Var. BICURVATUM (Delp.) mihi.

Forma *Cl. gracilis* sæpissime bi-undulata, apicibus obtusis truncatis.

Long. 265-400, lat.6, ap.3 μ.

Lismore (260). Cum f. typica.

I first obtained this form many years ago in profusion, from weeds out of a tank in the Botanic Gardens. There is no doubt of its being *Cl. bicurvatum* Delp., Desm. Subalp., ii., p.209, T.18, f.37-39. The hollow back, which makes it bi-undulate, and the blunt ends sufficiently characterise it. It is also certainly a form of *Cl. gracile*, cf. Borge, Feuerland u. Isla Desolacion, p.30, fig.6. *Cl. toxon* West, in Monog. i., p.160, Pl.20, f.13, 14, is really a *forma crassior* of this variation.

Var. SUBSTRIGOSUM (Rac.) mihi. (Pl. xli., f.8.)

Forma *Cl. gracilis* apicibus subrostratis, extremis acutis.

Long. 114-250, lat. 5-6, rarius 8 μ, ap. $1\frac{1}{2}$-2 μ.

Lismore (260).

Syn., *Cl. macilentum β substrigosum* Rac., Desm. Ciast., p.9, T.1, f.38; *Cl. substrigosum* W. & G. S. West, Alg. fr. Burmah, p.192, Pl. xiii., f.19. In this form, the sides do not converge evenly to the apices, but, when a short distance from the tip, the concave side becomes more or less parallel to the other, making the end subrostrate. Not at all uncommon round Sydney, generally mixed with the type. Quite certainly a form of *Cl. gracile*.

CLOSTERIUM PRONUM Bréb. (Pl. xli., f.9.)

Long. 300, lat. 8-10, ap. 2 μ. Membrana luteola, striis nullis. Kyogle.

Brébisson, Liste, Pl. ii., f.42. Not *Cl. pronum* W. & G. S. West, Monog., i., Pl.23, f.1-3(= *Cl. acutum* forma *major*), nor *Cl. pronum* Klebs, Desm. Ostpreuss., p.19, T. ii., f.12a (= *Cl. linea* Perty, f. *major*. The extremities of the cell, it should be noted, are *filiform*, shorter, however, than the part of the semicell in which the chloroplast lies. These details agree exactly with Brébisson's note (Liste, p.157). Moreover, he unites *Cl. pronum* with *Cl. setaceum*, *Cl. Kützingii* and others, in a group characterised as "Corpuscules fusiformes terminés par un long bec sans endochrome (Stauroceras Kütz.)." *Cl. pronum* is quite unlike the forms of *Cl. acutum* with which Klebs classes it; the membrane also is of quite a different character.

CLOSTERIUM KUTZINGII var. CAPENSE Nord.

Long. 285, lat. 15 μ.

Lismore, Kyogle, cum priori.

Desm. Lugduno-Batavi, p.1, f.1, including *Cl. Kützingii* Bréb., *ibid* A small form having, in length, the same range as *Cl. pronum*, in company with which it is nearly always found here. It is more inflated, however, in the centre, the breadth varying generally from 14-16 μ, with about the same relative proportions of body and rostrum as in *Cl. pronum*. Biologically, indeed, it is a form of that species. The membrane is usually faintly yellowish and clear, occasionally distinctly striate.

CL. PRÆLONGUM Bréb. (Pl. xli., f.10.)

Long. 565-770, lat. 14-20, ap. 4-5, subap. 6 μ.

Lismore (223, 225, 254, 259, 260).

This species is characterised by W. & G. S. West, Monog., i., p.165, as one of the rarest species of the genus. It is not uncommon, however, at Lismore, especially in shallow meres and pools on grassland, and is not infrequent round Sydney. Australian forms differ from the European in being less regularly arcuate, much straighter in the back, and suddenly bent in, about one-third of the distance from the ends. Also particularly in the tip, which is only the very slightest bit recurved (not at all as in Monog. i., Pl.21, f.1-3). The membrane is nearly always pale yellow or pale buff, and not striate.

Forma BREVIOR West.

Long. 162-345, lat. 18, ap. 4 μ. Membrana dilute luteola.

Lismore (223, 236, 254).

Cf. *Cl. prælongum* var. *strigosum* (Bréb.)(?), these Proceedings, 1908, p.605, Pl. xi., f.3; which gives a good idea of Australian forms of *Cl. prælongum*, but the extreme tip should be very slightly recurved. I doubt very much if the form figured, *l.c.*, is identical with *Cl. strigosum* Bréb.; it is a specimen of *Cl. prælongum* f. *brevior* West, in which the tips are quite straight, not recurved at all. The dimensions may be taken as including f. *brevior*, as my description says "apicibus . . . . nonnunquam levissime reflexis." There is no real difference either between f. *brevior* and *Cl. tumidum* Johnson; they are only degrees in reduction; the recorded length of *Cl. tumidum* overlaps that of f. *brevior*, and the length of the latter runs right up to the type. They all three have the same range of breadth; *Cl. prælongum* lat. 14-24, f. *brevior* 16-24, *Cl. tumidum* 18-24 μ are my records.

CLOSTERIUM TUMIDUM Johnson.

Long. 150-180, lat. 23-24, ap. 5-6 μ. Membrana dilute luteola.

Lismore (236). Cum priori.

Cl. tumidum Johnson (syn., *Cl. cornu* in Wille, Fersk. Nov. Semlja, T. xiv., f.80, 81) is biologically a form of *Cl. prælongum* very much reduced by repeated self-division. I find it always in company with forms of that species. The membrane and apices also are of the same character in both. Repeated division immensely reduces the length of the cell without alteration of the breadth.

Genus Cosmarium Corda.

Cos. rectangulare var. nodulatum f. minor Playf.

Long. 40, lat. 31, ap. 12, isth. 10 μ. Noduli apicales abfuerunt.

Lismore (185).

Cf. Polym. and Life-hist., p.476, Pl.iii., f.5. The apical nodules are sometimes wanting in these forms of *Cos. rectangulare.* (Pl. xli., f.11*a*).

Cos. rectangulare var. Boldtii f. minor, n.f. (Pl. xli., f.11*b*.)

Forma minor, angulis basalibus magis rotundatis; lateribus e basi levissime divergentibus.

Long. semic. 12, lat. 22, ap. 10, isth. 10 μ.

Lismore (185).

Found only as companion-semicell to one of the previous form (nodules present, however). *Cos. rectangulare* forma, Boldt, Desm. Grönl., T. i., f.18, to which I gave the name var. *Boldtii* in Some Syd. Desm., p.613, measured 43-44 × 34-36 μ. This form, though only about one-half the size, is almost exactly like Boldt's figure.

Cos. rectangulare var. biretum, n.var. (Pl. xli., f.12.)

Forma parva; semicellulæ inæqualiter hexagonæ; e basi plana lateribus levissime divergentibus (paullo magis quam in var. *Boldtii* f. minore) ad apices rapide convergentibus; apicibus truncatis paullulo productis; angulis lateralibus latissime-rotundatis, basalibus obtusis; isthmo angusto. Membrana levis infra apicibus papillis singulis interdum ornata.

Long. 25, lat. 22, basis 19, ap. 8-9, isth. 6 μ.

Lismore (185).

Forma rectilinearis, n.f. (Pl. xli., f.13).

Forma lateribus rectis, apicibus non productis, angulis lateralibus obtusis nec rotundatis.

Long. 27, lat. 22, basis 19, ap. 8, isth. 6 μ.

Lismore (185).

Forma angustior, n.f. (Pl. xli., f.14.)

Forma angustior, parte superiore laterum retusa.

Long. 26, lat. 20, basis 16, ap. 8, isth. 6 μ.

Lismore (185).

Something like *Cos. (Eu.) leiodermum* Gay, Conj., p.58, Pl. i., f.16, which itself is a form of *Cos. rectangulare* Grun. Differs from *Cos. rect* var. *africanum* W. & G. S. West, Alg. Centr. Afr., p.377, Pl.361, f.14, in having the upper part ot the sides retuse. Var. *biretum* and its forms are all closely connected with var. *Boldtii*. f. *minor*, *supra*, indeed are merely modifications of it; and their association, in the same gathering with the mixed form of var. *nodulatum* and var. *Boldtii* f. *minor*, shows quite plainly how smaller forms, with new characteristics, are produced from a very different type by repeated self-division.

Cos. RECT. var. QUADRIGEMINATUM f. LATIOR, n.f. (Pl. xli., f.15.)

Forma paullo minor. Semicellulæ quam f. typica paullo latiores; apicibus nodulis 4 (fronte cernendis 2) aut infra marginem, aut protrusis, instructis; a latere globosæ apicibus nodulis 2 (cernendis) ornatæ.

Long. 36, lat. 28, basis 23, ap. 12, isth. 9 μ.

Lismore (185).

Syn., *Cos. rect.* var. *Cambrense* (Turn.) W. & G. S. West, forma, Polym. and Life-hist., p.476. This form falls better here than under var. *Cambrense*, as the latter is a form with square semicells.

Cos. RECT. var. ANGUSTIUS f. MINOR, n.f. (Pl. xli., f.16.)

Forma dimidio minor. Semicellulæ inæqualiter hexagonæ, parte superiore arcuata angulata; angulis lateribus pæne centralibus; lateribus haud retusis; apicibus truncatis angustis. Vertice visæ ellipticæ polis acuminatis.

Long. 16, lat. 12, basis 10, ap.4, isth. 2 μ.

Lismore (185).

Cf. Nordstedt, N.Z., Pl. vi., f.15, 16. The figures of *Cos. pseudoprotuberans β angustius* Nord., contain two distinct types. Of these, the lower semicell of f.15 and the upper semicell of f.16 are identical with *Cos. rect.* var. *Finmarkiæ* Playf., Polym. and Life-hist., p.478, Pl. xiii., f.13. The other semicells, with angular apices, I have arranged as *Cos. rect.* var. *angustius* (Nord.), *l.c.*, p.477.* The latter is certainly a form of *Cos. rectangulare.* The

* The note at the top of p.478—" this really goes under var. *repandum*. . . . . . Its sides are not so sloping as in var. *Finmarkiæ* "—is evidently erroneous. I must have had some other form in mind. Var. *angustius* is quite close to var. *Finmarkiæ*.

form under consideration somewhat resembles *Cos. sexangulare* f. *minima* Nord. It is of the same size, but the apices are narrower, and the sides not at all retuse; the lateral angles also opposite the centre of the semicell, higher rather than lower. Cf. Nordstedt, N.Z., p.60, Pl. vii., f.26, 27; W. & G. S. West, Monog. iii., p.82, Pl.72, f.4, 5. It should be remembered that *Cos sexangulare* Lund., and *Cos. sulcatum* Nord., are themselves, biologically, forms of *Cos. rectangulare* Grun., cf. Polym. and Life-hist, p.481-2, Pl. xiii, f.20-22. All the above forms, with *Cos. rect.* var. *cyclopeum* Playf. (30 × 24, basis 16, isth. 5 μ)., *l.c.*, Pl. xiii., f.7, were found together in the same gathering; compare my remarks, *l.c.*, p.475.

Cos. PSEUDOPROTUBERANS var. AUSTRALE, n.var. (Pl. xli., f.17.)

Forma major validor. Semicellulæ papillis binis infra apices a fronte non cernendis; a vertice ellipticæ apicibus acuminatis, utrinque in medio papillis binis instructæ.

Long. 50, lat. 42, basis c. 28, isth. 9 μ.

Lismore (185).

With the type, 34 × 28, isth. 6 μ. This large form is not at all uncommon round Sydney, in shallow waters where *Xan. hastiferum* is to be found. It is practically a spineless form of the latter. *Cos. pseudoprotuberans* forma, Borge, Austral. Süssw. Alg., p.23, T.3, f.39, is certainly a form of *Cos. rectangulare*, probably near to, if not identical with, var. *australe*, Playf., Polym. and Life-hist., p.480, Pl. xiii., f.14, 15.

Cos. MONILIFORME var. SUBQUADRATUM, n.var. (Pl. xli., f.18.)

Semicellulæ subquadratæ ubique rotundatæ, apicibus paullo deplanatis; a vertice visæ, orbiculatæ. Membrana glabra.

Long. 30, lat. 18, isth. 3 μ.

Lismore (185).

One semicell was very slightly produced and angulate at each side, a little above the centre. This indicates a connection with *Cos. pseudoprotuberans*. Var. *subquadratum* is intermediate between *Cos. moniliforme* and Jacobsen's form (*Cos. Jacobsenii* Roy). It shows that Nordstedt was right in making the one a f. *elliptica* of the other (Norges Desm., p.22). W. & G. S. West, Monog. ii., p.171, Pl.61, f.26, have just as correctly arranged *Cos. Jacobsenii* as a variation of *Cos. contractum*, as the latter is the base of the whole series. It is an instance of the difficulties that attend the arranging of a lot of closely connected, polymorphic forms, not one of which can be definitely particularised as the direct outgrowth of any other; on a basis, too, partly of outline, and partly of a biological connection which cannot be evaded.

Cos. OBSOLETUM var. SITVENSE f. DENTATA, nom.nov. (Pl. xlii., f.3.)

Long. 54-56, lat. 58-60, isth. 28, crass. 34 μ.

Lismore (185).

Cf. *Cos. obsoletum* var. *Sitvense* Gutw., in W. & G. S. West, Monog. ii., Pl.56, f.4. Neither of Gutwinski's figures, however, (Alg. in Java coll., T.38, f.39, 40) has a tooth at the basal angle, nor is it mentioned in his description, *l.c.*, p.594. The authors of the Monograph are in error, also, in considering the basal angles to be incrassate, with a central pore. The hyaline tip is formed by an extension of the fine outer primordial membrane of the cell, and the supposed pore is a true conical tooth. Cf. Nordstedt, De Alg. Lugd.-Bat., p.7, fig.9. In Gutwinski's figures, this outer membrane is shown separated from the cell-wall all round. The sloughing of this membrane is well known in *Doc. trabecula.* I have observed it also in *Cos. glyptodermum* W. & G. S. West, in which case the marks of the large depressions were plainly visible on it Not only is there a decided tooth at the basal angle in this form, but occasionally from two to four teeth form in a vertical line at the extreme edge, bursting the outer membrane, and giving rise to *Cos. auriculatum*, which is, therefore, a form of *Cos. obsoletum.* A mixed form of f. *dentata* mihi and *Cos. auriculatum* forma was observed. Cf. Pl. xlii., f.5. There is nothing extraordinary either in *Cos. obsoletum* having a tooth at the basal angle; it is found just as decidedly in *Cos. Smolandicum* Lund. Gutwinski's description of var. *Sitvense*, l.c., p.594, says "membrana granulata"; this is a mistake, as his own figures show. The membrane is covered with very coarse puncta-scrobiculæ.

Cos. AURICULATUM Reinsch. (Pl. xlii., f.4,5.)

Long. 57, lat. 57, isth. 25, crass. 30 μ.

Lismore (185).

As I have not access to Reinsch, Contributions, I have had to depend on Turner, Alg. E. Ind., p.50, Pl. vii., f.35, and Pl. ix., f.8. The latter is said by the author to be verrucose, but, as his figure does not show any verrucæ at the margin, the membrane had probably the coarse puncta-scrobiculæ of *Cos. obsoletum* var. *Sitvense* Gutw. Although *Cos. auriculatum* is certainly a form of *C. obsoletum*, yet, on account of its distinct shape, it is best kept separate. *Cos. laticollum* Delp., Desm. subalp., ii., p.116, T.8, f.20-23, *C. erosum* Delp., *l.c.*, Pl.8, f.24-27, and *Cos. suberosum* Gutw., Alg. in Java coll., p.592, T.38, f.36, might all be very well arranged as variations of this type.

Cos. VENUSTUM var. BORGEI, nom.nov. (Pl. xli., f.19.)

Forma lateribus e basi plana ad apices truncatos sensim convergentibus, valde undulatis; lobis lateralibus nullis; lobo apicali rectangulari, lateribus verticalibus parallelis; supra medium granulo instructa.

Long. 30, lat. 22, isth. 4; lob. apic. lat. 12, alt. 6 μ.

Lismore (185).

Syn., *Cos. venustum*, forma, Borge, Nordamerik. Süssw. Alg., p 8, fig.5. The latter gives long. 31-32½, lat. 19-19½, ap. 13-14½ μ as the dimensions. Cf. *Cos. venustum*, forma, Borge, Austral. Süssw. Alg., p.23, T.3, f.40, which is somewhat larger, but is a form of this variety. It is the common Australian form.

Cos. ASKENASYI var. CRATERIFORME, n.var. (Pl. xlii., f.6.)

Semicellulæ crateriformes adpressæ; sinu lineari extrorsum ampliato; basi plana; angulis basalibus latissime rotundatis, granulis paucis sparsis ornatis; lateribus convexis ad apicem convergentibus; apicibus angustis levissime deplanatis. Inflatione(?) supra isthmum.

Long. 158, lat. 126 μ.

Lismore (240).

For the type, see Schmidle, Alg. Sumatra, p.304, T. iv., f.7. This form is very close to the *forma* in Borge, Austral. Süssw.

Alg., p.21, T.3, f.35, but form more regular, base flatter, semicells more adpressed, apex flattened, fewer granules (spines in his form). Cf. also Bernard, Protococc. et Desm., p.113, f.175, and f. *javanica* Gutw., Alg. in Java coll., p.596, Pl.38, f.45(= *Cos.* spec., Möbius, Austral. Süssw. Alg., ii., p.340, T. ii., f.20; long. 110, lat. 94, isth. 43 μ), which is broader in proportion.

Cos. Blyttii var. Lismorense, n.var. (Pl. xlii., f.7.)

Semicellulæ fere rectangulares; apicibus productis, truncatis 4 granulatis; lateribus e basi plana verticalibus, parallelis, 4 granulatis, infra marginem granulis paucis; angulis basalibus superioribusque fere rectis; a vertice visæ, ellipticæ, papillis nullis.

Long. 17, lat. 16, ap. 8, isth. 4 μ.

Lismore (185).

The body of the semicell is transversely rectangular, the apex suddenly produced above, with a marked hollow on each side between it and the upper angles, sides of semicell almost vertical, basal and upper angles almost square, just rounded off; sides and apex 4-granulate, with inner series as in the type. No papilla above isthmus.

Cosmarium Woodlawnense, n.sp. (Pl. xlii., f.8.)

Semicellulæ subtriangulares; basi plana (sinu lineari extrorsum ampliato); angulis basalibus rotundatis; lateribus levissime arcuatis, 5-6 crenulatis, ad apices rapide convergentibus; apicibus angustis, levissime deplanatis, 4 crenulatis. Membrana hyalina, infra marginem serie granulorum, inter apicem et inter mediam semicellulam papillis 3 in triangulo dispositis, ornata. A vertice anguste-oblongæ, granulis minutis in seriebus transversis ornatæ; apicibus late-rotundatis; lateribus arcuatis; utrinque in medio papillis 3.

Long. 32, lat. 34, ap. 10, isth. 10μ.

Woodlawn, river.

The semicells are triangular, with flat base, and slightly depressed narrow apex. Across the sides, run 5-6 rows of minute granules, the margins and apex crenulate. Three large papillæ in a triangle between the apex and the middle of the semicell.

Cos. THOLIFORME Cohn.

Long. 100, lat. 75, isth. 42 μ.

Lismore (185).

Cf. Cohn, Desm. Bongoenses, p.9, T. xi., f.9, semicell inferior. This desmid belongs to a small group of *Cosmaria* which have depressions in the membrane alternating with verrucæ. In this form, the markings on the membrane are arranged in vertical and decussating lines. They are of two kinds; the larger, with indistinct edges, appear to be depressions; the smaller, which focus sharply, smooth verrucæ. Cohn classes them all together as conical papillæ, but the markings on the upper semicell of his figure seem to contradict this. The depressions are first triangular, then irregularly hexagonal, finally circular.

Genus EUASTRUM Ehr.

EU. SINUOSUM var. CAMPANULATUM mihi.

Long. 100, lat. 55-57, ap. 20-21, isth. 12 μ.

Lismore (185, 240).

Syn., *Eu. campanulatum* Playf., Desm. N.S.W., p.176, Pl. iii., f.16.

EU. TURGIDUM var. MOEBII (W. & G. S. West) Playf.

Long. 114, lat. 95, lob. apic. 74, isth. 32 μ.

Lismore (185, 250).

Syn., *Micr. Möbii* W. & G. S. West, Desm. Singapore, p.162. The figures of *Eu. turgidum* Wallich, Desm. Bengal, T.14, f.17, 18, show that the type has a simple apical lobe (not bifid at each side as in var. *Möbii*), Wallich's side-view agrees exactly with mine (for var. *Auburnense* Playf.) in Some Sydney Desm., Pl. xii., f.2. In forms with bifid apical lobes, the apex, in side-view, is much broader.

Genus MICRASTERIAS, Ag.

MICRASTERIAS TROPICA Nord.

Long. max. 125, centr. 114; lat. max. 100, lob. pol. 44, coll. 20, isth. 18; crass. 33 μ.

Lismore (185).

Cf. W. & G. S. West, Alg. fr. Burmah, Pl.14, f.23, and Nordstedt, Desm. C. Braz., Pl.2, f.15*b*. *Micr. tropica* is a form of *M. Mahabuleshwarensis* with a single lateral lobule. Raciborski's three forms, Desm. Tapakoomasees, f.7, 15, 16, also belong to that species. The forms with two lateral lobules are the direct outgrowth of those with one, and those with three are developed from those with two. The peculiar polar lobe with its apical prolongations is characteristic, and every *Micrasterias* having such belongs, biologically, to the same species. *M. euastroides* Joshua, Burmese Desm., Pl.22, f.14, is another variant of *M. Mahabuleshwarensis*, and its *β indivisa* Nord., might, from the point of view of its form alone, be placed under *M. tropica*. Having regard, however, to the variability of all these forms, and especially of *M. Mahabuleshwarensis*, it is perhaps better to keep them as three distinct conventional types.

M. MAHABULESHWARENSIS var. AMPULLACEA (Maskell) Nord.

Long. max. 174, centr. 142; lat. max. 154, lob. pol. 86, coll. 28, isth. 22 μ.

Lismore (187, 193).

Micr. ampullacea Maskell, Trans. N.Z. Inst., 13, Pl. xi., f.6, 7, differs only from *M. Hermanniana* Reinsch, Spec. generibusque, Pl.2, f.B, in having the three lateral lobules thicker, shorter, and more stumpy. A form with the third lateral lobule just started, as figured by Hardy, Vict. Natural., 1905, f.3, is common in this country, and is found here in the river along with the full-grown form.

Genus XANTHIDIUM Ehr.

XANTHIDIUM INCHOATUM Nord. f. (Pl. xlii., f.9*a*.)

Long. semic. 18, lat. 32, isth. 8 μ. Spinis nullis.

Lismore (240).

Cf. Nordstedt, Frw. Alg. N.Z., 1888, Pl. 4, f. 30*a*, semicell. superior. Synonyms of *Xan. inchoatum* are *Ar. Incus* Bulnh., Desm. Sachs., Pl.ix., f.3; *Ar. Incus* forma *a*, Lund., Desm. Suec.; *Ar. Bulnheimii* Rac., Desm. Nowe, 1889, p.23, T. ii., f.17; *Ar. Incus*, "large form," Wolle, Desm.U.S, Pl.24, f.1.

Var. MAMMILLATUM Playf. (Pl. xlii., f.11*b*.)

Long. semic. 20, lat. 40, isth. 6, ap. 28, basis 25 μ.

Lismore (240).

Cf. Some Sydney Desm., p 619, Pl. xii., f.6.

Var. CRACOVIENSE (Rac.) mihi. (Pl. xlii., f.9*b*, 10.)

Forma semicellulis *Cos. pseudoprotuberanti* similibus, latioribus autem; sinu lineari, aut angusto introrsum ampliato; angulis superioribus magis subapicalibus.

Long. 36-44, lat. 32-44, basis 20-24, isth. 8 μ.

Lismore (240). Cum prioris duabus.

Syn., *Cos. contractum* var. *Cracoviense* Rac., Desm. Polon., p.28, T. x., f.10. Found also as a mixed form with *X. inchoatum*, f., *supra*. However much this may resemble *Cos. pseudoprotuberans*, it is quite certainly a spineless form of *X. inchoatum*, produced, as were the forms with it, by repeated self-division. We are here faced by a serious difficulty in the nomenclature, viz., what to do with these pseudo-*Cosmaria*, a large number of which are included in the genus *Cosmarium*, but are, biologically, forms of *Xanthidium*, and can be found as *formæ mixtæ* with semicells of that genus.

Var. ALPINUM (Rac.) mihi. (Pl. xlii., f.11*a*.)

Long. semicell. 18, lat. 38, basis 25, isth. 6 μ.

Lismore (240). Cum precedentibus quattuor.

Syn., *Cos. pseudoprotuberans* var. *alpinum* Rac., Desm. Polon., p.27, T. x., f.11. The latter is very much smaller (long. = lat. = 10·5-12·5, isth. 6·5 μ, Rac.), but agreeing so exactly in shape with our form that I thought it best to accept the name. The equality of length and breadth also is characteristic of *Xan. inchoatum* and its forms.

Genus STAURASTRUM Meyen.

ST. TONSUM (Nord.) mihi.

Long. 46-54, lat. 70-88, bas. infl. 18-20, isth. 11 μ.

Lismore (185).

Syn., *St. pseudosebaldi* tonsum* Nord., Frw. Alg. N.Z., p.36, T.4, f.4. The form agrees almost exactly with the lower semicell of Nordstedt's specimen. Others with more slender processes were noted also. The inflation in the centre of the semicell shows that it is a reduced form of *St. assurgens.* The *formæ immaturæ* figured by me, Desm. N.S.W., p.192, Pl.v., f.31, are very similar forms; the dimensions there given, viz., long. 36-42, lat. 50-70, taken with those above, exactly tally with Nordstedt's.

Genus ONYCHONEMA Wallich.

ONYCHONEMA FILIFORME (Ehr.) R. & B. Bisset. (Pl. xli., f.20.)

Long. cell. 12-16, lat. 16-22, isth. 2-3 μ.

Lismore (185).

Syn., *Sphærozosma filiforme* (Ehr.) Ralfs; *Onych. Nordstedtianum* Turner, Alg. E Ind., p.139, Pl.17, f.17. Forms, much broader than generally given, were observed. Filaments are occasionally seen with the cells separated from one another, attached only by the tips of the clasper-processes.

ONYCHONEMA LÆVE var. MICRACANTHUM Nord. (Pl. xli., f.21.)

Long. cell. 20, lat. 30 μ.

Lismore (185).

Cf. Nordstedt, Desm. C. Brazil, T.3, f.34; Alg. Lugd.-Bat., p.3. This species is, biologically, the fully developed form of *O. filiforme.*

PROTOCOCCOIDEÆ.

Fam. VOLVOCACEÆ.

Genus CHLAMYDOMONAS Ehr.

Including *Chloromonas* Gobi. Gobi has segregated forms of *Chlamydomonas* which have no pyrenoids, into the genus *Chloromonas.* But, in all the *Protococcoideæ*, the presence or absence of pyrenoids depends entirely on the nutrition of the cell. Moreover, even when absent, the pyrenoids are often represented by a greater or less number of scattered, irregularly-shaped, amylaceous granules which seem to carry on the functions of a pyrenoid.

CHLAMYDOMONAS GLOBULOSA Perty. (Pl. xlii., f.12.)

Diam. 14-28 μ.

Lismore (236, 237, 242, 244, 247, 253, 258).

Chl. pulvisculus Stein (*non* Ehr.), Flagellaten, Pl. xiv., f. vii.; *Chl. Pertyi* Goroschankin, Chlamydomonaden, Pl. ii., f. 13. Spherical, generally without anterior papilla, pyrenoid circular, quadrate or transversely oblong. Occasionally, the enveloping membrane grows faster than the body, and shows as a rim all round. Mother-cells with 4, more rarely 8, autospores observed. Goroschankin, quoting Rabenhorst, gives the diameter as 32-42 μ; the dimensions of our specimens are just half these figures. Wille, Gatt. Chlamyd., p.150, gives diam. 9-22 μ, generally 14 μ.

CHLAMYDOMONAS MONADINA (Ehr.) Stein. (Pl. xlii., f.13.)

Diam. 26 μ.

Lismore (248). With *Chl. globulosa* (258).

Syn., *Chl. Braunii* Gorosch., Chlamyd., T. xiv., xv. Spherical, generally without a papilla, pyrenoid band-shaped. Probably a form of *Chl. globulosa* Perty. Cf. Stein, Pl xv., f.39. Very much rarer than the foregoing.

CHLAMYDOMONAS INTERMEDIA Chodat.

Long. 20, lat. 15 μ.

Lismore (242).

Oval or oblong-oval in shape, generally without papilla. Cf. Chodat, Hist. d. Protococc., Pl. 22, 23; Wille, Gatt. Chlamyd., T. iv., f.15; Playfair, Syd. Water-Supply, Pl.57, f.14, 15 (size 13 x 10 μ). Chodat, Alg. Vertes, p.135, gives dimensions (length?) 18-20 μ.

CHL. GLŒOCYSTIFORMIS var. AUSTRALIS, n.var. (Pl. xliv., f.10.)

Membrana oblonga, hyalina; cellula ipsa ovata, fronte angustata, pyrenoidibus singulis sphæricis.

Membr. long. 20, lat. 14; cell. long. 12, lat. 9 μ.

Lismore (230).

Cf. *Chl. glœocystiformis* Dill, in Chodat, Alg. Vertes, p.133, f.61-ix., and in Wille, Algol. Notizen xi., T. iv., f.17. I observed the type in Sydney. Bernard notes it from Java.

CHL. PISIFORMIS Dill. (Pl. xliv., f.11.)

Long. 20-25, lat. 12-13, papill. long. 1-2, lat. 2 μ.

Lismore (236).

Cf. Dill, Chlamyd., p.14, T.5, f.13-19; Wille, Gatt. Chlamyd., p.138, T. iv., f.8. The latter gives dimensions, long. 18-24, lat. 11-14 μ. The papilla in this species is apt to mislead. From the front, it is sometimes very indistinct, showing as a short truncated cone, but, from the side, it is quite evident and appears as a short, rod-like projection (long. 1-2, lat. 1 μ) unlike that of any other species. All the forms of *Chl. pisiformis* were alike in this respect.

Var. CYLINDRACEA, n.var. (Pl. xliv., f.12.)

Cellulæ oblongæ vel cylindraceæ nec postice attenuatæ; angulis rotundatis; ceteris ut in f. typica.

Long. 16-26, lat. 11-16 μ.

Lismore (236, 246, 247, 248, 260).

Probably the mature form of the type, which is more or less cylindrical in front but attenuate behind. As in all species of *Chlamydomonas*, the pyrenoid is sometimes wanting. This form is too short for *Chl. grandis* Stein, Flagellaten, Pl. xv., f.47, 49, (long. 28-40, lat. 8-12 μ in Wille, *l.c.*, p.146) which is the only strictly cylindrical species, and which besides has two pyrenoids to the cell. From *Chl. Steinii* Goroschankin, (founded on Stein's *Chl. grandis*, Pl. xv., f.48, cf. Goroschankin, Chlamyd, Pl. ii., f.1, 2) it is distinguishable by the absence of the longitudinal ridges in the chloroplast.

Var. OVALIS, n.var. (Pl. xliii., f.1; Pl. xliv., f.13.)

Forma ovalis; ceteris ut in f. typica.

Long. 16-22, lat. 12-17 μ.

Lismore (236, 247). Wyrallah. Cum priori.

Var. OBESA, n.var. (Pl. xliv., f.14, 15.)

Forma oblonga præ longitudine latior, angulis late-rotundatis; ceteris ut in f. typica.

Long. 12-22, lat. 10-16 μ.

Lismore (236, 248, 260). Cum prioris duabus.

This and the preceding form are certainly growing forms of the type.

CHL. DEBARYANA Gorosch., f. (Pl. xliv., f.16.)

Long. 14, lat. 12 μ. Pyrenoidibus nullis visis.

Lismore (236).

Cf. Gorosch., *l.c.*, p.106, Pl. i., f.9; Wille, *l.c.*, p.141, T.iv., f.14. *Chl. DeBaryana* is ovate, with a large protruding papilla in front; long. 12-20 μ Gorosch. As found here, it is certainly a young growing form of *Chl. pisiformis* Dill.

Genus CARTERIA Diesing.

CARTERIA OVATA, n.sp. (Pl. xliv., f.17.)

Cellulæ ovatæ fronte late-rotundatæ non excavatæ, postice attenuatæ acutæ; chloroplastidibus non observatis; endochromate denso granulato; pyrenoidibus (ut videtur) nullis.

Long. 16, lat. 12, flagell. 4, circa 15 μ long.

Lismore (259).

Obtained, as usual in this genus, from rainwater pools, in some quantity.

Genus PTEROMONAS Seligo.

PTEROMONAS ALATA var. AUSTRALIS, n.var. (Pl. xlii., f.14)

Cellulæ ipsæ ovatæ, fronte attenuatæ acuminatæ, postice late-rotundatæ. Membrana investiens, tenuis, hyalina, modice rectangularis lateribus parallelis, a tergo latissime rotundata angulis nullis, a fronte medio producto atque angulis etiam. Endochroma densum, granulatum.

Membr. long. 21, lat. 16; cell. long. 18, lat. 12 μ.

Lismore (247).

Genus PHACOTUS Perty.

PHACOTUS RECTANGULARIS, n.sp. (Pl. xlii., f.15; Pl. xliii., f.2.)

Cellulæ a fronte visæ circulares; margine scabra; papilla parva inter setas duas; jugis humilibus arcuatis 3-4 decussatim dispositis ornatæ; a latere rectangulares apicibus truncatis; lateribus levissime arcuatis jugis humillimis 3 notatis. Membrana aspera, dilute luteola. Autosporæ ovales.

Long. = lat. = 18-22; crass. c. 10 μ. Cell. matric. long. 22, lat. 24 μ.

Lismore (244, 246).

Differs from *Ph. lenticularis* (Ehr.) Stein, and *Ph. Lendneri* Chodat, in its rectangular side-view, and the more or less regular curved ridges across the face. Cf. Chodat, Alg. Vertes, p.147, f.71, 72.

PHACOTUS RETICULATUS, n.sp. (Pl. xlii., f.16.)

Cellulæ a fronte visæ circulatæ; margine glabra; papilla humillima inter setas; membrana inæqualiter reticulata, colore dilute rufescente; a latere ovales (ut videtur).

Long. = lat. = 22 μ.

Lismore (246)

The lenticular form of the type is only a specific distinction, and not characteristic of the genus.

Genus GONIUM Müller.

GONIUM PECTORALE Müller.

Cœn. long. 40, lat. 44 μ.

Lismore (236, 237, 239, 260).

Genus PANDORINA Bory.

PANDORINA MORUM (Müll.) Bory.

Cœn. long. 31-36, lat. 25-32 μ.

Lismore (221, 237, 244, 246, 249).

Var. TROPICA, n.var. (Pl. xliv., f.18.)

Forma magna, cœnobio ovali; cellulis magnis conicis disjunctis.

Cœn. long. 52-70, lat. 44-60; cell. diam. 9-14 μ.

Lismore (242).

Our Australian specimens of *Pandorina morum* seem to differ somewhat from the European. G. S. West, Br. Frw. Alg., p.192, says: "The cœnobia are spherical or subspherical . . ." and, with this, his fig.76A agrees. So also Chodat, Alg. Vertes, p.150, "Colonies globuleuses ou subglobuleuses . . . ." and his fig.58,xi., p.123. Our forms are invariably oval, cf. Stein, T.xvi., f.14, 15; I have never seen a spherical specimen. Var. *tropica* is rare, twice as large as usual, and the cells more isolated. The latter are arranged in three layers, whose planes are parallel to the long axis of the cœnobium, viz., a central ring of 10, above and below which is a rosette of 6 + 1. The cells do not reach the centre. Were it not that the sexual reproduction and germination of the zygotes are reported to be different (G S. West, *l.c.*, pp.193-4), I should consider var. *tropica* to be an intermediate form between the two genera *Pandor na* and *Eudorina*, especially since the oval form of *Eudorina* (very rare here) was found in company with *P. morum* var *tropica* in the same gathering (both in profusion).

Genus EUDORINA Ehr.

EUDORINA ELEGANS Ehr.

Cœn. ovale, long. 110-128, lat. 95-110, cell. diam. 20-22 μ. Cœn. sphæric. diam. ad 100 μ.

Lismore (223, 241, 242, 249, 260).

Eudorina elegans here is generally spherical. In sample No. 242, however, the oval form was present in company with *P. morum* var. *tropica*, supra, and showing a great likeness to it. The cells were certainly globose, but were arranged (7 + 10 + 7) in three planes *parallel* to the *long axis* of the cœnobium (as in *Pandorina*), not across the axis as shown by Chodat, *l.c.*, p.151, f.76A.

VOLVULINA, gen.nov.

Character idem ac speciei.

VOLVULINA STEINII, n.sp. (Pl. xliii., f.3, 4.)

Cœnobium sphæricum vel ovale, cavum, *Volvoci* simillimum; integumento tenui, hyalino, membranaceo (ut videtur) nec mucoso; intus cellulis æqualiter dispersis, integumento adhærentibus instructum; cellulis tholiformibus magnis, a vertice circulatis, a latere semicirculatis vel rotundato-conicis, fronte planis, postice rotundatis; stigmate rubro distincto juxta flagella posito; flagellis distinctis 2 quam in *Volvoce* vel in *Eudorina* paullo latius inter se distantibus; vesiculis contractilibus aliquot (3 visis) circa marginem anteriorem dispositis. Cytoplasma densum, granulosum; endochromate dilute viridi in granulis minutis ut videtur disperso; chloroplastidibus nullis distinctis nec pyrenoidibus.

Cœnob. sphær. diam. 50-58; cell. diam. 10-15, alt. 8-12 μ.

Lismore (244, 246).

Eudorina elegans Stein (*non* Ehr.), *l.c.*, T. xvi., f.8. Obtained in abundance on June 26th, 1914, (winter) from rainwater pools on grassland (once a swamp, I am told) alongside the Drill

Hall. Stein's figure would seem to suggest a *mucous* investment; probably, however, it is merely an incrassate membrane. The integument of our specimens is quite thin, and appeared to be membranous. Stein gives two contractile vesicles at the base of the flagella, as in *Chlamydomonas*; but my observations showed several, at least three, at intervals round the anterior margin. The flagella, also, were more widely apart than I have ever seen them in any bi-flagellate form. The difference in the cell-contents is merely a matter of nutrition. A central nucleus, × 3 μ, was noted.

Var. SUBRENIFORMIS, n.var. (Pl. xliii., f.5, 6.)

Cellulæ subreniformes, fronte planæ, a tergo subreniformes depressæ, in cœnobii ambitu circa 12-15; ceteris ut in f. typica.

Cœn. subsphær. long. 88-126, lat. 78-94; sphær. diam. 110-114; cell. diam. 10-14, inter se distant. 6-8 μ.

Lismore (246).

Cf. *Eudorina elegans* Stein, *l.c.*, T. xvi., f.9, peripheral cells. This form was gathered in abundance from the same place as the type, but a month later (July 8th, 1914).

Var. PARVICELLULA, n.var. (Pl. xliii., f.7-9.)

Cœnobium plerumque minus interdum minimum; cellulis ut in f. typica vel in var. *subreniformi* sed minoribus.

Cœn. subsph. long. 64-100, lat. 60-90; cell. diam. 6-8 μ.

Cœn. sphær. diam. 20-64; cell. diam. 5-6, inter se distant. 8-12 μ.

Lismore (244, 246).

This variation was formed to include the small spherical cœnobia with cells ⅓ size of the type, of which any quantity were observed, of all dimensions. Cœnobia were occasionally noted, however, of almost the largest size, with cells just as small; and both in cœnobia, and in cells, a complete series was exhibited, from the very smallest to the very largest. Cells of two sizes were often present in the same cœnobium.

Var. LENTICULARIS, n.var. (Pl. xliii., f.10.)

Cellulæ paucæ, latissimæ, lenticulares, integumento intus adhærentes; ceteris ut in f. typica.

Lismore (244).

This interesting flagellate combines, in itself, some of the characteristics of *Volvox*, *Eudorina*, and *Chlamydomonas*. The likeness to *Volvox* is more apparent than real. The organism looks, at first sight, exactly like a minute *Volvox*, with relatively large cells. No trace of parthenogonidia was observed, however, which are almost always present in *Volvox*, and the construction of the cœnobium is entirely different. The latter is hollow, and built up of a single layer of Chlamydomonadine cells of the Pteromonas-type, having a loose membranous investment. These are so closely adpressed as to show, generally, a regular even margin in optical section; but cœnobia were observed (Pl. xliii., f.11) in which the component cells had worked loose, the cœnobium being glœocystiform and irregular at the edge. The peripheral cells, however, have the same relative position to the membrane as in the type—*there is no integument to the cœnobium other than the loose investing membrane of the cells.* In this, *Volvulina* differs from *Eudorina* and *Pandorina*. Nevertheless, it is like them in its vegetative multiplication. Each cell, when mature, forms an 8-16-32-celled daughter-cœnobium. The latter are set free by the breaking up of the mother-cœnobium, and the solution of the membrane of the mother-cell. Such broken cœnobia were noted (cell. matric. diam. 36, cœn. filial. 24, cell. 3-4 μ) in which it could be noted that there was a single layer of cells without any investing mucus or membrane.

Genus VOLVOX (Linn.) Ehr.

VOLVOX TERTIUS Meyer.

Syn., *Volvox Bernardii* Playf., Biol. Richm. R., p.106, Pl. ii., f.5-11. Too late for correction, I came across a casual note by Lemmermann in Plankt. Schw. Gewäss., p.105, on *Volvox*. He says, "*V. aureus* Ehr., and *V. tertius* A. Meyer,* seem in many ways to be interchangeable with one another, as they both possess round cells; these in *V. aureus* Ehr., are connected with one another by protoplasmic threads, in *V. tertius* A. Meyer, on the other hand, they are not." As the absence of these threads is

* Janet, Le Volvox, p.143, gives the reference: Arthur Meyer, Die Plasmaverbindungen und die Membran von *Volvox globator*, *aureus*, und *tertius* mit Rücksicht auf die Thiereschen Zellen. 1896.

characteristic of *V. Bernardii*, it is evident that the latter must be identical with *V. tertius* Meyer.

While there is no doubt that, biologically, *V. aureus* and *V. tertius* belong to the same species, since their zygotes are identical (*vide infra*), the latter seems to be a distinct permanent variety, and worth keeping separate (as a conventional species) for that reason, and also on account of the forms connected with it. In Europe, it would appear that *V. aureus* is common, while *V. tertius* is hardly known. Neither Chodat in Alg. vertes de la Suisse, 1902, nor G. S. West, Br. Frw. Algæ, 1904, mention the latter, nor have I seen any reference to it. On the other hand, in this country, to judge at any rate from the Richmond River district, *V. aureus* is very rare (I have only one record of it), while *V. tertius* is common and widespread. It is probably a permanent tropical and subtropical variety.

Cœn. sphær. diam. 214, 220, 300, 320, 325, 360, 450, 500, 635, 700, 800, 950; membr. crass. 2-8, vulgo 2-3 μ; cell. diam. 5-8, plerumque 8, inter se distant. 5-20 μ. Cœn. filial. sphær. diam. ad 250, rarius oval. long. 123-247, lat. 105-180 μ, numero 2-10 plerumque 6-8; cell. diam. 4 μ. Oosporæ (usque ad 17) diam. 30 μ.

Lismore (223, 241, 249, 259, 260, 261), Wyrallah, Kyogle.

Var. OVALIS, n.var. (Pl. xliv., f.4.)

Cœnobium ovale vel oblongum, paullo minus; cœnobiis filialibus paucis; plerumque ovalibus vel oblongis.

Cœn. long. 114-475, lat. 101-425; cœn. membr. crass. 2-4 μ; cell. diam. 4-8 plerumque 6 μ. Cœn. filial. long. 86-114 μ(numero 1-5). Oosporæ (numero 9-20) diam. 42-55, membr. crass. 3-4 μ. Androgonidia immatur. diam. 10-15, matur. diam. 20-22. Antheroz. long. 8-10, lat. 2-2½ μ.

Woodburn (227), Lismore (241, 259).

A very rich gathering of this form was brought me by Mr. Dan Jolly from a lagoon at Woodburn. On examining the cœnobia in the living state with the aid of a Coddington lens, it was noticeable that, in a large majority of cases, the specimens were smaller than usual and quite distinctly oval or oblong, as also were the daughter cœnobia. The number of the latter also in the mother-conobium was less, 2-3 were common, 4 were frequent, and in no case were there more than 5. Male, female, and vegetative cœnobia were observed. The oospores correspond exactly to the description given for *V. aureus* by Overton, Gatt. *Volvox*, p.33, (*V. minor*), and by Janet, Le Volvox, p.99. They are smooth, with a thick outer and thin inner membrane, and (apparently) a mucilaginous packing between the two. The membrane is first hyaline, then yellow, orange, and finally red-brown (Pl. xliv., f.4).

Var. GUTTULOSA, n.var. (Pl. xliv., f.1.)

Cellulæ subpyriformes, postice subglobosæ, fronte in rostro angusto acuto productæ; stigmate rubro in extremo rostro posito; cytoplasmate granuloso, chloroplastibus etiam; pyrenoidibus nullis, granulis autem paucis magnis.

Cell. long. max. 16, rostra. ca. 6; cell. lat. max. 6, ap. $1\frac{1}{2}$ μ. Cell. inter se distant. 12 μ. Cœn. integum. crass. 6 μ.

Lismore (250).

A very rare form, interesting, however, as showing how the cells may vary in shape.

Var. TESSELLATA, n.var.

Cellulæ a vertice visæ dense congregatæ, inter se distantes 1-2 μ, interdum fere contiguæ, ambitu inæqualiter orbiculatæ, subpolygoniæ, dimensionibus variis.

1. Cœn. matric. diam. 475-600; cell. diam. 2-6 vulgo 4 μ. (Pl. xliv., f 2.)

Lismore (242).

2. Cœn. filial. diam. 180; cell. diam. circ. 3 μ. (Pl. xliv., f.3.)

Lismore (242),

This form is found both in the free mother-cœnobia and in daughter-cœnobia; in the latter case, the mother-cœnobium very often conforms to the type. The variation was plentiful in No. 242, a gathering taken out of roadside rainwater-pools on June 2nd, 1914, (winter) after heavy rains.

VOLVOX GLOBATOR (Linn.) Ehr. (Pl. xliv., f.5, 6.)

Cœn. diam. 450-600; integum. crass. 1-8; cell. diam. 4-6, vel 6-8, filis connect. crass. ca. 1 μ, inter se distant. 2-3 μ. Zygotæ, numero circ. 200, diam. max. 50-60, cell. diam. 34-36, membr. s.sp. circ. 3, spin. long. ad 8 μ.

Lismore (260, 261).

V. globator is only a little less rare in the district than *V. aureus.* The cells, of the specimens I have noted, did not show as distinctly stellate as the European forms, and as figured in Overton, Gatt. Volvox, T. i., f. 4, rather than in Klein, Gatt. Volvox, 1889, T. x., f.2, or in Janet, Le Volvox, p.39, f.3. The connecting filaments (for they can hardly be termed arms) are very faint and indistinct, and not more than 1 μ thick, hyaline; while the cells are very irregular in outline, but apparently more compact than in European specimens, and rather closely packed. The chloroplast is sometimes pale yellow-green, but just as often the same pale green colour as in *V. aureus.* The oospores are yellow or green, with a hyaline integument consisting of an inner and an outer membrane separated by a mucous zone, the outer membrane covered with conical spines somewhat longer and more pointed than generally figured.

Var. AUSTRALIS, n.var.

Cœnobium cellulis a vertice visis inæqualiter polygoniis, densissime ordinatis indiciis filorum solis cernendis; cellulis a latere (sectione opticali) *globosis.* Chloroplastides dilute virides.

Cœn. diam. 500; cell. diam. 3-4, vel 4-6, inter se distant. 1 μ.

Lismore (261). Cum priori.

This form is almost indistinguishable from *V. tertius* var. *tessellata*; the cells are of the same colour, *globose* in sideview, very closely packed, almost touching in places, and the connecting strands are absent. The cells, seen from above, however, are, in this variation, a little more irregular in outline, and here and there, at the angles, a slight point indicates the position of the missing filaments.

VOLVOX LISMORENSIS, n.sp. (Pl. xliv., f. 7, 8.)

Cellulæ a vertice visæ inæqualiter polygoniæ nec stellatæ, filis tenuissimis, sæpe inter se reticulatis, conjunctæ; stigmate rubro distincto. Cellulæ a latere ut in *V. globatore*, pyramidales, a tergo pæne planæ, angulis lateralibus productis, filis tenuissimis conjunctæ, stigmate ad apicem. Chloroplastides luteo-virides, pyrenoidibus nullis visis.

Cœn. diam. 790; cell. diam. 8, inter se distant. 20 μ. Cœn. filial. diam. 215-275, cell. diam. 6, inter se distant. 2 μ.

Lismore (250).

This species resembles *V. globator* in the colour of the chloroplasts, and in the shape of the cells in optical section. From above, however, the cells are not stellate, but only irregularly polyhedral, with a minute point at the angles sometimes. They are connected by extremely delicate threads, much more delicate than in *V. aureus*, sometimes hardly visible. Generally, the threads are double, rarely triple, and, instead of running directly between the cells, they have a habit of anastomosing with one another.

Var. GLOBULIFERA, n.var, (Pl. xliv., f.9.)

Cœnobium cellulis a vertice inæqualiter polygoniis, filorum indiciis solis raro cernendis; cellulis a latere *globosis*.

Cœn. diam. 290-500; cell. diam. 7-8, inter se distant. 6-20 μ. Cœn. filial. diam. 150, cell. diam. circ. 8, partic. ultim. circ. 3 μ.

Lismore (250). Cum priori.

The cells, from above, are irregularly polygonal, with the angles occasionally drawn out a little; here and there, but only rarely, one of the very delicate filaments might be noted. In sideview, the cells are globose. A figure (Pl. xliv., f.9) is given of the surface of one of the daughter-cœnobia; the cells were large, 8 μ in diameter, and indistinctly outlined with smaller cells of many shapes and sizes between. The large cells seemed to be fragmenting into 4-6 smaller cells, 3 μ in diameter—the "*partic. ultim.*", *supra*.

Genus HYDRODICTYON Roth.

HYDRODICTYON RETICULATUM (L.) Lag.

Cell. long. 200, lat. centr. 32, ap. 40 μ.

Lismore (255).

Genus INEFFIGIATA W. & G. S. West.

INEFFIGIATA NEGLECTA W. & G. S. West.

Small pieces, up to diam. 90 μ, plentiful, of a brownish- or yellowish-green colour.

Lismore (185, 223, 260, 261).

Botryococcus Braunii very rare, only just recorded.

[For genus *Trochisia*, see Appendix, under *Chytridiaceæ.*]

BACILLARIEÆ.

Genus Amphora Ehr.

Amph. Lagerheimii var. minuta, n.var. (Pl. xlv., f.8.)

Forma minima, striis nullis visis.

Long. 15-20; lat. frust. 7-9, ap. 3; lat. valv. 4-5 μ.

Lismore (211).

Cf. *A. Lagerheimii* Cleve, Diatomiste ii., p.99, Pl. vii., f.2; Synopsis ii., p.118. The latter is a very rare form, known only from Ecuador. Characteristic of the species is the short, stauriform mark in the centre of the dorsal margin. The type measures 50-70 μ in length, and was obtained from rocks moist with fresh water. Var. *minuta* was found, alive, in some quantity, in a mucous stratum of *Phorm. corium*, at the edge of an open concrete water-table in Carrington Street. The chloroplasts were very distinct, with four minute elæoplasts as figured.

Genus Stauroneis Ehr.

Stauroneis fulmen Brightwell. (Pl. xlv., f.9.)

Long. 114-196; lat. valv. 30, subapic. circ. 12; crass. frust. 30-33 μ.

Lismore (185, 240, 249).

Known only from Java, Australia, and New Zealand. Cf. Brightwell, Micr. Journ., vii., p.180, Pl. ix., f.6. Widespread in swamps throughout this country. There is a double columella, with a true raphe (undulate) in the space between. Cleve, Syn. i., p.150, gives this form as capitate. I have never noted it, however, with more than a rostrate apex. Here, the apices are exactly those of *Staur. acuta.* of which Cleve considers it a variety.

Genus Pinnularia Ehr.

Pinn. streptoraphe var. gibbosa A. Cleve. (Pl. xlv., f.10.)

Long. 140, lat. 20 μ. Striæ 7 in 10 μ.

Lismore (185).

Cf. Astrid Cleve, Diat. Lule Lappmark, p.6, T. i., f.1; P. T. Cleve, Diat. Finland, p.23. Ends conical, frustule only very slightly inflated in the middle. P. T. Cleve gives striæ 5 in 10μ; A. Cleve, 7 in 10μ.

P. DIVERGENS var. ELLIPTICA Grun. (Pl. xlv., f.11.)

Long. 70, lat. 16 μ. Striæ 7 in 10 μ.

Lismore (185).

Grunow, Diat. Fr. Josefs Ld., p.98, Pl. i., f.19; Cleve, Syn. ii., p.79; the latter gives 75 × 15 μ, striæ 8-10 in 10 μ. The larger sizes of *P. Brébissonii* type and the smaller of *P. divergens* var. *elliptica* seem to be identical in appearance, cf. Lagerstedt, Diat. Spetsb., Pl. i., f.2*a*, which is accepted by Cleve as *P. Brébissonii*; the figure gives long. 62, lat. 17 μ

Genus NAVICULA Bory.

NAVICULA SUBTILISSIMA Cleve. (Pl. xlv., f.12.)

Long. 38, lat. 8, ap. 5 μ.

Lismore (185).

Syn., *Stauroneis linearis* Lagerstedt, Sötv. Diat. Spetsb., 1873, Pl. ii, f.13. Cf. Cleve, Diat. Finland, 1891, Pl. ii., f.15, who gives 32 × 5 μ; Lagerstedt, long. 30-34, lat. 7-8 μ. *Nav. linearis* Grun., 1860, prevents the adoption of Lagerstedt's specific name. A rare diatom, known only from Lappland, Sweden, and Spitzbergen. There is a faint pseudostauros on either side of the central nodule.

DIADESMIS-forms.

N. CONFERVACEA var. PEREGRINA (W. Sm.).

Long. 15-20; lat. valv. 8, crass. frust. 4-8 μ.

Lismore (178, 187, 188, 190, 192, 193, 195, 197).

Diadesmis confervacea var. *peregrina*, Biol. Richm. R., Pl. v., f.25. The frustules are so strongly agglutinated together, that the filaments always break by the valves coming apart. The following species, which were also found in long ribbons, I have arranged as *Diadesmis*: but the ribbons seem of a different nature from those of *Nav. confervacea*, being very fragile; and, in gatherings, the frustules are generally found separate, or in groups of 4-8.

Navicula minima Grun. (Pl. xlv., f.13.)

Long. 14-16, lat. valv. 5-6; crass. frust. 3 μ.

Navicula atomus Näg. (Pl. xlv., f.14, 15.)

Long. 6-9, lat. valv. 3-4, plerumque 4; crass. frust. 3 μ.

Navicula exilissima Grun. (Pl. xlv., f.16.)

Long. 10-14, lat. valv. 4-5; crass. frust. 3 μ.

Navicula Flotowii Grun. (Pl. xlv., f.17.)

Long. 14-22, lat. valv. 5-6, ap. 2-3; crass. frust. 3 μ.

Lismore, all four forms (178, 186); the last three (176, 178); *Nav. atomus* (176, 178, 186, 192, 196).

Cf. Van Heurck, Diatomaceæ, pp. 227-230, Pl.5, f.229, 231, 234, 238. *Nav. Flotowii* is the only one of these four that is recognised by either Cleve or Van Heurck as *Diadesmis*. Here, however, I find them all in long ribbons(diam.6, 8, 10, 11, 12, 13, 14 μ in sample No.186). Also, they all exhibit a similar appearance under the microscope, and are all found in quantity associated together. There seems, therefore, to be some connection between them.

Genus Vanheurckia Bréb.

Vanheurckia rhomboides (Ehr.) Bréb. (Pl. xlv., f.18.)

Long. 68, lat. 16, ap. circ. 4 μ.

Lismore (185).

Cf. Donkin, Brit. Diat., Pl. vi., f.11. A very rare form of the genus; this is only my second record of it. The other specimen, from the Sydney Water Supply, measured 90 × 16 μ. The apex is simply rounded, not rostrate at all.

Vanh. vulgaris (Thw.) Van Heurck. (Pl. xlv., f.19-21.)

Long. 40-50, lat. 10-14, ap. 3-4 μ.

Lismore (185).

Thwaites, Ann. Mag. Nat. Hist., Ser. 2, Vol. i., Pl.xii., f.H1-5. Not Van Heurck, Diatom., p.239, f.39 (= *V. viridula*) nor Pl.5, f.252. Thwaites says "lanceolate, suddenly narrowed near the apices," and his figures show a plump little frustule, not at all slender, elliptic-lanceolate, with sides well arched, not parallel, suddenly constricted near the ends into a short rostrate apex. Forms of this genus are common enough in the swamp-waters of this country, but I have never yet seen them in mucous tubes.

Var. RICHMONDIÆ, n.var. (Pl. xlv., f.22.)

Forma fasciâ transversâ, usque ad margines valvæ non pertinente, utrinque ad nodulum centralem instructa.

Long. 54-58, lat. 12-14 μ.

Lismore (185). Cum priori.

This form is more like those given for the type by Van Heurck.

VANH. CUSPIDATA var. AMBIGUA (Ehr.) Cleve.

Long. 66-80, lat. 19-20, ap. 4-5 μ.

Lismore (213, 221, 253).

Nav. ambigua Ehr., in Donkin, *l.c.*, Pl. vi., f.5. Cleve, Synopsis i., p.109. This form is very like *V. vulgaris*, from which it may be distinguished by its larger size, and specially by a very slight angularity here and there in the arched sides. It is frequent at Lismore in waterholes and swamps, and in the mucous strata of the *Myxophyceæ*.

Forma.

Forma fasciâ transversâ utrinque ad nodulum centralem instructa.

Long. 76, lat. valv. 20, ap. 6; crass. frust. 10 μ.

Lismore (223).

Compare *V. vulgaris* var. *Richmondiæ*, supra.

Genus GOMPHONEMA Ag.

GOMPH. LANCEOLATUM var. INSIGNE Greg. (Pl. xlv., f.23.)

Long. 62, lat. 10 μ. Striæ 8 in 10 μ.

Lismore (185).

Genus ACHNANTHES Bory.

ACHNANTHES WOODLAWNENSIS, n.sp. (Pl. xlv., f.24.)

Frustula oblonga genuflexa, zona connectente per longitudinem striata, striis tenuibus 8-9. Valvæ lineari-lanceolatæ, in medio evissime inflatæ, apicibus conicis, transverse striatis. Valva inferior lineâ centrali et fascia transversali instructa. Valva superior striata tantum, linea centrali nulla nec fascia.

Long. 84, lat. valv. 18, frust. crass. 24 μ. Striæ 8 in 10 μ.

Woodlawn (225).

I can find no description answering to this form, in Cleve's Synopsis. The stauros is 3 μ broad.

ACHNANTHES EXIGUA Grun. (Pl. xlv., f.25, 26.)

Long. 13-16, lat. 6-7, ap. 3; frust. crass. 4 μ.

Lismore (176, 178, 190).

Cf Schumann, Preuss. Diat., Nachtrag ii, Pl. ii., f.59. This species was found, in some quantity, along with *Nav. minima* and its three companions (*supra*), and there was reason to believe that its frustules had been originally, like the others, in long filaments. Cleve, Syn., ii, p.190, gives dimensions, long. 13-17, lat. 5-6 μ. He places the species in a class of *Achnanthes* which, he says, has affinities with the groups of *Navicula*, including the four mentioned above. The chromatophores of all are of the same shape, so that it is highly probable that this form is really a *Navicula*, and that the *Achnanthes*-features are merely temporary. I could see no genuflexion in the sideview of the frustules.

ACHNANTHES LINEARIS W. Sm.

Long. 13-16, lat. 4; crass. frust circ. 3 μ.

Lismore (178).

Found in company with *Ach. exigua*, above, and the four small *Diadesmis*-forms of *Navicula*. I had a suspicion that the latter were occasionally to be found *curved* in girdle-view.

Genus STENOPTEROBIA Bréb.

STEN. ANCEPS var. HERIBAUDII Playf.

Long. 105, lat. 6 μ.

Lismore (240).

These Proceedings, 1913, p.535, Pl.56, f.21. Syn., *Sten. anceps* Heribaud (not Lewis), Diat. Auvergne, Pl. v., f.4. Forms of *Sten. anceps* Lewis, (= *Nitz. franconica* Rein.) are widespread in this country.

MYXOPHYCEÆ.

Genus Anabæna Bory.

Anabæna oscillarioides Bory. (Pl. xlvi., f.1.)

Cf. Biol. Richm. R., p.127, for dimensions. Three shapes of gonidia were noted in this one sample, viz.: (1) oblong, with arched sides, and broadly rounded ends; (2) broadly cylindrical, with flat sides, and broadly rounded subtruncate ends; (3) long narrow cylinders, with straight sides, and truncate ends.

Lismore (185).

Genus Cylindrospermum Kütz.

Cylindrospermum rectangulare, n.sp.

Stratum obscure-viride. Trichomata pallidissime æruginosa, ad genicula constricta, apicibus conicis. Vagina tenuissima, distincte observata Cellulæ quadratæ vel cylindraceæ, disjunctæ, protoplasmate homogeneo vel minute granulato. Heterocystides rotundato-conicæ vel oblongæ subcylindraceæ: apicibus rotundatis. Gonidia stricte cylindracea, lateribus planis, apicibus truncatis; vel doliformia, lateribus levissime arcuatis, apicibus truncatis; vel rarius elliptico-lanceolata, apicibus rotundatis; protoplasmate granulato, dilutissime æruginoso pæne hyalino.

Trich. diam. 4-5; cell. alt. 6-10, sæpe 8 μ. Heterocyst. conic. long. 6-10, lat. 5-6, cylindr. long. 11-12, lat. 6 μ. Gonid. cylindr. long. 12-15, lat. 5-6, doliform. long. 16-20, lat. 7-8, lanceol. 22 × 10 μ.

Lismore (256).

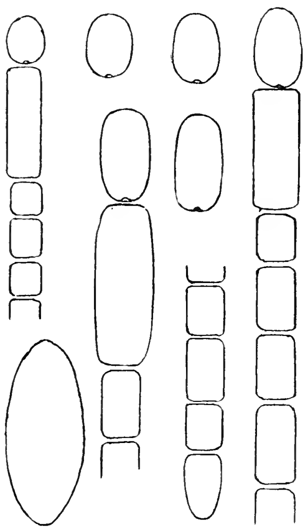


Fig. A.
Cylindrospermum rectangulare, n.sp.; (× 1000).

Found on dripping rocks halfway up the New Cut. The specimen showed very well the development of the heterocysts and of the gonidia. The trichomes and gonidia were very pale blue, almost hyaline. A delicate sheath was distinctly observed.

Genus PLECTONEMA Thuret.

PLECTONEMA NOSTOCORUM Bornet.

Plentiful, much branched, almost hyaline, in a mucilaginous stratum with other *Lyngbyeæ*. I have never found this species pale yellow-green, as noted by Gomont, Monog. d. Oscill., p.103; but almost all the blue-green *Lyngbyeæ* have a yellow-green form.

Lismore (213).

PLECTONEMA CRISPATUM, n.sp. (Pl. xlvi., f.2.)

Stratum sordide olivaceum. Fila primum sessilia cæspitosa, deinde arcte intricata, abundanter pseudo-ramosa, pseudo-ramis solitariis, curvatis. Vaginæ distinctæ hyalinæ. Trichomata pallide æruginosa pæne hyalina, apicibus conicis, ad genicula haud constricta, protoplasmate homogeneo. Dissepimenta distincta haud granulata.

Trich. diam. 2-3, cell. alt. 1-2 μ.

Lismore (210).

Found as a pinky-brown stratum on a zinc-footwasher at the Presbyterian Church. Other parts of the stratum, however, were dull green, and the purple colouration was found to be entirely due to inert vegetable débris. The trichomes themselves were very pale blue, almost hyaline.

Genus LYNGBYA C. Ag.

LYNG. ÆRUGINEO-CÆRULEA (Kütz.) Gomont.

Trich. diam. 6-8, cell. alt. 2-4, plerumque $2\frac{1}{2}$ μ.

Lismore (199).

Trichomes strongly blue-green; dissepiments very distinct, in the larger trichomes apparently minutely granulate; ends conical or rounded. Sheath noted.

LYNG. KUTZINGII var. DISTINCTA (Nord.) Lemm. (Pl. xlvi., f.3)

Trich. diam. $1\frac{1}{2}$-2, cell. alt. circa $1\frac{1}{2}$ μ.

Lismore (201, 206, 211).

Cf. Lemmermann, Engl. Bot. Jahrb., 34, 1905, p.620. Syn., *Lyngbya subtilis* West, Alg. Lake Dist., p.29, Pl, x., f.58 ; *L. Martensiana β distincta* Nord., Alg. Sandvich., p.4; *L. circumcreta* G. S. West, Third Tanganyika Exp., p.174, Pl.9, f.7. Trichomes pale blue, with homogeneous but generally opalescent protoplasm, so that the dissepiments are barely visible; occasionally, however, with translucent protoplasm, when the septa are distinct. The same occurs in *O. splendida.* The cells are square or a little shorter than the diameter, the sheath very delicate, filaments often spirally twisted, apices truncately-rounded. *Lyngbya circumcreta* G. S. West, *l.c.*, is a plankton-form of the species, the coiling of the filaments being a plankton-phenomenon of not infrequent occurrence(cf. *Melosira granulata* var. *circinalis* Playf., Syd. Water-Supply, p.536), and not of any specific value. It should be noted as confirmatory that this form was obtained from the same two localities as *L. Kützingii* var. *distincta*, l.c., pars.308. 309, at the same time of year.

Genus Phormidium Kütz.

Phormidium uncinatum (Ag.) Gomont. (Pl. xlvi., f.4.)

1. Fila distincta, libera, vaginis haud agglutinatis. Dissepimenta plerumque haud granulata.

Trich. diam. 7-8, cell. alt. 2-4, vulgo 3-4 μ.

Lismore (212).

2. Fila distincta, libera, vaginis haud agglutinatis. Septa granulata.

Trich. diam. 8, cell. alt. 4-5 μ.

Lismore (230).

3. Fila distincta, libera, vaginis haud agglutinatis. Septa sæpe granulata. Trichomata omnia apicibus capitatis.

Trich. diam. 8, cell. alt. 4-6 μ,

Lismore (252).

Oscill. uncinata Ag., *Ph. uncinatum* (Ag.) Gomont, Monog. d. Oscill., p.184, Pl. v., f.21, 22. Three, fine, mucous strata of this plant were obtained, not one of which, as stated above, was in the *Phormidium*-condition. The filaments were free, and wandered about the field of view. The trichomes pale blue-green, transparent, attenuate, and curved at the tips; dissepiments distinct, sometimes smooth, sometimes granulate. A great variety of apices were noted, the prevailing types, however, being rounded, capitate, or with depressed conical calyptra.

PHORMIDIUM LUCIDUM (Ag.) Hansg. (Pl. xlvi., f.5.)

Fila distincta, libera: vaginis haud agglutinatis. Trichomata dilutissime æruginosa, ad genicula constricta, cellulis altioribus plerumque dissepimentis incipientibus instructis.

Trich. diam. 8-10; cell. alt. 2-3 μ.

Lismore (213) Cum sequenti intermixtum.

Var. AMŒNUM (Kütz.) mihi. (Pl. xlvi., f.6.)

1. Fila distincta, libera; vaginis haud agglutinatis. Trichomata dilutissime æruginosa semper pæne hyalina, ad genicula non constricta, apicibus conicis vel late-rotundatis, cellulis angustis, dissepimentis conspicuis haud granulatis.

Trich. diam. 5-6; cell. alt. $1\frac{1}{2}$-3 μ, interdum ad 1 μ approx.

Lismore (213).

2. Fila libera. Trichomata saturate æruginosa, apicibus rotundatis subtruncatis, dissepimentis interdum minute granulatis, sæpe septis inconspicuis alternantibus. Cetera ut in f. precedente.

Trich. diam 8-10 (rarius 11); cell. diam. 3-4 μ.

Lismore (213).

3. Fila glabra libera. Trichomata dilute æruginosa, ad genicula quam levissime constricta, apicibus rotundatis conicis, dissepimentis validis non autem granulatis.

Trich. diam. 6; cell. diam. 2-4, vulgo 2 μ.

Lismore (232).

Amphitrix amœna Kützing, (pro parte) Tab. phyc i., p 45, T.79, f.1 (*sec.* Gomont). *Phorm. ambiguum* Gomont, Monog. d Oscill., p.178, Pl. v., f.10. This is a form of *Ph. lucidum* without constricted joints. Not only are the two forms otherwise exactly alike in general characteristics, but, in sample No.213, I find them intermixed; and, in No.232, an intermediate form in which the constriction is very faint, represented only by a minute puncta-spot. In neither of these samples were the filaments in the *Phormidium*-condition.

PHORMIDIUM CORIUM (Ag) Gomont. (Pl. xlvi., f.7.)

Trich. diam. 3-3½; cell. alt. 3-8, vulgo 4 μ.

Lismore (205, 209).

Cf. Gomont, *l.c.*, p.172, Pl. v., f.1, 2. Pale blue, generally transparent, with distinct dissepiments, protoplasm minutely granulate, sometimes a central body in the middle of each cell. Stratum membranous or coriaceous.

Var. ACUMINATUM, n.var. (Pl. xlvi., f.8.)

Formæ typicæ consimile sed latius. Trichomata dilute viridia apicibus acute conicis.

Trich. diam 5-8; cell. alt. 3-8, apical. 8-10 μ.

Lismore (207, 211, 228).

First obtained from a roadside ditch near the Cathedral. Gomont gives diam. 3-4½ μ for the type, cell. alt. 3-8 μ. Our specimens agree exactly with his details. In this form, the trichomes are green rather than blue, and the natural tips are acutely conical, in broken filaments (with projecting sheath) they may vary from simply rounded to bluntly conical *Phorm. Crouani* Gomont, *l.c.*, p.175, is a still broader form of this species, diam. 7½-10½, cell. alt. 4-8 μ; the description agrees perfectly with that of *Ph. corium*, and var. *acuminatum* just connects the two sizes. I do not see how *Ph. papyraceum* (Ag.) Gomont, *l.c*, p.173, Pl. v, f.3, 4, can be distinguished from *Ph corium.*

Var. CONSTRICTUM, n.var. (Pl xlvi., f.9.)

Trichomata dilutissime æruginosa, ad genicula constricta, apicibus naturalibus acutissime conicis; cellulis cylindraceis, diametro ad duplum longioribus, protoplasmate minute granulato.

Trich. diam. 4-5; cell. alt. 8 μ.

Lismore (228). Cum priori.

Trichomes about the size of the type, but distinctly constricted at the joints, and very sharply pointed; the cells cylindrical, not quadrate as usual in this species. All the forms of *Ph. corium* were true *Phormidia*, the stratum membranous, sheaths agglutinated.

Genus OSCILLATORIA Vaucher.

OSCILLATORIA PRINCEPS Vaucher (Pl. xlvi., f.10.)

Trích. diam. 28-44, ap. 18; cell. alt. 4-8 μ.

Lismore (187).

Gomont, *l.c.*, p.207, Pl. vi., f.9. Colour pale grey-green, protoplasm very finely granular, dissepiments not granulate. Specimens are often found with a very thick sheath, and there are indications of permanent septa across the sheath between the cells (Pl. xlvi., f.10*c*). Found only in the river here.

OSCILLATORIA CORAKIANA, n.sp. (Pl. xlvi., f.11.)

Fila lata, vaginis observatis. Trichomata subrubicunda vel atrochalybea, viridi tincta, interdum ad genicula constricta; apicibus leviter attenuatis rotundatis, aut arcuatis subtruncatis; cellulis angustis; dissepimentis conspicuis, granulatis; protoplasmate minute granulato.

Trich. diam. 11-12; cell. alt. 2-4 μ.

Coraki (202).

The colour of the trichomes, a pale pinky-brown, or dark grey, flashed with pale green, seems to distinguish this species from all others. The trichomes are sometimes constricted, sometimes not; it is a character that I find to be of very doubtful value.

OSCILLATORIA FORMOSA Bory. (Pl. xlvi., f.12, 13.)

Trichomata dilute cyanea vel dilute viridia, vulgo ad genicula constricta sed non semper, dissepimentis rarissime granulatis.

Trich. diam. 4-7; cell. alt 2-4 μ Vagina repetitim observata

Lismore (201, 206, 207, 208, 221, 226, 229).

Gomont, *l.c.*, p.230, Pl. vii., f.16. Very frequent in the district; the smooth, rounded, uncinate tip cannot be mistaken The breadth is usually 5-6 μ, with cell. alt. 3-4 μ. The dissepiments are almost invariably smooth; in No.229, however, (a pure mucous stratum) the dissepiments have the appearance of thin lines, with 3-4 very distinct granules strung on them.

Var AUSTRALICA, n.var. (Pl. xlvi., f.14.)

Trichomata dimensionibus et ceteris ut in forma typica, cellulis autem protoplasmate spisso, globo centrali colore pallido, ubique zonâ angustâ coloris saturatioris circumcincto.

Trich. diam. 4-8, vulgo 5-6; cell. alt. 2-4, plerumque 3-4 μ.

Lismore (202, 213).

The contents of the cells are peculiarly arranged in this form, giving it a distinct appearance. The protoplasm is opalescent, the central portion very pale and surrounded by a narrow zone slightly darker in colour.

Appendix on the Algal Fungi and Schizomycetes.

ALGAL FUNGI.

CHYTRIDIACEÆ.

Genus CHYTRIDIUM A.Br.

CHYTRIDIUM GREGARIUM Nowakowski.

Filling the carapaces of dead rotifers, as usual. The identification is certain, and I have followed Nowakowski in the nomenclature; but it seems to me that this form is doubtfully placed under *Chytridium*.

Lismore (237, 244).

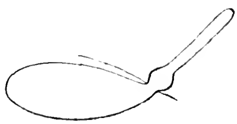


Fig. 1.
Chytridium gregarium; mature cell about to dehisce; (× 665).

CHYTRIDIUM AMPHOROIDIUM Playf.

Olpidium amphoridium, e lapsu, Biol. Richm. R., p.137; *Chytridium amphoridium*, ibid., Pl. vii., f.5.

Lismore (220). On *Macrothrix spinosa* (Entomostraca).

CHYTRIDIUM GRACILLIMUM, n.sp.

Cellulæ gracillimæ, ensiformes vel fusiformes; apicibus acutis acuminatis; inferne lateribus ad basin acutam sensim sensimque convergentibus; stipite nullo nec pede. Cytoplasma hyalinum, granulatum, chloroplastidibus nullis. Membrana hyalina tenuissima.

Cell. long. ad 240; lat. 6-8 μ.

Lismore (236) on *Lemna*; (249) on *Moina propinqua* (Entomostraca); (254).

Var. FALCIFORME, n.var.

Cellulæ superne pulcherrime crispatæ.

Long. vertical. 90, lat. 54 ; cell. diam. 6 μ.

Lismore (236)

This species is very like *Characium ensiforme* Herm., (cf. G. S. West, Br. Frw. Alg., p.200, fig.80D), but it has no stipes or expanded base, and no chlorophyllaceous contents. It is still more like *Chamæsiphon curvatus* Nord., Alg. Sandvich., p.4, T.i., f.2, but the forms of *Chamæsiphon* have a definite sheath of considerable thickness, enclosing a chlorophyllaceous core. The membrane in *Chytridium gracillimum* is very thin, is not of the nature of a sheath, and also there is no chlorophyll in the cell-contents. The species is not uncommon, and small forms may sometimes be met with in numbers.

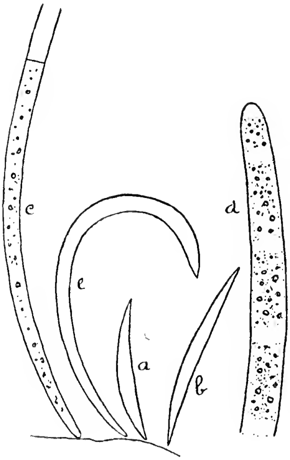


Fig. 2.
Chytridium gracillimum, n.sp.; *a*, *b*, young forms (× 330); *c*, mature cell dehiscing (× 400); *d*, tip of another ripe specimen (× 500); *e*, var. *falciforme*, n.var. (× 330).

CHYTRIDIUM CLAVUM, n.sp.

Cellulæ claviformes, apice inflatæ, capitatæ; inferne lateribus ad basin acutam sensim sensimque convergentibus, stipite nullo nec pede. Cytoplasma hyalinum homogeneum.

Cell. long. 20; lat. 2, ap. 3 μ.

Lismore (254). In quantity on *Hyal. dissiliens*.

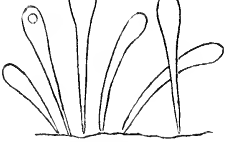


Fig. 3.
Chytridium clavum, n.sp.; (× 665).

Genus TROCHISIA Kütz.

Syn., *Acanthococcus* Lagerheim. In every form mentioned below, the contents of the cell were hyaline, without a trace of chlorophyll.

TROCHISIA HIRTA (Reinsch).

Cell. diam. s.sp. 27-34; sp.long. 4-6 μ. Lismore (225, 236).

Syn., *Acanthococcus aciculiferus* Lag.; *A. hirtus* Reinsch, Genus *Acanthococcus*, p.240, T. xi., f.1, 5, 15. Reinsch gives diam. 15-32 μ, cf. Biol. Richm. R., Pl. vii., f.2, and the dimensions on p.136.

Var. ELLIPTICA Playf.

Cell. long. s.sp. 74-80, lat. s.sp. 38-62; sp.long. 5-12 μ.

Lismore (236, 244). Biol. Richm. R., p.136, Pl, vii., f.1.

TROCHISIA HYSTRIX (Reinsch).

Cell. diam. s.sp. 133; sp. long. 16 μ.

Lismore (236).

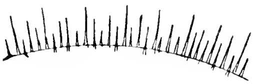


Fig.4. *Trochisia hystrix*; segment of margin; (× 665).

Reinsch, *l.c.*, p.241, T. xii., f.25. It ought, by rights, I think, to be set down as a variation of *Tr. hirta*. Noted in the same sample with that species and var *elliptica*. Diam. cell. 43-46 μ. Long. spin. 4-7 μ. Reinsch.

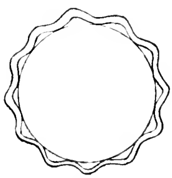


Fig.5. *Trochisia pachyderma*; (× 1000).

TROCHISIA PACHYDERMA (Reinsch)

Cell. diam. s. membr. 18, rugis membr. 2 μ alt. Lismore

Reinsch, *l.c.*, p.240, T. xi., f.8, 9, gives diam. 12-19 μ. A good number of his other species would seem to be only forms of *T. pachyderma*. Eight cells found together, apparently, in a rotifer-skin.

TROCHISIA LISMORENSIS, n,sp.

Cellulæ sphæricæ setis brevibus bifidis dense vestitæ. Cytoplasma hyalinum.

Cell. diam. s. setis 26; set. long. 4 μ.

Lismore (225).

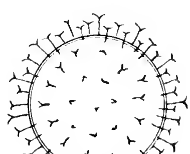


Fig.6. *Trochisia Lismorensis*, n.sp.; (× 665).

Two species somewhat like this are *Tr. brachiolata* (Möb.) Lemm., Nord. Plankt., Flagell., &c., p.16, fig.58, and *Tr.* (*Acanth.*) *spinosa* (Reinsch), *l.c.*, p.241, T. xi., f.6. The former is a marine species, and, in both, the spines, though bifid, are of a different character, much stouter and more like elongated verrucæ. In *Tr. Lismorensis*, they are mere bifid setæ, very fine and thickly strewn.

SCHIZOMYCETES.

Micrococcus prodigiosus (Ehr.) Cohn.

The two zooglœa-forms attributed to *Bacterium termo*, Biol. Richm. R., p.140, Pl. vii., f.14, belong, probably, to this schizophyte. *B. termo* has, indeed, a similar zooglœa-state, but coarser in the grain, on account of its larger cells.

Lismore (206).

Bacterium termo (Ehr.) Duj.

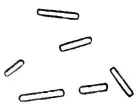


Fig. 7. *Bacterium termo*; (× 1000).

Cell. long. 2-4, lat. 1 μ; plerumque 3 × 1 μ.

Lismore (185, 225).

I have never been able to see the flagella, but, by the way in which the cells tend to adhere to the glass-slip by one end for some moments after the other end is free, I consider they have a flagellum at each end. This getting temporarily stuck to the glass-slip by a flagellum is quite a common occurrence among the smaller flagellates, both animal and vegetable.

Bacterium gigas, n.sp.

Cellulæ bacilliformes ex inflationibus globosis 4-6 contingentibus compositæ; in extremis flagello singulo præditæ.

Cell. long. 8-12, lat. 2 μ.

Lismore (225).

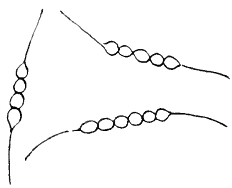


Fig. 8. *Bacterium gigas*, n.sp.; (× 1000).

Bacillus ulna Cohn.

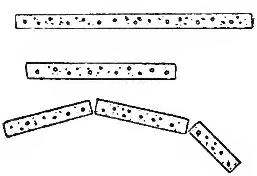


Fig. 9.—*Bacillus ulna* Cohn.; (× 1000).

Cell. alt. 5-20, diam. 2 μ.

Lismore (259).

In quantity with *B. subtilis*, broken filaments in pieces up to 60 μ long. The cells generally 20 μ long, dividing into 10 μ and 5 μ. The contents homogeneous, with scattered granules, large and small. The faint blue colouration, which was apparent, is probably caused by an opalescent refraction from the granules, and not by any colouring matter. *B. ulna* is very rare; I remember to have noted it only once before.

SPIRILLUM VOLUTANS Ehr.

Anfract. diam. 7, alt. 12; fil. diam. 1½ μ.

Lismore (178, 186, 187, 233).

This is exactly the size of Cohn's broadest figures.

Var. MAXIMUM Playf.

Anfract. diam. 14, alt. 24; fil. diam. 1½ μ.

Lismore (233).

The spirals are twice as broad as in the type, cf. Biol. Richm. R., p.139, Pl. vii., f.8.

SPIRILLUM LAXISSIMUM Playf.

Long. 10; fil. diam. 1 μ. Anfractibus singulis.

Lismore (236, 259).

Cf. Biol. Richm R., p.139, Pl.vii., f.10. *Spirochæte plicatilis* (f.10), and *Vibrio serpens* were also observed.

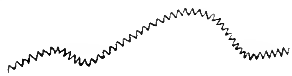


Fig. 10.
Spirochæte plicatilis Ehr.; (× 1000).

EXPLANATION OF PLATES XLI.-XLVI.

(All figures magnified 665 diameters, unless stated otherwise.)

Plate xli.

Fig.1.—*Gonatozygon monotænium* var. *tenue*, n.var.
Fig.2. ,, *Brébissonii* var. *minutum* W. & G. S. West.
Fig.3.—*Penium margaritaceum* var. *pulverulentum*, n.var.; (× 500).
Figs.4, 5. ,, ,, var. *indivisum*, n.var.; (× 500).
Fig.6. ,, *cucurbitinum* var. *subpolymorphum* f. *crassior*, n f.;(× 350).
Fig.7.—*Closterium Spetsbergense* var. *palustre*, n.var.; tip.
Fig.8. ,, *gracile* var. *substrigosum* (Rac.) mihi.
Fig.9. ,, *pronum* Bréb.; (× 335).
Fig.10. ,, *prælongum* Bréb.; tip of Australian form.
Fig.11.—Mixed form, (*a*) *Cosmarium rectangulare* var. *nodulatum* f. *minor* Playf., (*b*) *Cos. rect.* var. *Boldtii* f. *minor*, n.f.
Fig.12.—*Cosmarium rectangulare* var. *biretum*, n.var.
Fig.13. ,, ,, ,, ,, f. *rectilinearis*, n.f.
Fig.14. ,, ,, ,, ,, f. *angustior*, n.f.

Fig. 15.—*Cosmarium rectangulare* var. *quadrigeminatum* f. *latior*, n.f.; (*a*) side-view.
Fig. 16. ,, ,, var. *angustius* f. *minor*, n.f.; (*a*) end; (× 1000).
Fig. 17. ,, *pseudoprotuberans* v. *australe*, n.var.; (*a*) end; (× 500).
Fig. 18. ,, *moniliforme* var. *subquadratum*, n.var.
Fig. 19. ,, *venustum* var. *Borgei*, nom.nov.
Fig. 20.—*Onychonema filiforme* (Ehr.) Roy & Bissett.
Fig. 21. ,, *læve* var. *micracanthum* Nord.

Plate xlii.

Fig. 1.—*Zygnema pectinatum* (Vauch.) Ag., forma; (× 220).
Fig. 2.—*Spirogyra Grevilleana* var. *australis*, n.var. (*a*, *b*) infertile; (× 335), (*c*) with spores; (× 220).
Fig. 3.—*Cosmarium obsoletum* var. *Sitvense* f. *dentata*, nom.nov.; (× 500).
Fig. 4. ,, *auriculatum* Reinsch, (× 500); (*a*) dentations; (× 1000).
Fig. 5. ,, ,, forma (× 1000) with the protruding membrane of *Cos. obsoletum* at the basal angles. The semicell constituted a *forma mixta* conjointly with a semicell of *Cos. obsoletum* var. *Sitvense* f. *dentata*.
Fig. 6.—*Cosmarium Askenasyi* var. *crateriforme*, n.var.; (× 220).
Fig. 7. ,, *Blyttii* var. *Lismorense*, n.var.; (× 1000).
Fig. 8. ,, *Woodlawnense*, n.sp.; (*a*) end.
Fig. 9.—(*a*) *Xanthidium inchoatum* Nord., f. *spinis nullis*; (× 500).
Fig. 10. ,, ,, var. *Cracoviense* (Rac.) mihi, (also 9*b*); (× 500).
Fig. 11. ,, ,, var. *alpinum* (Rac.) mihi (*a*), with var. *mammillatum* Playf. (*b*); (× 500).
Fig. 12.—*Chlamydomonas globulosa* Perty.
Fig. 13. ,, *monadina* (Ehr.) Stein.
Fig. 14.—*Pteromonas alata* var. *australis*, n.var.; (× 1000).
Fig. 15.—*Phacotus rectangularis*, n.sp., (*a*) side; (× 1000).
Fig. 16. ,, *reticulatus*, n.sp., (*a*) side; (× 1000).

Plate xliii.

Fig. 1. *Chlamydomonas pisiformis* var. *ovalis*, n.var., (*a*) front, (*b*) side; (× 1000).
Fig. 2.—*Phacotus rectangularis*, n.sp., with autospores; (× 1000).
Figs. 3, 4.—*Volvulina Steinii*, gen. et sp.nov.
Figs. 5, 6. ,, ,, var. *subreniformis*, n.var.; (× 500).
Figs. 7-9. ,, ,, var. *parvicellula*, n.var.; (fig. 7 × 500).
Fig. 10. ,, ,, var. *lenticularis*, n.var.
Fig. 11. ,, ,, forma; (× 335).

Plate xliv.

Fig. 1.—*Volvox tertius* var. *guttulosa*, n.var.
Figs. 2, 3. ,, ,, var. *tessellata*, n.var.; (× 1000).
Fig. 4. ,, ,, var. *ovalis*, n.var., ripe oospore; (× 500).
Figs. 5, 6. ,, *globator* (L.) Ehr.; (5)surface-view (× 1000), (6)ripe oospore; (× 500).
Figs. 7, 8. ,, *Lismorensis*, n.sp.; (7)front view, (8) optical section.
Fig. 9. ,, ,, var. *globulifera*, n.var., surface-view of daughter-cœnobium.
Fig. 10.—*Chlamydomonas glœocystiformis* var. *australis*, n.var.; (× 1000).
Fig. 11. ,, *pisiformis* Dill.; (× 1000).
Fig. 12. ,, ,, var. *cylindracea*, n.var.; (× 1000).
Fig. 13. ,, ,, var. *ovalis*, n.var.; (× 1000).
Figs. 14, 15. ,, ,, var. *obesa*, n.var.; (× 1000).
Fig. 16. ,, *DeBaryana* Gorosch. f.; (× 1000).
Fig. 17.—*Carteria ovata*, n.sp.; (× 1000).
Fig. 18.—*Pandorina morum* var. *tropica*, n.var.; (× 600).

Plate xlv.

Figs. 1, 2.—*Synura uvella* Ehr.; (× 1000).
Fig. 3. ,, *granulosa*, n sp.; (× 1000).
Figs. 4, 5. ,, *australiensis*, n.sp.; (× 1000).
Figs. 6, 7.—*Tessella volvocina*, gen. et sp.nov.; (6)cœnobium (× 335), (7)cells enlarged (× 665).
Fig. 8.—*Amphora Lagerheimii* var. *minuta*, n.var.; (*a*) frustule, (*b*) with chromatophores, (*c*, *d*) valve-view; (× 1000).
Fig. 9.—*Stauroneis fulmen* Brightwell; (× 335).
Fig. 10.—*Pinnularia streptoraphe* var. *gibbosa* A. Cleve; (× 500).
Fig. 11. ,, *divergens* var. *elliptica* Grun.
Fig. 12.—*Navicula subtilissima* Cleve; (× 1000).
Fig. 13. ,, *minima* Grun.; (× 1330).
Figs. 14, 15 ,, *atomus* Näg., two forms, (15) showing chromatophores; (× 1330).
Fig. 16. ,, *exilissima* Grun.; (*a*) with chromatophores; (× 1330).
Fig. 17. ,, *Flotowii* Grun.; (× 1330).
Fig. 18.—*Vanheurckia rhomboides* (Ehr.) Bréb.
Figs. 19-21. ,, *vulgaris* (Thw.) Van Heurck.
Fig. 22. ,, ,, var. *Richmondiæ*, n.var.
Fig. 23.—*Gomphonema lanceolatum* var. *insigne* Gregory.
Fig. 24.—*Achnanthes Woodlawnensis*, n.sp., (*a*) girdle-view; (× 500).
Figs. 25, 26. ,, *exigua* Grun.,(25) × 1330; (26)showing chromatophores × 1000 .

Plate xlvi.

Fig. 1.—*Anabæna oscillarioides* Bory, types of gonidia.
Fig. 2.—*Plectonema crispatum*, n.sp.
Fig. 3.—*Lyngbya Kützingii* var. *distincta* (Nord.) Lemm.; (x 1000).
Fig. 4.—*Phormidium uncinatum* (Ag.) Gomont.
Fig 5. ,, *lucidum* (Ag.) Hansg.
Fig. 6. ,, ,, var. *amœnum* (Kütz.) mihi.
Fig. 7. ,, *corium*(Ag.)Gomont: the cells showing a central body.
Fig. 8. ,, ,, var. *acuminatum*, n.var.
Fig. 9. ,, ,, var. *constrictum*, n.var.
Fig. 10.—*Oscillatoria princeps* Vauch.; (*a*, *b*) tips of trichomes, (*c*) broken filament showing the thick sheath and one of the permanent dissepiments; (x 335).
Fig. 11.—*Oscillatoria Corakiana*, n.sp,
Fig. 12. ,, *formosa* Bory.
Fig. 13. ,, ,, granulate form; (*a*) stouter, (*b*) more slender.
Fig. 14. ,, ,, var. *australica*, n,var.

THE MOSSES OF LORD HOWE ISLAND.

By Dr. V. F. Brotherus and the Rev. W. Walter Watts.

Introductory Notes by Rev. W. W. Watts.

At the beginning of July, 1911, I started on a health-trip to Lord Howe Island, and it was not until towards the end of August that I again saw Sydney. Seven weeks was I privileged to spend on the far-famed island, experiencing much kindness from the hospitable residents, and collecting Ferns, Mosses, and Hepatics from almost every accessible part of this beauty-spot of the near Pacific.

The Ferns of the Island have been dealt with in these Proceedings (1912, xxxvii., p.395, and 1914, xxxix, p.257); and the Hepatics in a paper on "Hepaticæ Australes," in the Journ. Proc. Roy. Soc. N. S. Wales, xlviii. (1914), p.94.

The present paper deals with the Mosses of the Island, which I collected somewhat exhaustively, though there are some localities which I was unable to visit.

From the bryologist's point of view, the most interesting part of Lord Howe is the southern end, where the Island attains its greatest width (nearly two miles), and where the twin mountains, Lidgbird and Gower, lift their impressive heads, the former to 2,504 feet, and the latter to 2,840 feet. These mountains, frequently "cloud-capped," are separated by the deep cleft of Erskine Valley, where many cryptogamic treasures probably yet remain for discovery. The top of Mt. Gower is a veritable paradise of plant-life—one of Nature's Botanic Gardens, consisting of some 120 acres of rich scrub-land, intersected by gullies that run always towards the north, and, on its southern edge, dropping almost sheer into the ocean.

Here, on this rich plateau, may be found fern after fern, and moss after moss, that occur nowhere else in the world. I was fortunate enough to add to the number of the indigenous mosses of Mt. Gower, and I have no doubt that others will yet be discovered. Very interesting, also, is the eastern side of Mt Lidgbird, where the land slopes up from the ocean to enormous cliffs that bar access, on that side at any rate, to the top of the mountain. The centre and north of the island, while less interesting bryologically than the southern end, are by no means negligible; and the neighbourhood of the northern "Look-Out," the Northern Hills, and the North Head, supplied me with many treasures.

Specimens of nearly all my packets of mosses were submitted to Dr. V. F. Brotherus, and he kindly found time to examine them and report upon them. The results of our joint work appear in the following pages. Twenty-two new species are described, and a few new varieties.

Some supplementary notes, dealing mainly with previous records, will be found at the end.

I take this opportunity of sincerely thanking Dr. Brotherus for his invaluable assistance, without which the publication of this paper would have been scarcely possible.

i. Group **Acrocarpi.**

DICRANACEÆ.

TREMATODON Michx.

TREMATODON sp. (sporogon destroyed).

Second open gully, south of King's, at western base of Mt. Lidgbird.

The specimens were indeterminable, on account of the capsules being too old; plants should be collected in April or May, or in October or November.

CERATODON Brid.

C. PURPUREUS (L.) Brid.

Open gully, south of King's.

HOLOMITRIUM Brid.

H. PERICHÆTIALE (Hook.) Brid.

Saddle-Back and Mt. Gower.

Var. ROBUSTUM Broth. et Watts, var.nov.

Robustior, folia sicca minus crispata, haud circinato-incurva. Saddle Back (No.449).

DICRANOLOMA Ren.

D. BARTRAMIOIDES (Broth.) Par.

Mt. Gower, on trees.

D. DICARPUM (Hsch.) Par.

Mt. Gower; Saddle Back; Erskine Valley; track to "Dinner Run"; etc.

D. MENZIESII (Tayl.) Par.

Mt. Gower, mixed with *D. bartramioides* and *D. dicarpum* (No.426).

LEUCOLOMA Brid.

L. SIEBERIANUM (Hsch.) Par.

Saddle Back; Mt. Gower; etc.

f. LONGIPILA.

On slopes of Mt. Gower, above the Saddle Back, mixed with the typical *L. Sieberianum.*

CAMPYLOPUS Brid.

C. CLAVATUS (R.Br.) H.f.W.

Mt. Gower.

C. INTROFLEXUS (Hedw.) Mitt.

At several places, mostly at northern end of the Island,—the typical plant and other forms.

C. PUDICUS (Hsch.) Jæg.

Northern Look-Out.

C. WOOLLSIANUS (C.M.) Par.

Face of Mt. Lidgbird (eastern side), mixed with *Bryum leptothecium.*

LEUCOBRYACEÆ.

LEUCOBRYUM Hampe.

L. CANDIDUM Brid.

Top of Mt. Gower.

L. PSEUDOCANDIDUM Broth.

Seacliff near Flagstaff; gully, south of King's; hillside above Johnson's; on decayed log, track to Dinner Run; Mt. Gower; etc.

L. SPEIROSTICHUM C.M.

Dinner Run, mixed with *Dicranoloma dicarpum.*

FISSIDENTACEÆ.

FISSIDENS Hedw.

Bryoidium C.M.

FISSIDENS (Bryoidium) AMBLYOTHALLIOIDES Broth. et Watts, sp.nov.

Dioicus; gracilis, cæspitosus, cæspitibus densiusculis, pallide viridibus, opacis; *caulis* usque ad 7 mm. longus, cum foliis c. 1·5 mm. latus, laxiuscule foliosus, simplex vel parce ramosus; *folia* sicca homomalla, apice circinato-incurva, humida stricti-uscula, erecto-patentia, infima minuta remota, superiora multo majora, ovato-lanceolata, acuta, marginibus apice minutissime serrulatis, limbata, limbo angustissimo, in parte basilari laminæ dorsalis deficiente, lamina vera ad medium folii evanida, lamina dorsali ad basin nervi enata, ibidemque angustata, nervo sat tenui, infra summum apicem folii evanido, cellulis minutissimis, rotundato-hexagonis, sublævibus. Cætera ignota.

Gully, south of King's (n.153, 157, 178, 145, 163); North Head (n.494 ex p.); edge of sideling on way to King's (n.102); paddock at north end of Island (n.78); Dinner "Run" (n.327).

Species habitu speciebus minoribus Sect. *Amblyothallia* similis, foliis dense areolatis, limbo in parte basilari laminæ dorsalis deficiente notabilis.

F. DIETRICHIÆ C.M.

Gully at back, and south, of "The Pines," and in open gully south of King's.

Aloma C.M.

FISSIDENS (Aloma) SUBTENELLUS Broth. et Watts, sp.nov.

Autoicus; tenellus, cæspitosus, cæspitibus laxiusculis, viridibus, opacis; *caulis* brevissimus, infima basi fusco-radiculosus, dense foliosus, simplex; *folia* pauci-juga, erecto-patentia, stricta, linearia, breviter acuminata, acuta, usque ad 1·5 mm. longa et medio 0·2 mm. lata, marginibus minutissime crenulatis, elimbata, lamina vera ad medium folii producta, lamina dorsali ad basin nervi enata ibidemque angustata, nervo crassiusculo, infra summum apicem folii evanido, cellulis rotundato-hexagonis, 0·010-0·012 mm., pellucidis, papilla media humili instructis; *seta* c. 3 mm. alta, tenuissima, rubella; *theca* minuta, erecta, ovalis, pallida; *operculum* recte rostratum ; *calyptra* mitræformis, operculum obtegens, scabra.

Track above sugarcane back of Paton's (n.56); back of Gower Wilson's (n.60 ex p.).

Species *F. tenello* Hook. fil. et Wils. valde affinis, sed foliis minutissime crenulatis, cellulis minutius papillosis dignoscenda.

FISSIDENS (Aloma) TENELLIFORMIS Broth. et Watts, sp.nov.

Species præcedenti affinis, sed foliis usque ad 2·5 mm. longis, nervo crassiore, plus minusve longe excedente, cellulis minoribus, papilla media altiore instructis diversa.

On earth, Northern Hills (n.209, 221, 223).

F. TENELLUS, H.f.W.

Gully at back of Henderson's.

Amblyothallia C.M.

F. ARBOREUS Broth.

Erskine Valley; Black Face, etc., Mt. Lidgbird; "Run," Scaly Bark; and Northern Hills.

F. (Amblyothallia) LONGILIGULATUS Broth. et Watts, sp.

Robustiusculus, gregarie crescens, saturate viridis, opacus; *caulis* fertilis c. 5 mm., sterilis usque ad 1·5 cm. longus, cum foliis c. 2 mm. latus, infima basi fusco-radiculosus, dense foliosus, simplex vel furcatus; *folia* multijuga, subæqualia, sicca plerumque apice circinato-incurva, humida erecto-patentia, stricta, e basi oblonga elongate et anguste ligulata, obtusiuscula vel obtusa, marginibus apice minutissime crenulatis, elimbata, lamina vera ad medium folii producta, lamina dorsali ad basin nervi enata ibidemque rotundata, nervo crasso, lutescente, infra summum apicem folii evanido, cellulis minutissimis, rotundato-hexagonis, valde chlorophyllosis; *seta* terminalis, c. 3 mm. alta, tenuis, pallide rubra; *theca* inclinata, asymmetrica, ovalis, sicca deoperculata sub ore paulum constricta, pallida; *operculum* ignotum; *calyptra* ignota.

On trees, Mt. Gower (n.382, 525).

Species *F. arboreo* Broth., affinis, sed foliorum forma, nervo crasso cellulisque minoribus optime diversa.

F. (Amblyothallia) WATTSII Broth., sp.nov.

Tenellus, gregarie crescens, glaucoviridis, opacus; *caulis* vix ultra 3 mm. longus, cum foliis c. 1·7 mm. latus, strictus, infima basi fusco-radiculosus, dense foliosus, simplex; *folia* infima remota, minuta, superiora raptim multo majora, 5-7 juga, sicca et humida erecto-patentia, stricta, linearia, lanceolato-acuminata, acutissima, marginibus crenulatis, elimbata, lamina vera ad medium folii producta, lamina dorsali ad basin nervi enata ibidemque angustata, nervo crassiusculo, continuo vel subcontinuo, cellulis rotundato-hexagonis, 0·007-0·010 mm., pellucidis. Cætera ignota.

Northern Hill (n.224); Dinner Run (n.337); "Run," Scaly Bark (n.515, 518); Stone, Intermediate Hill (n.136).

Species pulchella, tenella, foliis strictis, linearibus, lanceolato-acuminatis faciliter dignoscenda.

F. (Amblyothallia) ARCUATULUS Broth. et Watts, sp.nov.

Tenellus, cæspitosus, cæspitibus laxis, sordide viridibus, opacis; *caulis* usque ad 5 mm. longus, cum foliis c. 1·2 mm. latus, infima basi fusco-radiculosus, dense foliosus, simplex; *folia* omnia æqualia, usque ad 15 juga, sicca homomalla, humida stricta, erecto-patentia, arcuatula, anguste linearia, breviter acuminata, acuta, marginibus minutissime crenulatis, elimbata, lamina vera ad medium folii producta, lamina dorsali ad basin nervi enata ibidemque angustata, nervo tenuisculo, albido, infra apicem folii evanido, cellulis rotundato-hexagonis, minutissimis; papillosis, subobscuris. Cætera ignota.

On ground beyond Robins' farm (n.118).

Species præcedenti affinis, sed statura minore, caule æqualiter folioso, foliis arcuatulis, breviter acuminatis, nervo tenuiore, cellulis subobscuris optime diversa.

CALYMPERACEÆ.

SYRRHOPODON Schwgr.

S. PLATYCERII Mitt.

Found at only one spot (up the slope at the back of Johnson's), and a mere scrap (n.114).

POTTIACEÆ.

HYMENOSTOMUM R.Br.

HYMENOSTOMUM sp.ster.

Second open gully, south of King's (n.183).

WEISIA Hedw.

W. FLAVIPES H.f.W.

Northern Look-Out; and second open gully, south of King's.

TORTELLA (C.M.) Limpr.

T. SUBFLAVOVIRENS Broth. et Watts, sp.nov.

Dioica; gracilis, cæspitosa, cæspitibus densis, læte viridibus, inferne fuscescentibus, nitidiusculis; *caulis* erectus, vix ultra 1 cm. longus, fusco-radiculosus, dense foliosus, dichotome ramosus vel simplex; *folia* sicca circinato-crispata, humida patentia, carinato-concava, e basi albicante, adpressa breviter lanceolato-linearia, obtusa, mucronata, usque ad 3 mm. longa, marginibus erectis, integerrimis, nervo crasso breviter excedente, dorso albido, nitido, cellulis minutissimis, dense verrucosis, opacis, basilaribus oblongis, teneris, hyalinis, utrinque ad marginem laminæ brevi spatio adscendentes; *seta* 1-1·5 cm. alta, tenuissima, rubra, apice lutescens; *theca* erecta, minuta, cylindrica; *annulus* 0; *peristomium* rubrum, papillosum, cruribus oblique positis, haud contortis; *operculum* cellulis in seriebus subobliquis positis.

Sandy Cliff by Flagstaff (n.300, 174); rocks near Wilson's (n.84, 83); Blenkenthorp's Beach (n.524); rocks by sea, Johnson's (n.108); stone-border, Wilson's Garden (n.502 ex p.); on rocks, Middle Beach (n.106), etc.

Species *T. flavovirenti* (Bruch.) Broth., valde affinis.

Very plentiful on rocks and sandy soil near the sea, on all sides of the Island. The only good fruiting specimen was found on sandy ground, near the Flagstaff. This plant was, earlier, confused with Hampe's *Trichostomum cirrhatum*, from Western Australia.

BARBULA Hedw.

B. CALYCINA Schwgr.

Northern Hills.

TORTULA Hedw.

T. BAILEYI Broth.

Northern Hills, on rocks and in rock-crevices; also on rocks below Wilson's, close to the water.

GRIMMIACEÆ.

GLYPHOMITRIUM Brid.

G. COMMUTATUM (C.M.) Broth.

On rocks, Northern Look-out; Northern Hills and North Head; very plentiful. I did not find it in the south of the Island (W.W.W.).

G. HOWEANUM (Hpe.) Broth.

Top of Northern Hills; also on Mt. Gower.

GRIMMIA Ehrh.

G. CAMPESTRIS Burch.; *G. leucophæa* Grev.; *G. leiocarpa* Tayl.
Northern Hills; Northern Look-out; and North Head.

G. PULVINATA (L.) Sm., var. OBTUSA (Brid.) Br. Eur.; *G. cygnicollis* Tayl.

Second gully south of King's; and on top of Northern Hills.

ORTHOTRICHACEÆ.

MACROMITRIUM Brid.

M. BREVISETACEUM Hampe.

Plentiful on trees on the coastal flats; also found on the Northern Hills, and on Transit and Intermediate Hills, but I have no specimens from Mounts Lidgbird and Gower.

M. PERARISTATUM Broth.

Mt. Gower. A remarkably fine species.

M. SUBBREVICAULE Broth. et Watts, sp.nov.

Species *M. brevicauli* Besch., foliorum structura valde affinis, sed statura robustiore oculo nudo jam dignoscenda. Sporogonia ignota.

Growing mostly on cliffs at North Head and on the Northern Hills (n.236, 239, 478, 504, 507).

MACROMITRIUM sp., ster.

Northern Look-out.

FUNARIACEÆ.

FUNARIA Schreb.

F. HYGROMETRICA (L.) Sibth.

Scarce; found at North Head, and on the ground near Dignam's.

BRYACEÆ.

BYRUM Dill., emend. Schimp.

Areodictyon C.M.

BYRUM (Areodictyon) DIVERSINERVE Broth. et Watts, sp.nov.

Dioicum; gracilescens, cæspitosum, cæspitibus densis, mollibus, pallide viridibus, opacis; *caulis* erectus, usque ad 1·5 cm. longus, basi fusco-radiculosus laxiuscule foliosus, simplex; *folia* sicca adpressa, humida patentia, carinato-concava, oblonga, breviter acuminata, acuta, marginibus erectis vel suberectis, integris, nervo crassiusculo, infra summum apicem folii evanido, cellulis teneris, laxis, rhomboideis vel oblongo-hexagonis, marginalibus elongatis, angustis, limbum angustissimum efformantibus, basilaribus rectangularibus. Cætera ignota.

Sea-cliff, Middle Beach (n.105); Northern Hills (n.283); gully, south of King's (n.190).

Species *Br. Wildii* Broth., affinis, sed foliis breviter acuminatis, nervo crassiore dignoscenda.

Argyrobryum C.M.

B. ARGENTEUM L.

Mt. Gower and Dignam's garden.

Var. NIVEUM H.f.W.

Top of Northern Hills.

Var. LANATUM Br.Eur.

Wilson's garden (border of footpath); and North Head.

Doliolidium C.M.

Bryum (Doliolidium) æquicollum Broth. et Watts, sp.nov.

Dioicum; gracile, cæspitosum, cæspitibus compactis, pallide viridibus, ætate lutescenti-viridibus sericeo-nitidis; *caulis* erectus, cum innovationibus usque ad 1 cm. vel paulum ultra longus, fusco-tomentosus, densiuscule foliosus, in axillis foliorum propagulis gemmiformibus instructus, innovationibus binis, breviusculis, erectis, æqualiter foliosis; *folia* erecto-patentia, carinato-concava, breviter ovato-lanceolata, aristata, marginibus erectis vel angustissime revolutis, apice minutissime denticulatis, nervo crasso, in aristam rigidam, lævem excedente, cellulis haud incrassatis, rhomboideis vel oblongo-hexagonis, basilaribus brevioribus, subrectangularibus, marginalibus angustis, limbum uniseriatum, indistinctum efformantibus; *seta* 1-1·5 cm.; tenuissima, flexuosula lutescenti-rubra; *theca* subnutans, cum collo subventricoso, sicco ruguloso, sporangii longitudinis oblongo-ovatis, fusco-rubra; operculum convexum, mammillatum.

Among rocks one mile south of King's (n.207); open gully south of King's (n.147d, 213a); Mt. Gower (n.360, 408); also Northern Hills, and sea-cliff, Middle Beach.

Species *Br. pachythecæ* C. Müll., affinis, sed collo nec sporangio crassiore nec basi impresso jam dignoscenda.

B. coronatum Schwgr., f. robusta.

Mt. Gower.

B. (Doliolidium) philonotideum Broth. et Watts, sp.nov.

Dioicum; gracile, cæspitosum, cæspitibus compactis, lutescenti-viridibus, nitidiusculis; *caulis* erectus, cum innovationibus usque ad 1·5 cm. longus, fusco-tomentosus, dense foliosus, propagulis gemmiformibus axillaribus instructus, innovationibus binis, brevibus, æqualiter foliosis; *folia* erecto-patentia, carinato-concava, ovato-lanceolata, aristata, marginibus anguste revolutis, apice serrulatis, nervo crassiusculo, in aristam elongatam, serrulatam excedente, cellulis anguste rhomboideis vel oblongo-hexagonis, basilaribus laxioribus, breviter rectangularibus. Cætera ignota.

Rocks, Blenkenthorp's Beach (n.526).

Species *Br. æquicollo* affinis, sed foliis angustioribus, nervo longius aristato, cellulis superioribus angustioribus dignoscenda, habitu *Philonotidis*, unde nomen.

B. SUBATROPURPUREUM C.M.

On sandy ground in front of "The Pines," in large quantities.

Alpiniformia Kindb.

B. (Alpiniformia) LIMBIFOLIUM Broth. et Watts, sp.nov,

Dioicum; gracilescens, cæspitosum, cæspitibus densis, viridibus, opacis; *caulis* procumbens vel adscendens, fusco-radiculosus, dense foliosus, parce et vage ramosus; *folia* sicca suberecta, humida patentia, elongate oblonga, breviter acuminata, mucronata, c. 2 mm. longa et c. 0·57 mm. lata, marginibus erectis, integris, nervo crasso, breviter excedente; cellulis oblongo-hexagonis vel rhomboideis, haud incrassatis, marginalibus linearibus, limbum pluriseriatum efformantibus, basilaribus rectangularibus. Cætera ignota.

Growing in the drip of a waterfall at the head of the "Dinner Run" on the eastern side of Mt. Lidgbird.

Species distinctissima, foliis angustis, late limbatis, nervo breviter excedente facillime dignoscenda.

Rosulata C.M.

B. (Rosulata) HOWEANUM Broth. et Watts, sp.nov.

Dioicum; gracilescens, cæspitosum, cæspitibus densis, viridibus, inferne fuscescentibus, nitidiusculis; *caulis* erectus, cum innovationibus c. 2 cm. longus, fusco-tomentosus, dense foliosus, innovando ramosus; *folia* sicca spiraliter contorta, humida erecto-patentia, carinato-concava, inferiora remotiuscula, minora, sæpe destructa, apicalia in rosulam dense congesta, e basi breviter et late spathulata ovalia, acutiuscula, aristata, marginibus fere ad apicem revolutis, apice minutissime serrulatis, haud limbata, nervo crassiusculo, superne sensim tenuiore, in aristam elongatam, strictam, integram excedente, cellulis ovali-hexagonis, basilaribus rectangularibus. Cætera ignota.

North Head (n.500, 501, 503, 510).

Species *Br. Billardierii* Schwægr., affinis, sed foliis siccis spiraliter contortis, nervo in aristam longam excedente optime diversa.

B. LEPTOTHECIUM Tayl.

Many parts of the Island, sometimes typical, but mostly in various forms, including "forma foliis acuminatis argute serratis." (at back of Gower Wilson's, plentiful).

B. (Rosulata) LEPTOTHECIOIDES Broth. et Watts, sp.nov.

Dioicum; gracilescens, cæspitosum, cæspitibus densis, viridibus, nitidiusculis; *caulis* erectus, cum innovationibus 5-7 mm. longus, fusco-tomentosus, dense comoso-foliosus, innovando-ramosus; *folia* sicca plus minusve distincte spiraliter contorta, humida erecto-patentia, carinato-concava, comalia e basi breviter et late spathulata ovalia, acutiuscula, aristata, marginibus fere ad apicem anguste revolutis, apice minute serrulatis, limbata, nervo crassiusculo, superne sensim tenuiore, in aristam elongatam, strictam, integram excedente, cellulis laxis, oblongo-hexagonis, in medio folii 0·05-0·06 mm. longis et c. 0·015 mm. latis, basilaribus subrectangularibus, marginalibus elongatis, angustis, limbum lutescentem, 2-3 seriatum efformantibus; *seta* usque ad 3 cm. alta, rubra; *theca* subnutans e collo sporangio æquante oblonga, macrostoma, fusca.

Rocks by sliprails south of Robins' farm (n.100); gully south of King's, base of Mt. Lidgbird (n.151, 152, 162, 176, 180); Blenkenthorp's Beach (n.489, 526); Northern Hills (n.235a, 284a); rock and soil back of Gower Wilson's (n.66); North Head (n.491, 494, 506a).

Species habitu formis minoribus *Br. leptothecio* similis, sed foliis nervo longe excedente cellulisque laxis optime diversa.

RHODOBRYUM.

R. LEUCACANTHUM Hampe.

North Head; gully south of King's; Mt. Gower.

LEPTOSTOMACEÆ.

LEPTOSTOMUM R.Br.

L. MACROCARPUM (Hedw.) R.Br.

Eastern face of Mt. Lidgbird; Saddle Back; Mt. Gower.

RHIZOGONIACEÆ.

MESOCHÆTE Lindb.

M. UNDULATA Lindb.

Dinner Run (n.336).

BARTRAMIACEÆ.

PHILONOTIS Brid.

PH. JARDINI (Besch.) Broth.

In "Run," Erskine Valley (n.453, 455, 463). Previous record: Tahiti.

PH. PSEUDOMOLLIS (C.M.) Jæg.

Gully, south of King's; Dinner Run; Soldier's Creek, etc.

In addition to the typical plant (several nos.), one or more "forms" were collected in the places named.

PH. TENUIS (Tayl.) Jæg.

Black Face, Mt. Lidgbird; Erskine Valley; face, eastern side of Mt. Lidgbird; Mt. Gower.

POLYTRICHACEÆ.

CATHARINEA Ehrh.

C. MUELLERI Hpe. et C.M.

Top of Mt. Gower.

ii. Group **Pleurocarpi.**

SPIRIDENTACEÆ.

SPIRIDENS Nees.

S. MUELLERI Hampe.

Growing mostly on the stems of tree-ferns on the top of Mt. Gower, in large quantities. It is one of the most striking and handsome mosses in the world, especially when seen in its native state.

ECHINODIACEÆ.

ECHINODIUM Jur.

E. HISPIDUM (H.f.W.) Jæg.

Dinner Run; Mt. Gower; etc. Plentiful on the top of the mountain.

E. PARVULUM Broth. et Watts, sp.nov.

Dioicum; tenellum, cæspitosum, cæspitibus laxis, rigidis, saturate viridibus, opacis; *caules secundarii* conferti, usque ad 2 cm. longi, inferne simplices, dein pinnatim ramosi, ramis patentibus, usque ad 1·5 cm. longis, densiuscule foliosis, simplicibus vel parce ramulosis; *folia* sicca crispulo-falcatula, humida falcatula, e basi late ovata subraptim ligulata, breviter lanceolato-acuminata, acuta, c. 2 mm. longa et basi c. 0·57 mm. lata, marginibus inferne late subrecurvis, apice minutissime serrulatis vel subintegris, nervo crasso, infra summum apicem folii evanido, cellulis minutis, incrassatis, subrotundis, pellucidis. Cætera ignota.

In "Run" above "Scaly Bark," Mt. Lidgbird (n.517).

Species *E. umbroso* (Mitt.), valde affinis, sed ramificatione foliisque basi latioribus, brevius acuminatis, cellulis pellucidis dignoscenda.

PTYCHOMNIACEÆ.

PTYCHOMNION H.f.W.

P. ACICULARE (Brid.) Mitt.

Top of Mt. Gower.

NECKERACEÆ.

PTEROBRYELLA (C.M.) C.M.

P. PRÆNITENS (Hpe.) C.M.

Saddle Back and slopes below, especially on eastern side.

TRACHYLOMA Brid.

T. WATTSII Broth., sp.nov.

Dioicum; robustum, cæspitosum, cæspitibus densis, læte viridibus, sericeo-nitidis; *caulis primarius* rhizomaticus, fusco-tomentosus; *caules secundarii* congesti, usque ad 7 cm. longi, corpuscula filiformia, articulata, fusca gerentes, dense et complanate foliosi, basi simplices, dein irregulariter pinnatim ramosi, ramis patentibus, vix ultra 2 cm. longis, complanatis, dense foliosis, simplicibus, obtusis; *folia* infima adpressa, squamæformia, sæpe destructa, cætera erecto-patentia, sicca erectiora, concava, elongate oblonga, sensim breviter lanceolato-acuminata, breviter subulato-acutata, subula semitorta, marginibus erectis, superne minute serrulatis, nervo simplici, basi crassiusculo, superne multo tenuiore, ultra medium folii evanido, cellulis anguste linearibus, basilaribus laxioribus, abbreviatis, inter se porosis, alaribus haud diversis; *bracteæ perichætii* erectæ, e basi vaginante, plicata, sensim lanceolato-subulatæ, superne minute serrulatæ; *seta* c. 2 cm. alta, rubra; *theca* erecta, oblongo-cylindrica, fusca; *peristomium* destructum.

Mt. Gower (n.357).

Species pulcherrima, cum nulla alia commutanda.

EUPTYCHIUM Schimp.

E. MUCRONATUM Hpe.

Slopes of Mts. Lidgbird and Gower.

E. ROBUSTUM Hpe.

Slopes and top of Mt. Gower.

WEYMOUTHIA Broth.

W. MOLLIS (Hedw. as *Leskea*) Broth.

Mt Gower.

BARBELLA (C.M.) Fleisch.

B. ENERVIS (Thwait. et Mitt.) Fl.; *Neckera trichophoroides* Hpe., fid. Fleisch.

Upper slopes and top of Mt. Gower.

ORTHORRHYNCHIUM Reichdt.

O. ELEGANS (H.f.W.) Reichdt.

Mt. Gower (n.369, 395, 416).

THAMNIUM Bryol. eur.

TH. GRACILLIMUM (Hpe. as *Rhizogonium*).

Erskine Valley; Mt. Gower; gully at back of "The Pines," etc.

CAMPTOCHÆTE Reichdt.

C. DEFLEXA (Wils.) Jæg.

Eastern side of Mt. Lidgbird; Mt. Gower.

C. GRACILIS (H.f.W.).

On rocks above Robins' farm; Mt. Gower.

C. VAGA (Hsch.) Broth.

Top of Mt. Gower.

ENTODONTACEÆ.

ENTODON C.M.

E. PANCHERIANUS Besch.

Very plentiful on the slopes of the Northern Hills (on wet rocks); and near the Northern Look-out: also on Mt. Gower.

Previous record: New Caledonia.

HOOKERIACEÆ.

DISTICHOPHYLLUM D. et M.

D. LONGICUSPES Broth.

Erskine Valley; Dinner Run; Mt. Gower.

PTERYGOPHYLLUM Brid.

PT. HEPATICÆFOLIUM (Hpe. et C.M.) Jæg.

Dinner Run; Erskine Valley; Mt. Gower.

PT. NIGELLUM (H.f.W.) Jæg.

Mt. Gower.

HYPOPTERYGIACEÆ.

CYATHOPHORUM Palis.

C. BULBOSUM (Hedw.) C.M.

Top of Mt. Gower.

HYPOPTERYGIUM Brid.

H. MUELLERI Hpe. et C.M.

Dinner Run; gully south of King's, etc.

RHACOPILACEÆ.

RHACOPILUM Palis.

RH. CONVOLUTACEUM Hpe.

Several localities, including the top of Mt. Gower.

f. ROBUSTA.

Robins' Swamp (n.138 and 306).

RH. PACIFICUM Besch.

On rocks by Wilson's boat-shed, mixed with a *Tortula* (n.82).

Previous record: New Caledonia, Samoa, Tahiti.

LESKEACEÆ.

THUIDIUM Br. eur.

TH. CYMBIFOLIUM (D. et M.) Br. jav.

Top of Mt. Gower (n.362, 377, 388, 425).

TH. FURFUROSUM (H.f.W.) Jæg., var.

Open gully south of King's.

THUIDIUM (Thuidiella) TRACHYPODIOIDES Broth. et Watts, sp.nov.

Autoicum; gracillimum, cæspitosum, cæspitibus densis, viridissimis, opacis; *caulis* elongatus, repens, per totam longitudinem hic illic fusco-radiculosus, laxe foliosus, bipinnatim ramosus; *folia caulina* erecto-patentia, e basi hastato-ovata lanceolato-subulata, marginibus erectis, integris, nervo crassiusculo, in apice evanido, cellulis minutis, angulato-rotundatis, pellucidis, levibus; *folia ramulina* sicca subincurva, humida, erecto-patentia, ovato-ovalia, obtusa, marginibus late recurvis, crenulatis, nervo pallido, longe infra apicem folii evanido, cellulis minutis, rotundatis, valde chlorophyllosis, papillosis, obscuris; *bracteæ perichætii* internæ erectæ, ovato-lanceolatæ, in subulam elongatam, filiformem sensim attenuatæ, longe et dense fimbriatæ, apice minute denticulatæ; *seta* brevis, tenuis, rubra, scaberrima. Cætera ignota.

On coral rocks, gully behind "The Pines" (n.287, 289, 293, 537); south of King's, open gully (n.164) and creek (n.171); top of Mt. Gower (n.389).

Species *Th. trachypodo* (Mitt.) habitu simillima, sed bracteis perichætii longe fimbriatis dignoscenda.

HYPNACEÆ.

Hylocomieæ.

CTENIDIUM (Schimp.) Mitt.

C. PUBESCENS (H.f.W.) Broth.

Face of Mt. Lidgbird; Mt. Gower.

Stereodonteæ.

ECTROPOTHECIUM Mitt.

E. HOWEANUM Broth. et Watts, sp.nov.

Autoicum; gracilescens, cæspitosum, cæspitibus densiusculis, depressis, viridissimis, nitidis; *caulis* elongatus, repens, per totam longitudinem fusco-radiculosus, dense pinnatim ramosus, ramis patulis, densiuscule foliosis, vix ultra 5 mm. longis, valde complanatis, cum foliis c. 1·5 mm. latis, obtusis; *folia* concaviuscula, *caulina* patentia, lanceolata, breviter acuminata, marginibus erectis, superne minute serrulatis, nervis binis, brevissimis, cellulis elongatis, angustissimis, levissimis, basilaribus infimis brevioribus et laxioribus, alaribus haud diversis, *ramea* patentia, superiora indistincte falcatula, brevius acuminata, argutius serrata; *bracteæ perichætii* internæ e basi vaginante subsensim longe lanceolato-subulatæ, superne serrulatæ; *seta* c. 2 cm. alta, tenuissima, lutescenti-rubra; *theca* nutans, ovalis, sicca deoperculata sub ore vix constricta, pallide fusca; *operculum* ignotum.

On rocks in deep gully at back of "The Pines," July, 1911, (n.530, 533).

Species *E. leucochloro* affinis, sed ramis valde complanatis, foliis breviter acuminatis, patentibus nec falcatis oculo nudo jam dignoscenda.

E. LEUCOCHLORON (Hpe.).

Very plentiful throughout the Island, on the lower levels.

STEREODON (Brid.) Mitt.

S. CHRYSOGASTER (C.M.) Mitt.

Top of Mt. Gower; and in Erskine Valley.

ACANTHOCLADIUM Mitt.

A. EXTENUATUM (Brid.) Mitt.

Top of Mt. Gower.

Plagiotheciea.

ISOPTERYGIUM Mitt.

I. CANDIDUM (C.M.) Jæg.

Frequent on the lower levels.

I. HOWEANUM Broth. et Watts, sp.nov.

Autoicum; robustiusculum, cæspitosum, cæspitibus densiusculis, depressis, lutescenti-viridibus, nitidis; *caulis* elongatus, repens, per totam longitudinem fusco-radiculosus, dense foliosus, dense pinnatim ramosus, ramis complanatis, vix ultra 5 mm. longis, obtusis; *folia* homomallula, concaviuscula, ovato-lanceolata, subulato-acuminata, marginibus erectis, superne minutissime denticulatis, enervia, cellulis anguste linearibus, basilaribus infimis multo brevioribus et laxioribus, alaribus haud diversis; *bracteæ perichætii* internæ e basi vaginante, raptim longe subulatæ, subula denticulata; *seta* 1·5-2 cm. alta, tenuissima, lutescenti-rubra; *theca* nutans, oblongo-ovalis, sicca deoperculata sub ore paulum constricta, pallide fusca; *operculum* breviter et obtuse rostratum

On rotten log, back of Johnson's (n.112).

Species distinctissima, ab *I. candido* statura multo robustiore, seta elongata thecaque nutante raptim dignoscenda.

CATAGONIUM (C.M.) C.M.

C. POLITUM (H.f.W. as *Hypnum*) Broth.

Top of Mt. Gower.

VESICULARIA (C.M.) C.M.

V. MONTAGNEI (C.M.).

On wet rocks, Dinner Run(n.320); and Run, Scaly Bark(n.520).

SEMATOPHYLLACEÆ.

RHAPHIDOSTEGIUM (Br. eur.) De Not.

RH. CONTIGUUM (H.f.W.) Par.

Throughout the Island; plentiful.

RH. (Cupressinopsis) SUBFALCATULUM Broth. et Watts, sp.nov.

Autoicum; gracilescens, cæspitosum, cæspitibus densiusculis, depressis, mollibus, lutescentibus, nitidis; *caulis* elongatus, repens, per totam longitudinem fusco-radiculosus, dense foliosus, pinnatim ramosus, ramis vix ultra 3 mm. longis, patentibus, complanatulis, obtusis; *folia* indistincte falcatula, concava, e basi oblongo-lanceolata sensim in acumen elongatum piliforme attenuata, marginibus erectis vel angustissime recurvis, apice serrulatis, enervia, cellulis angustissime linearibus, levissimis, alaribus magnis, oblongis, vesiculosis, fusco-aureis; *bracteæ perichætii* internæ e basi vaginante in subulam elongatam, argute serratam sensim attenuatæ; *seta* c. 1·5 cm. alta, tenuissima, rubra, levissima; *theca* horizontalis, minuta, ovalis, sicca deoperculata sub ore vix contracta, pallide fusca; *operculum* longe rostratum.

On rotten log, Intermediate Hill (n.134, 135); Creek above Johnson's (n.122); gully at back of Henderson's (n.131); Mt. Gower (n.370, 400); top of Mt. Gower (n.364a).

Species *Rh. callidioidi* (C. Müll.), affinis, sed statura robustiore foliisque indistincte falcatulis oculo nudo jam dignoscenda.

TRICHOSTELEUM (Mitt.) Jæg.

T. MUSCICOLUM Broth.

Several places on the slopes of Mts. Lidgbird and Gower; also on the top of Mt. Gower, and in Erskine Valley.

BRACHYTHECIACEÆ.

OXYRRHYNCHIUM (Br. eur.) Warnst.

O. HOWEANUM Broth. et Watts, sp.nov.

Synoicum; robustiusculum, cæspitosum, cæspitibus densiusculis, rigidis, læte viridibus, dein fuscescenti-viridibus, nitidis; *caulis* elongatus, repens, flexuosus, plus minusve fusco-radiculosus, laxe foliosus, pinnatim ramosus, ramis patulis, laxiuscule et complanate foliosis, vix ultra 1 cm. longis, simplicibus, singulis longioribus, attenuatulis, parce ramulosis; *folia caulina* erecto-patentia, e basi ovata sensim in acumen lanceolato-subulatum attenuata, marginibus erectis, ubique serrulatis, nervo crassiusculo, superne multo tenuiore, ad $\frac{3}{4}$ folii longitudinis vel ultra producto, cellulis angustissime linearibus, basilaribus infimis brevioribus et laxioribus, alaribus, haud diversis; *folia ramea* oblongo-ovata, breviter acuminata, argute serrata, nervo longiore, apice dentiformiter exstante; *bracteæ perichætii* internæ albidæ, e basi vaginante sensim lanceolato-subulatæ, subintegræ; *seta* c. 2 cm. alta, fuscescenti-rubra, scabriuscula; *theca* subnutans, ovalis, sicca deoperculata sub ore constricta, fusca; *operculum* breviter et crasse rostratum.

Mt. Gower, 2,800 p. (n.376, 392).

Species *O. remotifolio* (Grev., Hook. fil. et Wils.) affinis, sed seta scabriuscula jam dignoscenda.

RHYNCHOSTEGIELLA (Br. eur.) Limpr.

R. MURICULATA (H.f.W.) Broth., *forma*.

Mt. Gower, mixed with *Ctenidium pubescens*.

R. (Eurhynchostegiella) CAMPYLIOIDES Broth. et Watts, sp.nov.

Autoica; gracilis, cæspitosa, cæspitibus densis, læte viridibus, nitidiusculis; *caulis* elongatus, repens, parce fusco-radiculosus, divisus, divisionibus irregulariter pinnatim ramosis, dense foliosis; *folia* squarroso-patula, concaviuscula, e basi subhastato-ovata lanceolato-subulata, marginibus erectis, subintegris, nervo tenui ad medium folii evanido, cellulis linearibus, apice palillose exstante, alaribus sat numerosis, laxis, oblongis, hyalinis. Cætera ignota.

Swampy ground, open gully, south of King's (n.201).

Species *Rh. muriculatæ* (Hook. fil. et Wils.) affinis, sed foliis squarroso-patulis, e basi subhastato-ovata lanceolato-subulatis, subintegris, optime diversa.

RHYNCHOSTEGIUM Br. eur.

RH. TENUIFOLIUM (Hedw.) Jæg.

Mt. Gower; western base of Mt. Lidgbird; North Head, etc.

Var. HOWEANUM Broth. et Watts, var.nov.

Foliis latioribus, densius areolatis, seta plerumque longiore.

Very plentiful at the back of Gower Wilson's; also found in Robins' Swamp.

Supplementary Notes by Rev. W. W. Watts.

The preceding pages record exclusively the species collected by myself in 1911. I have made no attempt to determine how many of these species are new records, but the following notes may be of service.

1. Collectors from the Melbourne Herbarium were apparently first in the field; and Mitten's "Catalogue of Australian Mosses" (1882) mentions 16 species, collected by Milne, McGillivray, Fullagar, and Lind. The new species recorded in the Catalogue are based on Hampe's "Species muscorum novæ ex herbario Melbourneo Australiæ," published in *Linnæa*, Vol.xxxviii.(1874), viz., *Brachystelium Howeanum* (*Glyphomitrium*), *Macromitrium brevisetaceum*, *Rhodo-Bryum leucacanthum*, *Spiridens Muelleri*, *Euptychium mucronatum*, *E. robustum*, *Neckera trichophoroides*

(*Barbella enervis*), *Drepano-Hypnum leucochlorum* (*Ectropethecium*), and *Dendro-Hypnum prænitens* (*Pterobryella*).

All these are included in my collection.

In addition, Mitten's "Catalogue" records *Syrrhopodon Platycerii* Mitt., *Macromitrium Tongense* Sull., *Bryum Billardieri* Schwgr., and *B. Commersonii* Brid., *Rhaphidostegium contiguum* H.f.W., *Plagiothecium Howeanum* C.M. (*Hypnum*), and *Isopterygium molliculum* Sull.,(*H. Norfolkianum*; *H. nitidulum* Hpe. et C.M.).

Of these, *Macromitrium Tongense*, the two *Brya*, *Plagiothecium Howeanum*, and *I. molliculum*, are not represented in my collection.

I question the occurrence of *M. Tongense*, *Bryum Billardieri* and *Commersonii*, and *I. molliculum*.

2. In 1887, Mr. Thomas Whitelegge collected a few specimens on the Island, and the resulting list (determined by Dr. Brotherus) was published in these Proceedings (1892, Vol. vii., p.277).

Mr. Whitelegge's list includes the following, as new species: *Macromitrium peraristatum*, *Bryum Whiteleggei*, *Distichophyllum leucoloma* (apparently an error for *D. longicuspes*), *Trichosteleum muscicolum*, *Campylopus bartramioides* (*Dicranoloma*), *Leucobryum pseudo-candidum*, and *Fissidens howeanus*. Of these new species, *M. peraristatum*, *D. longicuspes*, *D. bartramioides*, *L. pseudo-candidum*, and *T. muscicolum* were published by Dr. Brotherus in "Some new Species of Australian Mosses," Part ii., 1893.

Mr. Whitelegge's list records two species which I did not find, viz., *Rhizogonium parramattense* C.M., and *Thuidium protensulum* C.M. Nor did I find the two undescribed species, *Bryum Whiteleggei* and *Fissidens howeanus*.

3. A few species were also brought to Sydney by Mr. J. H. Maiden, and Messrs. Hedley and Dun, but without any addition being made to previous lists.

4. *Tortella cirrhata* (Hpe.) is recorded for Lord Howe Island in the Melbourne Herbarium, but *T. cirrhata* belongs to Western Australia. The Lord Howe Island moss is a new species, *T. subflavovirens*.

5. *Catharinea semilamellosa* C.M., "Symbolæ" (1897), must be merged in *C. Muelleri.*

6. In the Sydney Herbarium, there is an interesting *Papillaria* (? *P. intricata* Mitt.) marked "Lord Howe Island, 26." I regard this as due to some error. I did not find any trace of *Papillaria* on the Island. Similarly, there is a specimen of *Macromitrium Dœmelii* C.M., marked "Lord Howe Island, 25," which must also be regarded with grave doubt. *Rhaphidostegium aciculum* C.M., is also recorded for Lord Howe Island, but this is, almost certainly, *Rh. contiguum.*

7. *Entodon pallidus* Mitt., has been recorded for the Island, but I did not find it.

TOPOGRAPHICAL AND ECOLOGICAL NOTES ON THE FLORA OF THE BLUE MOUNTAINS.

By A. A. Hamilton.

During occasional visits to the Blue Mountains, extending over a period of twenty years, desultory observations were made on the limitation of the range of several species of the flora, chiefly in respect of elevation. Three years ago, a systematic survey of the boundaries of certain well known species was commenced, but, as is invariably the case, the sphere of operations has become considerably enlarged, so that this paper deals briefly with some four hundred (400) species of the mountain-flora, which have been collected between the Nepean-Hawkesbury on the east, and Eskbank on the west, an area embracing the lowest and highest elevations on the Blue Mountains. A commencement was made with the material at hand in the National Herbarium, which, though rich in species, was found to be topographically weak, not a few of the labels, especially those of the early collectors, giving a no more explicit locality than the Blue Mountains. A fair sprinkling of the commoner plants were conspicuous by their absence, each collector, doubtless, considering that they had already been forwarded by an earlier one; while Glumiferæ, especially Juncaceæ, Restiaceæ, and Cyperaceæ, were, as usual, neglected. It was noted that fully fifty per cent. of the specimens had been collected by the Government Botanist, Mr. J. H. Maiden, many of them in company with Mr. R. H. Cambage, on their various journeys over the routes followed by Allan Cunningham and other Blue Mountain explorers (Journ. Proc. Roy. Soc. N. S. Wales, xliii., p.123), all of which are from specific localities. A field-collection was then started, to bridge the gaps, but an exhaustive search of such a large area was found to be impracticable in the time at the writer's disposal; and his justification for offering such an incomplete work is, that it may prove useful as a basis, which may be conveniently added to as occasion presents itself for further observations by the numerous devotees of this exceptionally interesting flora. Examples from the localities given in this paper, which were not already in the National Herbarium, have been incorporated in the collection.

In a paper published in Barron Field's "Geographical Memoirs on New South Wales," Allan Cunningham has given us, "A Specimen of the Botany of the Blue Mountains." "The Flora of Mt. Wilson," was dealt with by Mr. A. G. Hamilton, in these Proceedings, 1899, p.346. Mr. W. M. Carne has treated of a section of the area at a lower elevation, in his "Note on the Occurrence of a Limestone Flora at Grose Vale" (These Proceedings, 1910, p.849). "A List of the Plants collected in the Vicinity of the Jenolan Caves," by Messrs. W. F. Blakely and J. C. Wyburd (communicated by Mr. J. H. Maiden), will be found in the Agricultural Gazette of New South Wales, 1901, p.1390. Messrs. J. H. Maiden, F.L.S., and R. H. Cambage, F.L.S., have mentioned the Blue Mountain flora generally in "The Handbook of New South Wales," published under the auspices of the British Association for the Advancement of Science, 1914, p.410; also in the botanical, topographical, and geological notes (taken on their carefully detailed traverse) on some routes of Allan Cunningham (Journ. Proc. Roy. Soc. N. S. Wales xliii., p.123); and Mr. Cambage has touched upon some aspects of the climatic and geological influences on the flora in a paper read before the Australasian Association for the Advancement of Science, at Adelaide (Report xi., 1907). Both Mr. Hamilton and Mr. Carne note, in the respective areas dealt with, that many of the plants listed are not typical of the ordinary sandstone-flora of the mountains; and the same may be said of the Jenolan Caves area.

Some examples of the hygrophytic Nepean-Hawkesbury flora have attained a considerable altitude by avoiding the direct westerly ascent of the mountains, and following, instead, the courses of the Warragamba and Cox Rivers into the Jamieson and Kanimbla Valleys, from which they have crept up the moist, sheltered, brush-clad gorges at Wentworth Falls, Leura, Katoomba, Blackheath, and Mt. Victoria, frequently climbing up the débris at the base of the uppermost ledges of the escarpment to within a few feet of the level of the tableland, the process being repeated on the other side of the mountains viâ the Valley of the Grose.

King's Tableland, Wentworth Falls, forms a natural barrier east and west, which either checks or entirely prevents the ascent or descent of many species. On this bleak, wind-swept, soil-denuded plateau, which is typical of much of the area westward and upward, a xerophytic flora is in undisputed possession; and many of the plants from the coast and foothills, which have reached the elevation at Lawson, find the ascent of this sterile ridge a feat beyond the limit of their endurance, and are content to remain in the shelter of its eastern slopes. On the other hand, most of the dry-ridge xerophytes descending from the higher altitudes make their last stand on this elongated spur, finding on it the lowest elevation to which they can safely descend. A percentage of the swamp-xerophytes, chiefly Glumiferæ, persists to a much lower elevation. This objection, on the part of the dry-ridge xerophyte, to surroundings which would be considered ideal by many plants, is exemplified in the case of *Eriostemon obovalis* A. Cunn., which grows on the baldest and most exposed hilltops out to the cliff-edge. The fruits of this species are of the explosive type, and, when ripe, the polished and somewhat rounded seeds are expelled with considerable force, many of them rolling over the cliffs into the rich detritus of the moist, sheltered gully below. The seeds, however, resist the softening influence of the unfamiliar environment, and decline to germinate. The winged seeds of *Casuarina nana* Sieb., which are carried by the wind into positions favoured by most plants, provide another instance of the characteristic inability of the dry-ridge xerophyte to reproduce itself in unaccustomed surroundings, which will at once recur to botanists familiar with the Blue Mountain flora. Apparently an exception is provided by *Boronia anemonifolia* A. Cunn., which, when growing on the ridges, is an insignificant, scabrous, twiggy shrub, a few inches high, but gradually improves in size and appearance as it descends into more hospitable quarters, and, finally, becomes an open spreading shrub of 3-4 feet. An even more remarkable exception occurs near Bell, where, on the bald ridges, a *Leptospermum* was noted, which, prostrate and almost leafless, with short branches and thickened shoots, appeared to be in the last stages of degeneracy. Followed down a bush-track, the plants were seen to assume an upright habit, and fling out an occasional rampant branch, responding to the superior conditions of shelter, moisture, and food-supply, until, on reaching the Valley of the Grose, it had, by various stages, become a graceful shrub 12 feet high, thickly clad with delicate foliage. Several species which traverse the area under notice, undergo considerable modifications. *Acacia suaveolens* Willd., (which invariably displays xerophytic tendencies) maintains its coastal configuration until it reaches King's Tableland, when it assumes the habit of the elevated dry-ridge xerophyte (These Proceedings, 1914, p.471). Another example is *Bæckea densifolia* Sm., which, in the neighbourhood of Valley Heights, is an open, graceful plant, but, on the dry ridges exposed to the bleak "Westerlies" at the 3,500 feet level, it exhibits the usual characters resultant from its harsher environment (These Proceedings, 1914, p.254).

Traffic, here as elsewhere, is responsible for the distribution of the more adaptable species. Two of the most prominent are *Calotis cuneifolia* R.Br., (with blue), and *C. lappulacea* Benth., (with yellow flowers), both of which may be noted from the train following the railway-track throughout the area. The ubiquitous, weedy *Helichrysum apiculatum* DC., may also be placed in this category.

The following species have not previously been recorded (so far as the writer has ascertained) from the Blue Mountains:—*Comesperma defoliatum* F.v.M., *Claytonia Pickeringi* F.v.M., *Zieria pilosa* Rudge, *Boronia parviflora* Sm., *Viminaria denudata* Sm., *Bæckea diosmifolia* Rudge, *Melaleuca linariifolia* Sm., *Leucopogon appressus* R.Br., [In Barron Field's "Geographical Memoirs on New South Wales," p.341, Allan Cunningham records *L. appressus* R.Br., as frequent on the mountains. Bentham, Fl. Austr., iv., 223, shows that *L. appressus* R.Br., had been collected in only one locality, viz., Port Jackson, Coll.

R. Brown, adding, "Not seen in any other collection. The plant sent by A. Cunningham to De Candolle and described by him as *L. appressus*, does not differ from *L. esquamatus* R.Br." This specimen is referred to in DC., Prod., vii., 754, as *L. appressus* Br., Blue Mts., "Kingsfalls," Coll. Cunn. *L. esquamatus* R.Br., is thus recorded from the Blue Mountains for the first time in the Fl. Austr., iv., 223, a record which has been overlooked by the authors of the Handbook of the Flora of N. S. Wales. The rare *L. appressus* R.Br., (These Proceedings, 1913, p.110) is now recorded as a member of the Blue Mountain flora]; *Epacris pulchella* Cav., [it is singular that such a conspicuous species, which crosses the Blue Mountains tableland at all elevations, should have so long escaped recognition as a member of its flora by botanical writers], *Logania pusilla* R.Br., *Veronica notabilis* F.v.M., *Micrantheum ericoides* Desf., *Lepironia mucronata* Rich., *Schœnus ericetorum* R.Br.

Species previously recorded on the Blue Mountains from Mt. Wilson only are—*Cryptandra ericifolia* Sm., *Mirbelia reticulata* Sm., (another species found throughout the mountains in swamps and on sandstone-ridges, which has apparently been overlooked), *Gompholobium glabratum* DC., *Cassinia denticulata* R.Br., *Monotaxis linifolia* Brongn., ("Flora of Mt. Wilson," by A. G. Hamilton, These Proceedings, 1899, p.346).

Callistemon Sieberi DC., is recorded in the "Handbook of the Flora of N. S. Wales," by Moore and Betche, from the dividing range, but not specifically from the Blue Mts. It is plentiful in the swamp below the Newnes Junction railway station, also in a swamp about one and a half miles from Eskbank on the road to "Brown's Gap." It is confined to the higher elevations, and has not been collected east of Newnes Junction.

Kunzea corifolia Reichb., is noted for the first time as a Blue Mountain species by Miss Florence Sulman (Wild Flowers of New South Wales, p.155). Messrs Maiden and Cambage, in the "Flora of the Tablelands," (Handbook of New South Wales, Brit. Assocn. for the Advancement of Science, 1914, p.411) mention *Backhousia myrtifolia* Hook. & Harv., from the lower slopes; it had been recorded previously (on the Blue Mts.) only from the Jenolan Caves by Messrs. Blakely & Wyburd (Agric. Gaz. N. S. Wales, 1901, p.1390).

The following species and vars. are endemic on the Blue Mts.:—*Zieria involucrata* R.Br., *Pultenæa glabra* Benth., *Acacia trinervata* Sieb., *A. asparagoides* A. Cunn., *A. Baueri* Benth., var. *aspera* Maiden & Betche (ined.), *A. obtusata* Sieb., var. *Hamiltoni* Maiden & Betche, *A. Dorothea* Maiden, *Acrophyllum venosum* Benth., *Actinotus Forsythii* Maiden & Betche, *Goodenia dimorpha* Maiden & Betche, *Epacris reclinata* A. Cunn., *E. rigida* Sieb., *E. Hamiltoni* Maiden & Betche, *E. apiculata* A. Cunn., *Rupicola sprengelioides* Maiden & Betche, *Sprengelia ponceletioides* Sond., *Isopogon Fletcheri* F.v.M., *Persoonia angulata* R.Br., *Grevillea Gaudichaudii* R.Br., *G. acanthifolia* A. Cunn., *Atkinsonia ligustrina* F.v.M., *Pherosphæra Fitzgeraldi* F.v.M., *Adenochilus Nortoni* Fitzg., *Alania Endlicheri* Kunth, *Notochloë (Triodia) microdon* (F.v.M.) Domin. Two well-known Blue Mountain species are noted, each having only once been collected elsewhere, viz., *Grevillea laurifolia* Sieb., Wombeyan Caves (Taralga Road), J. H. Maiden, x., 1905; and *Persoonia Chamæpitys* A.Cunn., Bylong Creek, Goulburn River, R. T. Baker, xi., 1892.

Note.—Numerals are used to denote previous records as under:

(1) Jenolan Caves List. Blakely & Wyburd, Agric. Gazette N. S. Wales, 1901, p.1390.

(2) Flora of Mt. Wilson. A. G. Hamilton, These Proceedings, 1899, p.346.

(3) Occurrence of a Limestone Flora. W. M. Carne, These Proceedings, 1910, p.849.

Unless otherwise stated, the species enumerated are found on the tableland-sandstone.

RANUNCULACEÆ.

Clematis glycinoides DC., (1), (2), (3), Nepean River. Its congener, *C. aristata* R.Br., is a more adaptable plant found at all elevations on the mountains.

DILLENIACEÆ.

Hibbertia bracteata Benth., from the Nepean River west to Lawson; *H. Billardieri* F.v.M.,(2), Nepean to Bell; *H. serpyllifolia*

R.Br.,(2), Wentworth Falls to west of Eskbank; *H. pedunculata* R.Br., Leura and Blackheath; *H. diffusa* R.Br., Nepean to Glenbrook; *H. saligna* R.Br., (2), Nepean, Springwood, Kurrajong Heights, (in moist, sheltered gullies).

Hibbertia nitida Benth., (*Pleurandra Cneorum* DC.).—In Barron Field's "N. S. Wales," A. Cunningham records *P. Cneorum* from "Brushes on King's Tableland." Bentham, Fl. Austr., i., 25, reduces this to a synonym of *H. nitida* Benth., and gives as a locality for his species, "About Port Jackson, R. Brown, Sieber n.141," and others, but does not mention A. Cunningham's specimen from the Blue Mts. In the Handbook of the Flora of N. S. Wales, by Moore & Betche, the only locality given for *H. nitida* is near Sydney, in peaty soil. The writer has not noted any form of *H. nitida* on the Blue Mountains, nor are there any specimens in the National Herbarium from that locality.

MAGNOLIACEÆ.

Drimys dipetala F.v.M.,(2), (3), Springwood (Sassafras Gully), and Blackheath, a coastal brush-plant which creeps up the gullies.

VIOLARIEÆ.

Ionidium filiforme F.v.M.,(1), (2), the normal coastal form is collected west to Glenbrook. At Wentworth Falls, a short-leaved, xerophytic form is met, which persists westward, to and beyond Eskbank.

PITTOSPOREÆ.

Citriobatus multiflorus A. Cunn.,(2),(3), Springwood (Sassafras Gully).

POLYGALEÆ.

Comesperma sphaerocarpum Steetz, Lawson, Mt. Tomah; *T. retusum* Labill., Mt. Victoria; *C. defoliatum* F.v.M., King's Tableland, Leura, Blackheath, a swamp-xerophyte, with a few linear leaves, occasionally reduced to scales.

CARYOPHYLLEÆ.

Stellaria pungens Brongn.,(1), (2), Eskbank, in elevated situations.

PORTULACEÆ.

Claytonia Pickeringi F.v.M., Glenbrook, a somewhat rare, rock-xerophyte, with tuberous roots, and succulent stems and leaves.

MALVACEÆ.

Howittia trilocularis F.v.M.. Nepean, Wentworth Falls, Grose River, in brush-gullies.

STERCULIACEÆ.

Rulingia pannosa R.Br., Nepean, Blaxland, Mt. Tomah.

Lasiopetalum dasyphyllum Sieb.,(2), Grose River.

TILIACEÆ.

Elæocarpus cyaneus Ait.,(1), (2), Glenbrook, King's Tableland, Mt. Tomah; *E. holopetalus* F.v.M.,(2), Wentworth Falls, Leura, (the Fishing Pool, near Gordon Falls), Katoomba, Mt. Tomah, in moist sheltered gullies.

RUTACEÆ.

Correa speciosa Andr.,(1), Springwood.

Zieria lævigata Sm.,(2), Wentworth Falls to west of Eskbank; *Z. pilosa* Rudge, Glenbrook, Springwood, Linden; *Z. involucrata* R.Br.,[The only locality from which this species has been recorded is "Valleys of the Blue Mountains, Backhouse."(Fl. Austr., i., 306). In his key to the species (p.304), Bentham gives, as a distinctive character of *Z. involucrata*, "Upper leaves simple"; in his specific description he gives "Lower leaves simple." Either of these statements may be accepted, as, in a large number of plants examined *in situ*, it was found that the position of the simple and trifoliate leaves was about equally distributed (upper and lower), and the foliage would, perhaps, be better described as heterophyllous. The only example of this species in the National Herbarium was collected on the north of the railway near Springwood, by Mr. J. J. Fletcher (x., 1888). The writer, a few years ago, found a group of these plants in a valley on the southern side of the railway-line, between Springwood and the Valley Heights, which may be conveniently entered by a branch-gully commencing at Valley Heights railway-station. The plants will be found within half a mile of the station near the water-course]; *Z. cytisoides* Sm., Glenbrook Creek, Wolgan Valley (does not cross the tableland); *Z. Smithii* Andr.,(2), Glenbrook, Springwood, Mt. Tomah.

Boronia Fraseri Hook., Nepean, Blaxland, Springwood (Sassafras Gully), a Nepean-Hawkesbury shrub, which does not cross the tableland; *B. microphylla* Sieb.,(2), King's Tableland to west of Eskbank; *B. anemonifolia* A. Cunn.,(2), Leura (Mt. Hay Rd.), to west of Eskbank, on dry ridges and in moist gullies; *B. polygalifolia* Sm., Glenbrook and Mt. Victoria; *B. parviflora* Sm., Springwood, Wentworth Falls, Leura, in swamps; *B. Barkeriana* F.v.M.,(2), Blackheath, between Blackheath and Mt. Victoria.

Eriostemon myoporoides DC.,(1), a riverbank-shrub found as far west as the Hartley Valley, viâ the Cox [At Emu Plains, it has attempted the ascent of the tableland, spreading over the Lapstone Hill towards Glenbrook. Several plants have reached Falconbridge, and established a small colony on the south-east side of the railway-station; and a solitary bush was noticed on the northern side of the Bathurst Road, which had reached within a quarter of a mile of Linden railway-station]; *E. hispidulus* Sieb., Nepean to Lawson; *E. obovalis* A. Cunn.,(2). The type-locality given by A. Cunningham for his species is "Verge of Regent's Glen" (now the Valley of the Waters, Wentworth Falls), and this is the lowest elevation at which, within the writer's knowledge, it has been collected on the Blue Mountains; it ascends to west of Eskbank.

Phebalium dentatum Sm., The Lagoon, Sassafras Gully, a coastal valley- and riverbank-species; *P. squamulosum* Vent., Nepean to Springwood; *P. Billardieri* A. Juss.,(2), Springwood, Blackheath, in brush-gullies

Phebalium lachnoides A. Cunn., (*P. phylicifolium* F.v.M., var. *lachnoides* F.v.M.) is recorded in Field's New South Wales, 332, as a handsome shrub found in bare rocky situations at Blackheath. In the Flora Austr., i., 339, the habitat given for *P. lachnoides* A. Cunn., is the Blue Mountains, but no specific locality is mentioned. There are no specimens of *P. lachnoides* in the National Herbarium, nor has the writer seen it on the mountains. Botanists visiting the mountains might note the specific locality (Blackheath).

RHAMNEÆ.

Pomaderris elliptica Labill.,(2), Leura; *P. phillyroides* Sieb., (1), (2), Leura, west to Eskbank; *P. ledifolia* A. Cunn.,(2), Wentworth Falls, west to beyond Eskbank; *P. apetala* Labill.,(1),(2), Grose River.

Cryptandra ericifolia Sm.,(2), King's Tableland and Leura, in moist places.

AMPELIDEÆ.

Vitis hypoglauca F.v.M.,(2), Linden, in gullies.

SAPINDACEÆ.

Dodonæa triquetra Wendl., Glenbrook, Valley Heights, Linden; *D. boroniæfolia* G. Don, Katoomba, on the banks of Megalong Creek, a few yards beyond the four-mile post, on the track to Jenolan Caves, via Nelly's Glen.

LEGUMINOSÆ.

Mirbelia grandiflora Ait.,(2), Wentworth Falls, to west of Eskbank; *M. pungens* A. Cunn., Leura and Newnes Junction, on dry ridges.

Gompholobium latifolium Sm.,(2), Glenbrook, west to Bell; *G. Huegelii* Benth.,(2), Medlow Bath (on track to Wall's Caves), west beyond Eskbank; *G. grandiflorum* Sm.,(2), var. *setifolium* DC., Glenbrook, west to Leura; *G. uncinatum* A. Cunn.,(2), Mt. Victoria (on the side of the road to Mt. Victoria Falls), west beyond Eskbank, a dry-ridge xerophyte; *G. glabratum* DC.,(2), Linden, Lawson, Leura.

Jacksonia scoparia R.Br. Lapstone Hill (creeps up by the old railway-line from Emu Plains), Burragorang to Wentworth Falls.

Viminaria denudata Sm., Glenbrook Lagoon, in swamps and watercourses.

Daviesia latifolia R.Br.,(2), Blackheath, Cox's River, Newnes Junction to Eskbank; *D. corymbosa* Sm.,(1), Nepean to Leura; *D. squarrosa* Sm., Nepean to Glenbrook; *D. alata* Sm.,(2), Glenbrook (on the flat, north side of the old railway-station), Leura

(Sublime Point), Medlow Bath (in moist places near Wall's Caves).

Pultenæa daphnoides Wendl., Hazelbrook, Lawson to Wentworth Falls; *P. mucronata* F.v.M., Blackheath, Leura (in a swampy piece of ground on track to the "Fishing Pool"), the lowest elevation recorded for this species on the Blue Mountains (These Proceedings, 1901, p.213); *P. polifolia* A. Cunn., Hazelbrook, at the head of a gully on the south side of the railway-line, about 300 yards west from the station; *P. microphylla* Sieb., midway between Bell and Newnes Junction; *P. incurvata* A. Cunn., Lawson to west of Eskbank, in swamps; *P. glabra* Benth., a species rarely collected, though it is plentiful in swamps, from Hazelbrook to Katoomba, [It bears a superficial resemblance to *P. stipularis*, and may easily be mistaken for that species. In the descent of "Leura Falls" by the old track from the "Meeting of the Waters," a group of these plants may be seen in the swamp to the left of the track by the side of the "Cascades"]; *P. plumosa* Sieb., Leura to west of Eskbank, on peaty flats and moist hillsides; *P. echinula* Sieb., Hazelbrook west to Mt. Wilson, frequently in company with *P. glabra*; *P. villosa* Willd., Nepean to Valley Heights, plentiful in the vicinity of Glenbrook Lagoon; *P. flexilis* Sm.,(2), Nepean, Glenbrook, Valley Heights, Mt. Tomah; *P. elliptica* Sm.,(2), Nepean, west to Leura.

Dillwynia brunioides Meissn., King's Tableland, west to Mt. Victoria, on dry ridges.

Platylobium formosum Sm., Lawson to Wentworth Falls.

Bossiæa lenticularis Sieb.,(2), Lawson, Mt. Tomah, Newnes Junction, Clarence, in moist situations; *B. prostrata* R.Br.,(1), Lapstone Hill, Eskbank; *B. rhombifolia* Sieb., Nepean, west to Linden; *B. microphylla* Sm., Nepean to Leura, Mt. Hay Road; *B. ensata* Sieb.,(2), Falconbridge, west to Mt. Wilson.

Hovea longifolia R.Br.,(2), Nepean to Valley Heights, in gullies.

Desmodium rhytidophyllum F.v.M., Glenbrook.

Hardenbergia monophylla Benth.,(1), (2), Nepean, Glenbrook, Mt. Victoria; *Kennedya rubicunda* Vent.,(2), Glenbrook, Valley Heights; *K. prostrata* R.Br., the only example of this species in the National Herbarium, from the Blue Mountains, was collected by the late Mr. E. Betche, and is labelled Blue Mts., without specific locality.

Acacia trinervata Sieb.,[The centre of activity of this species is in the neighbourhood of Springwood, thence westerly to Falconbridge, and northerly to the "Kurrajong." A fine plantation may be seen on the Windsor Road, about three miles from Springwood. The writer recently found three isolated plants on a rise a few hundred yards east of the present Glenbrook Railway-Station; and Mr. R. H. Cambage has collected specimens below Wilberforce near Windsor]; *A. asparagoides* A. Cunn,.(2), a species which is more widely diffused than has hitherto been suspected [Its general appearance, when not in flower, is so similar to its ubiquitous congener, *A. juniperina* Willd., that it has undoubtedly been permitted to pass as that species by many collectors, for it is common on both sides of the Bathurst Road between Medlow and Blackheath (These Proceedings, 1910, p.414); and there are many clumps of these shrubs on the higher elevations between the type-locality (Regent's Glen, Wentworth Falls) and Eskbank]; *A. pumila* Maiden & Baker,(2), Falconbridge, Lawson, King's Tableland, Mt. Victoria, a dry-ridge xerophyte; *A. oxycedrus* Sieb., Falconbridge; *A. Baueri* Benth., var. *aspera* Maiden & Betche, King's Tableland, a dry-ridge xerophyte; *A. hispidula* Willd., Blaxland to Linden; *A. falcata* Willd.,(2), Nepean to Glenbrook; *A. penninervis* Sieb.,(1), (2), Wentworth Falls, a form of this variable species was collected near the commencement of the descent of "Brown's Gap" into the valley of the Lett, and again at about the same elevation on the ascent from the valley at Hartley Vale; *A. obtusata* Sieb., on the roadside, Bell to Mt. Wilson, about two miles from Bell Railway-Station, a few isolated plants; *A. obtusata* Sieb., var. *Hamiltoni* Maiden & Betche, Leura, Bell, Mt. Wilson, Newnes Junction; *A. rubida* A. Cunn.,(2), Glenbrook Lagoon, west to Blackheath, in swamps and on the banks of watercourses; *A. Dorothea* Maiden, Leura and Mt. Victoria, thence west beyond Eskbank, the chief stronghold of this species and of *A. obtusata* var., with which it is frequently found associated, being at

Leura, where the two species face each other, east and west, in gregarious assemblies, neither crossing the other's boundary (The Australian Naturalist, 1913, p.180); *A. linifolia* Willd.,(2), Nepean to Leura; *A. buxifolia* A. Cunn., Nepean, Wentworth Falls, Blackheath (top of Blackheath Glen) sparsely, plentiful in "Lett Valley," between Mt. Victoria and Eskbank; *A. elongata* Sieb.,(2), var. *angustifolia* Maiden & Betche, Woodford to Blackheath, in swampy places and watercourses; *A. melanoxylon* R.Br., (2), Lawson, Blackheath (a small clump of young trees near the top of the western slope of Blackheath Glen), Cox's River; *A. implexa* Benth.,(1), (2), Glenbrook and Wentworth Falls.

A. pubescens is recorded in Moore and Betche's "Handbook of the Flora of N. S. Wales," p.172, from the Blue Mountains; but the writer has not yet found it in, nor are there any specimens in the National Herbarium from, that locality.

ROSACEÆ.

Acæna ovina A. Cunn.,(1),(2),(3), Medlow Bath and Mt. Victoria; *A. sanguisorbæ* Vahl,(1),(2),(3), Grose Vale and Leura, thence west to Eskbank, frequent on roadsides.

SAXIFRAGEÆ.

Quintinia Sieberi DC.,(1),(2), Blackheath, west beyond Eskbank, in brush-gullies.

Ceratopetalum gummiferum Sm.,(2), Lapstone Hill, Springwood, Katoomba.

Acrophyllum venosum Benth., Linden, Lawson, in crevices of dripping rocks.

MYRTACEÆ.

Darwinia taxifolia A. Cunn.,(2), Woodford, west to Blackheath, a swamp-xerophyte in the coastal area, which exhibits a preference for shallow basins in the benches of shelving rocks on the flattened tops of exposed ridges (on the mountains).

Calythrix tetragona Labill.,(2), Burragorang to Wentworth Falls.

Micromyrtus microphylla Benth., Springwood, Linden, on a stony ridge, Bathurst Road, near Linden Railway-Station.

Bæckea diffusa Sieb., Glenbrook to Linden; *B. crenulata* R.Br., Hazelbrook to Leura and Mt. King George, in swamps near the top of the ridge; *B. brevifolia* DC.,(2), Springwood, Woodford (between the Bathurst Road and the railway-line, west of Woodford Station), Wentworth Falls, Bell; *B. diosmifolia* Rudge, Glenbrook (on a swampy flat opposite the old railway-station), Valley Heights, Wentworth Falls; *B. camphorata* R.Br., Medlow Bath, Blackheath to Mt. Victoria, on dry ridges [Though patches of this species are not uncommon within the area quoted (there is a quantity of it on the ridge over which the Grand Canyon track from the Bathurst Road approaches Wall's Caves), it has been forwarded to the National Herbarium from the Blue Mountains by one collector only. This may be accounted for by the short flowering-period, the position of the flowers, which are borne chiefly on the underside of the branches, and the fugacious character of the almost colourless petals. The shrub, when not in flower, is so similar to much of the surrounding xerophytic flora as to pass unnoticed (These Proceedings, 1901, p.213)]; *B. densifolia* Sm., Valley Heights to Woodford on the lower, and Bell to Clarence on the higher elevations.

Kunzea corifolia Reichb., Glenbrook Lagoon, prefers a moist situation.

Callistemon lanceolatus DC.,(2), Linden to Leura, in swampy places; *C. Sieberi* DC.,(1), Newnes Junction, Eskbank; *C. linearis* DC., Glenbrook Lagoon; *C. pinifolius* DC., Nepean-Hawkesbury to Glenbrook, in swamps.

Melaleuca hypericifolia Sm., Wentworth Falls (National Pass in the "Valley of the Waters") on rocky ledges; *M. thymifolia* Sm., Nepean to Glenbrook, in moist situations; *M. linariifolia* Sm., Nepean (Glenbrook Creek), Glenbrook Lagoon: a solitary plant of this usually gregarious species was also noted on the side of the Bathurst Road, which had reached an elevation midway between Lawson and Wentworth Falls.

Tristania neriifolia R.Br.,(2), Springwood, Woodford, in watercourses; *T. laurina* R.Br.,(2), Nepean, Valley Heights, in a watercourse.

Syncarpia laurifolia Ten.,(2), Glenbrook to Springwood.

Backhousia myrtifolia Hook. & Harv., Glenbrook, in brush-gully.

Myrtus tenuifolia Sm., Springwood ("The Lagoon," Sassafras Gully).

UMBELLIFERÆ.

Hydrocotyle laxiflora DC.,(1), Wentworth Falls, Medlow Bath, Mt. Victoria, on roadsides and in grassland.

Siebera ericoides Benth.,(2), Glenbrook.

Xanthosia dissecta Hook., Wentworth Falls, Katoomba (on the swampy flat bordering Katoomba Creek, near Yosemite Park), a small, almost herbaceous plant, hardly discernible among the rushes and sedges of the swamp; *X. Atkinsoniana* F.v.M.,(2), Mt Tomah.

Actinotus Helianthi Labill.,(9), Glenbrook to Eskbank, a gregarious species which favours the rocky hill-tops [An isolated patch, covering approximately half an acre of ground, was noted on a dry, rocky ridge on the Mt. Hay Road at Leura, about two miles from the Bathurst Road. Between Linden and Woodford, the ridge above, and parallel to, the road and railway-line, is covered with these plants, the area occupied extending rather more than a mile]; *A. minor* DC.,(2), Linden to beyond Eskbank; *A. Forsythii* Maiden & Betche, Katoomba, Blackheath, Clarence.

Eryngium vesiculosum Labill.,(1), Hartley Vale, Eskbank, in grassland.

Oreomyrrhis andicola Endl., Mt. Wilson, Eskbank.

ARALIACEÆ.

Astrotricha longifolia Benth., Glenbrook, Springwood, Linden.

Panax sambucifolius Sieb.,(1),(2), Woodford to Blackheath (a broad leaved form), Mt. Victoria to Eskbank (a narrow-leaved form), *P. cephalobotrys* F.v.M., Katoomba [The only example of this species collected on the Blue Mountains, was taken from an isolated plant growing between the sleepers of a disused tram-line leading to the old coal-mine in Miners' Glen. The tramway may be approached by a short branch-track to the Orphan Rock, diverging from the main track in the descent of Katoomba Falls.

First recorded from the Blue Mountains in The Australian Naturalist, v., 2, p.222].

RUBIACEÆ.

Coprosma hirtella Labill.,(2), Leura, Blackheath, Mt. Victoria, Eskbank (Brown's Gap, on roadside); *C. Billardieri* Hook.;(1),(2), Mt. Victoria, Mt. Tomah, in brush-gullies.

COMPOSITÆ.

Olearia myrsinoides F.v.M.,(1),(2), Springwood, west beyond Eskbank, a species exceptionally responsive to environment, as demonstrated by the varied forms forms found on the Blue Mountains (These Proceedings, 1914, p.159); *O. dentata* Mœnch, (2), Glenbrook to Woodford; *O. stellulata* DC., var. *quercifolia* Benth.,(2), Leura, Mt. Victoria, Newnes to Eskbank, in swamps; *O. elliptica* DC.,(2), Wentworth Falls, Leura, Katoomba, Mt. Victoria, on rocky benches in brush-gullies.

Celmisia longifolia Cass., Wentworth Falls, Leura, Katoomba, Clarence, in swamps.

Lagenophora Billardieri Cass.,(1),(2), Mt. Victoria.

Brachycome diversifolia Fish. & Mey., (1), Blackheath (top of Blackheath Glen), Mt. Victoria (road to Victoria Falls); *B. discolor* C. Stuart, Hartley Vale, near the Lett River.

Cassinia denticulata R.Br., Kurrajong Heights, Bell, about 1½ miles on the road to Mt. Wilson; *C. longifolia* R.Br.,(1),(2), Woodford, Lawson, Mt. Victoria; *C. aurea* R.Br.,(2), Nepean, Glenbrook Lagoon, Mt. Tomah; *C. aculeata* R.Br., Linden, west to Eskbank; *C. quinquefaria* R.Br., Newnes Junction, Clarence.

Humea elegans Sm.,(2), Wentworth Falls, Mt. Tomah, in brush-gullies.

Leptorrhynchos squamatus Less., Hartley Vale, in the valley near the "Lett."

Helichrysum leucopsidium DC.,(2), Leura, Newnes Junction, Clarence (two distinct forms were noted from the higher elevations); *H. collinum* DC.,(1), Nepean, Glenbrook, Burragorang to Wentworth Falls; *H. semipapposum* DC.,(1), Medlow to Blackheath, (marked morphological differences may be noted between the adult and juvenile plants of this species); *H. adnatum* Benth.,(1), Linden.

Helipterum incanum DC.,(1), Hartley Vale: *H. dimorpholepis* Benth., Hartley Vale; both species in the valley in grassland.

Gnaphalium luteo-album L.,(1),(2), Blackheath; *G. japonicum* Thunb.,(1),(2), Leura, Blackheath, (both species in grassland and waste places); *G. japonicum* Thunb., var. *radicans* F.v.M., MS., Leura, in peaty soil.

Erechthites Atkinsoniæ F.v.M., Blackheath (foot of Govett's Leap), in brush-forest; *E. mixta* DC.,(1),(2), Lawson, west to Eskbank.

Senecio vagus F.v.M., Burragorang to Wentworth Falls, Blackheath, in moist gullies; *S. velleioides* A. Cunn.,(2), Mt. Victoria, a brush-gully denizen which exhibits considerable adaptability at Mt. Victoria, where it was found growing on a dry ridge on the road to Victoria Falls; a patch of this species was also noted in a somewhat exposed position on the Mt. Victoria Pass.

CANDOLLEACEÆ.

Stylidium laricifolium Rich., Glenbrook.

GOODENIACEÆ.

Velleya montana Hook., Medlow Bath (in grassland), between Clarence and Wolgan, a subalpine species rare on the Blue Mountains.

Goodenia decurrens R.Br., (2), Valley Heights, west to Newnes Junction, usually on dripping rocks; *G. dimorpha* Maiden & Betche, Springwood to Blackheath, in swamps; *G. ovata* Sm.,(1), Springwood (Sassafras Gully), Burragorang to Wentworth Falls; *G. heterophylla* Sm.,(2), Glenbrook to Bell.

Scævola ramosissima (Sm.) Krause, (*S. hispida* Cav.),(2), Glenbrook, Woodford, Wentworth Falls; *S. Hookeri* F.v.M., Hazelbrook, Leura (on the old track from Leura to the Meeting of the Waters, Leura Falls), Blackheath (Govett's Leap), in swampy places.

Brunonia australis Sm.,(2), Blackheath, near Bell, on dry ridges.

CAMPANULACEÆ.

Lobelia gibbosa Labill.,(1),(2), Blackheath, Bell (on road to Mt. Wilson).

EPACRIDEÆ.

Styphelia læta R.Br., var. *angustifolia*,(2), Springwood, Linden, Blackheath: *S. triflora* Andr., Valley Heights to Eskbank; *S. tubiflora* Sm., Leura (in the valley between Sublime Point and the Golf Links), Blackheath, Bell, on a track leading from the Mt. Wilson Road to the Valley of the Grose.

Astroloma humifusum R.Br., Glenbrook, Mt. Victoria (in the valley at the foot of Mt. Victoria Pass), not noted crossing the tableland.

Melichrus rotatus R.Br., Glenbrook.

Lissanthe sapida R.Br., (2), Glenbrook, west to Wentworth Falls; *L. strigosa* R.Br.,(1), Nepean to Springwood.

Leucopogon microphyllus R.Br.,(1), Leura, west beyond Eskbank; *L. virgatus* R.Br., Hartley Vale, in the valley near the Lett; *L. esquamatus* R.Br., Leura (Mt. Hay Road), Medlow Bath (ridges near Wall's Caves), Bell, on stony ridges; *L. setiger* R.Br., Valley Heights to Mt. Wilson; *L. appressus* R.Br., Woodford to Linden, on a bald ridge above the Bathurst Road.

Monotoca elliptica R.Br.,(2), Springwood (Sassafras Gully), Leura (The Cascades, Leura Falls), Medlow Bath (in the valley near Wall's Caves); *M. ledifolia* A. Cunn., Wentworth Falls.

Epacris reclinata A. Cunn.,(2), Lawson to west of Eskbank; *E. rigida* Sieb.,(2), Linden (on rocks, Bathurst Road, about 200 yards west of the railway-station), Lawson, Wentworth Falls; *E. crassifolia* R.Br.,(2), Wentworth Falls, Mt. Victoria, thence to Eskbank; *E. obtusifolia* Sm.,(2), Woodford, west to Leura, in swamps; *E. Hamiltoni* Maiden & Betche, Blackheath, near Wall's Caves, in swampy ground at the base of overhanging water-dripping rocks [an extremely local species; the original patch (which was discovered fifteen years ago) might be contained within a rood of ground. It has not yet been located outside this area]; *E. paludosa* R.Br.,(1),(2), Hazelbrook, west beyond Eskbank, in swamps, and on the banks of watercourses; *E. micro-*

phylla R.Br.,(1), (2), Lawson to Mt. Wilson: *E. apiculata* A. Cunn., Wentworth Falls, Leura (Leura Falls), Blackheath (near Wall's Caves), in swampy detritus at the base of dripping rocks: *E. purpurascens* R.Br., Leura; *E. onosmæflora* A. Cunn., Blackheath (top of Govett's Leap), Mt. Victoria, Lithgow.

[*E. ruscifolia* R.Br., (non Sieb.) is mentioned by Allan Cunningham in Barron Field's New South Wales, 340, as a depressed shrub on moist rocks, King's Tableland. In the Flora Austr., iv., 235, R. Brown's *E. ruscifolia* is referred by Bentham to *E. impressa* Labill., and *E. ruscifolia* Sieb., (non Br.) is held to be synonymous with *E. reclinata* A. Cunn. The latter species, with the exception of one of its forms resultant from environment (These Proceedings, 1914, p.543), agrees both in habit and habitat with Cunningham's statement in Field's New South Wales respecting *E. ruscifolia* R.Br., and is quite distinct from *E. impressa* Labill., which is described and figured in Labillardière's Plantæ Novæ Hollandiæ, i., 43, t.58, as a shrub of 3 feet (Frutex semiorgyalis), and a reference is made to the five cavities at the base of the corolla (tubus . . . . cavitatibus quinque versus basim extus impressus) which form the characteristic external impressions from which the specific name is derived; while *E. reclinata* is found reclining (and specifically named from this habit) on moist, shelving rocks among ferns and sphagnum moss in the Blue Mountain gorges. No impressions are found in the corolla of *E. reclinata*, which is endemic on the Blue Mountains. *E. impressa* is (in New South Wales) found only in the extreme southern districts, and has not been collected on the Blue Mountains. In the Flora of Tasmania, i., 257, Sir. J. D. Hooker doubtfully refers *E. ruscifolia* R.Br., to *E. reclinata* A. Cunn., and includes, under that species, two specimens with Gunn's Herbarium Nos.857 (which he also queries) and 858, giving, as one of the localities in its distribution, the Blue Mountains, A. Cunn. In a footnote, he says:—"This again [Gunn's 858] approaches very closely indeed to states of *E. impressa*, to which Gunn is inclined to refer some of his specimens; it, however, appears to differ in the low, more or less procumbent, straggling habit. . . . Sieber's No.82 (in Herb. Hook.) does not appear distinct from this [Gunn's 858] except in the larger tube of the corolla; and Allan Cunningham sends the same plant from Port Jackson under the name of *E. ruscifolia* Br." Examples of both of Gunn's specimens are now in the National Herbarium, Sydney, and neither of them can be placed under *E. reclinata* A. Cunn., both being well marked forms of *E. impressa* Labill., the Tasmanian species to which Gunn proposed to refer them. This confirms the decision of Bentham, given above, that the affinity of *E. ruscifolia* R.Br., is with *E. impressa* Labill.; and *E. ruscifolia* Sieb., together with the specimen sent by Allan Cunningham to Hooker labelled *E. ruscifolia* Br., (from the Blue Mts.) are both referable to *E. reclinata* A. Cunn.

Lysinema pungens R.Br., Lawson.

Rupicola sprengelioides Maiden & Betche, King's Tableland (These Proceedings, 1898, p.775).

Sprengelia ponceletioides Sond.,(*Ponceletia monticola* A. Cunn.), [In Barron Field's New South Wales, p.341, Allan Cunningham records *Poncletia sprengelioides* R.Br., as a rare, suffruticose, dense-habited plant adhering to rocks perpetually damp, margins of the Cascade, King's Tableland. In the Fl. Austr., iv., 248, *P. sprengelioides* R.Br., is recorded in marshes near Sydney, Coll. R. Brown, Sieber, and others, but is not mentioned as found on the Blue Mountains. De Candolle, Prod. vii., 767, also records *P. sprengelioides* R.Br., from Sydney, Coll. A. Cunningham. *Sprengelia ponceletioides* Sond.,(*P. monticola* A.Cunn.) is recorded in the Fl. Austr., iv., 248, on rocks perpetually wet, near Campbell's Cataract, Blue Mts., Coll. A. Cunn.; and *P. monticola* (A. Cunn., in litt.) is given in DC., Prod. vii., 768, from the Blue Mts., Coll. A. Cunn. It will be seen that Allan Cunningham has perpetrated a (presumably) clerical error in his paper, incorporated in Barron Field's New South Wales, by recording R. Brown's *Ponceletia sprengelioides* from the Blue Mountains, instead of his own *P. monticola*.], Lawson, Wentworth Falls, Leura (Leura Falls, on the face of the cliffs): *S. incarnata* Sm.,(2), Leura, Clarence, in swamps.

Dracophyllum secundum R.Br.,(2), Springwood to west of Eskbank, in crevices of moist rocks.

LOGANIACEÆ.

Mitrasacme pilosa Labill.,(2), Wentworth Falls; *M. serpyllifolia* R.Br., Hazelbrook, west to Eskbank, in swamps.

Logania pusilla R.Br., Linden, on the northern side of the Bathurst road approaching the railway-station from Falconbridge.

SCROPHULARINEÆ.

Veronica perfoliata R.Br., (1), Eskbank (Brown's Gap); *V. Derwentia* Littlj., Eskbank (Brown's Gap); *V. notabilis* F.v.M., Katoomba (Nelly's Glen).

Euphrasia Brownii F.v.M., (1), (2), Leura, Mt. Hay Road, Blackheath to west of Eskbank.

GESNERACEÆ.

Fieldia australis A. Cunn.,(2), Leura (The Forest, Leura Falls), Katoomba, Mt. Tomah.

ACANTHACEÆ.

Eranthemum variabile R.Br.,(3), Glenbrook.

VERBENACEÆ.

Chloanthes stœchadis R.Br.,(2), Mt. Irvine; *C. glandulosa* R.Br., Springwood. In a note on *C. glandulosa*, Bentham, Fl. Austr., v., 45, says, "observations may possibly show this to be a luxuriant form of *C. stœchadis*." Specimens in the National Herbarium from "The Valley," Hornsby (W. F. Blakely, iv., 1914) and West Maitland (Miss A. Brewster, x., 1908) are connecting links between the two species, and strongly support Bentham's suggestion.

LABIATÆ.

Prostanthera lasianthos Labill., (2), Mt. Tomah, Bell; *P. cœrulea* R.Br.,(2); *P. violacea* R.Br., Nepean, Valley Heights, Springwood; *P. rhombea* R.Br., Katoomba (in the valley at the foot of Minnie-Ha-Ha Falls), Mt. Wilson; *P. linearis* R.Br.,(2), Springwood ("The Lagoon," Sassafras Gully); *P. saxicola* R.Br., (a form), Katoomba (on a ridge at Narrow Neck), Blackheath, Mt. Victoria.

Hemigenia purpurea R.Br.,(2), Linden, Woodford, on the dry ridge overlooking the Bathurst Road between Linden and Woodford.

PARONYCHIACEÆ.

Scleranthus biflorus Hook., Woodford, to west of Eskbank, in grasslands.

LAURINEÆ.

Cassytha glabella R.Br.,(2), Glenbrook (Lagoon), Woodford, Leura; *C. pubescens* R.Br., Valley Heights, Wentworth Falls, Blackheath; *C. paniculata* R.Br., Springwood; *C. melantha* R.Br., Bell, on side of road to Mt. Wilson.

PROTEACEÆ.

Petrophila pedunculata R.Br.,(2), Nepean to Katoomba.

Isopogon anethifolius R.Br.,(2), Leura, Mt. Hay Road; *I. Fletcheri* F.v.M., Blackheath (These Proceedings, 1894, p.151), an exceedingly rare species collected by Mr. J. J. Fletcher in the neighbourhood of Govett's Leap, November, 1893.

Conospermum longifolium Sm., var. *angustifolium* R.Br., Glenbrook to Wentworth Falls; *C. tenuifolium* R.Br.,(2), Lawson to Bell. *C. ellipticum* Sm., is recorded in Moore and Betche's Handbook of the Flora of New South Wales, from the Blue Mountains, but there are no specimens in the National Herbarium from this locality, nor has the writer noted its occurrence.

Symphyonema montanum R.Br.,(2), Linden to Eskbank.

Persoonia hirsuta Pers.,(2), Glenbrook, Blaxland: *P. Chamæpitys* A. Cunn.,(2), Lawson to west of Eskbank: *P. linearis* Andr.,(1), Nepean to Springwood, Cox's River, Eskbank; *P. pinifolia* R.Br., Valley Heights, Springwood, Linden; *P. mollis* R.Br.,(1),(2), Valley Heights to Mt. Wilson; *P. oblongata* A. Cunn., Glenbrook to Springwood [The only specimen in the National Herbarium from the Blue Mountains was collected by Mr. J. J. Fletcher at Springwood (the western boundary of the species) in 1888. About a year ago, the writer noticed it on the Bathurst Road between Valley Heights and Springwood. It is remarkable that this gregarious species should have so long escaped the notice of collectors, as no difficulty was experienced in tracing the plants from the roadside, most of the journey between Springwood and Glenbrook. It was seen to be exceptionally plentiful in the neighbourhood of the 41-mile-post, but only a few scattered bushes were noted at Glenbrook, on the northern side of the old railway-station]; *P. myrtilloides* Sieb., (2), Wentworth Falls to Eskbank; *P. angulata* R.Br., Woodford to Mt. Victoria [an individualistic species, which, like most of its congeners, fruits freely. No seedlings have been noted in the neighbourhood of any of the invariably isolated plants known to the writer, though the seeds germinate readily under artificial treatment]; *P. acerosa* Sieb.,(2), Valley Heights to Eskbank.

Grevillea asplenifolia R.Br., Springwood, Lawson, on the banks of watercourses, in brush-gullies; *G. laurifolia* Sieb.,(2), Valley Heights to Eskbank; *G. Gaudichaudii* R.Br., Wentworth Falls, Katoomba, Blackheath, Clarence [This rare species was, until recently, known only from Wentworth Falls and Katoomba (a few isolated plants). In view of the question of natural hybridism raised by Mr. J. J. Fletcher in relation to this species (These Proceedings, 1910, p.434) it is of interest to note that, at Clarence, it was again found (an individual specimen) on the slope of a hill leading into a swamp, *G. laurifolia* being noted on the plateau above, and *G. acanthifolia* in the swamp below]; *G. acanthifolia* A. Cunn., Wentworth Falls, to west of Eskbank, in swamps; *G. mucronulata* R.Br., Nepean to Valley Heights; *G. phylicoides* R.Br., Nepean to Wentworth Falls; *G. sericea* R.Br., Glenbrook to Blackheath and Mt. Tomah.

Hakea pugioniformis Cav., (2), Woodford to Eskbank, in swamps, and on dry, stony ridges; *H. saligna* R.Br.,(1),(2), Hazelbrook, Lawson, Blackheath, in moist, sheltered gullies; *H. propinqua* A. Cunn.,(2), Linden to Eskbank, chiefly in swamps; *H. acicularis* R.Br.,(1), Nepean, Glenbrook: *H. microcarpa* R.Br., (1), Cox's River.

THYMELEÆ.

Pimelea collina R.Br.,(2), Katoomba to Eskbank; *P. curviflora* R.Br., Leura, near Golf Links.

LORANTHACEÆ.

Atkinsonia ligustrina F.v.M., (2), Linden to Lawson, Mt. Tomah, Bell, on side of the road to Mt. Wilson, about 1½ miles from Bell Railway-Station.

SANTALACEÆ.

Choretrum spicatum F.v.M.,(1), Mt. Victoria, to west of Eskbank; *C. Candollei* F.v.M.,(2), Glenbrook to Mt. Wilson.

Omphacomeria acerba DC.,(1),(2), Leura, to west of Eskbank.

Exocarpus stricta R.Br ,(1),(2), Nepean, Glenbrook.

EUPHORBIACEÆ.

Poranthera ericifolia Rudge,(2), Glenbrook to Leura; *P. corymbosa* Brongn.,(2), Glenbrook to Blackheath.

Micrantheum ericoides Desf., Blaxland, Linden, Hazelbrook.

Pseudanthus pimeleoides Sieb.,(2), Linden, Mt. Hay; *P. divaricatissimus* Benth., Wentworth Falls to Eskbank.

Ricinocarpus pinifolius Desf., Nepean, Springwood (Sassafras Gully).

Monotaxis linifolia Brongn.,(2), Leura (near the Fishing Pool), Katoomba, in swamps.

CASUARINEÆ.

Casuarina nana Sieb.,(2), Wentworth Falls, to west of Eskbank.

CONIFERÆ.

Pherosphæra Fitzgeraldi F.v.M., Wentworth Falls, Katoomba.

CYCADEÆ.

Macrozamia corallipes Hook., Glenbrook.

ORCHIDÆ.

Thelymitra venosa R.Br., Lawson to Mt. Victoria.

Cryptostylis longifolia R.Br.,(2), Woodford to Eskbank, on dry hillsides [in the coastal area, this species is found in swamps]; *C. leptochila* F.v.M., (2), Springwood, Kurrajong, Wentworth Falls, Bell.

Prasophyllum australe R.Br., Leura, Blackheath; *P. flavum* R.Br.,(2), Hazelbrook to Katoomba [Fitzgerald (Aust. Orchids, i., 23) says of this species, "possibly epiphytal on the roots of trees." The writer has on many occasions carefully unearthed the tubers of this species, without finding any connection between them and other root-growths]; *P. striatum* R.Br.,(2), Woodford to Blackheath.

Lyperanthus ellipticus R.Br., Woodford, Wentworth Falls, Leura (near the Amphitheatre, Leura Falls).

Caladenia dimorpha Fitzg.,(2), Newnes Junction to Eskbank.

Adenochilus Nortoni Fitzg., Lawson, Wentworth Falls, Medlow Bath, Mt. Victoria (type-locality).

IRIDEÆ.

Libertia paniculata Spreng.,(1),(3), Wentworth Falls, Blackheath; *L. pulchella* Spreng., Hazelbrook, Lawson, Leura (The Fishing Pool), Mt. Tomah, on boulders in the watercourses, and on the face of dripping rocks.

LILIACEÆ.

Blandfordia grandiflora R.Br., (2), Wentworth Falls, Mt. Tomah, Leura (in peaty pockets, on the craggy escarpment overhanging Leura Gorge).

Tricoryne elatior R.Br., Glenbrook, Bell.

Stypandra glauca R.Br.,(2), Lapstone Hill, Valley Heights.

Alania Endlicheri Kunth,(2), Woodford to Wentworth Falls, Mt. Tomah, in the crevices of wet rocks.

Xerotes Brownii F.v.M.,(2), Falconbridge; *X. glauca* R.Br.,(2), Valley Heights to Mt. Victoria; *X. flexifolia* R.Br.(2), Glenbrook to Leura.

XYRIDEÆ.

Xyris gracilis R.Br.,(2), Wentworth Falls to Eskbank (in peaty soil); *X. operculata* Labill., var. *macrocephala* Benth., Woodford to Bell, in swamps.

JUNCACEÆ.

Luzula campestris DC.,(1),(2), Newnes Junction to Eskbank.

Juncus Fockii Fr. Buch., Lawson.

RESTIACEÆ.

Lepyrodia scariosa R.Br.,(1),(2), Wentworth Falls to Eskbank; *L. anarthria* F.v.M., Eskbank, in a swamp on the eastern side of the Eskbank Basin.

Restio fastigiatus R.Br., Medlow (near Wall's Caves), Blackheath, Mt. Wilson; *R. australis* R.Br.,(2), Medlow Bath to Eskbank, in swamps.

CYPERACEÆ.

Cyperus eragrostis Vahl,(1), Nepean to Blackheath.

Heleocharis multicaulis Sm., Wentworth Falls, Katoomba, Mt. Tomah.

Lepironia mucronata Rich., Glenbrook Lagoon, the prevailing reed in the waters of the Lagoon, and it is somewhat remarkable that it has not been previously noted, as the flowerheads are very conspicuous, and differ considerably in appearance from the usual lake-vegetation. It is recorded generally in the coast district, and specifically from Port Jackson, but the only example in the National Herbarium from Port Jackson was collected by the late Mr. Betche, and is labelled, near Sydney, xi., 1883. It is plentiful in the Picton Lakes.

Cyathochæte diandra Nees, Hazelbrook, on the fringe of a swamp.

Schœnus turbinatus Poir., Springwood to Eskbank; *S. imberbis* R.Br., Valley Heights to Woodford, Mt. Wilson; *S. ericetorum* R.Br., Leura to Newnes Junction; *S. tenuissimus* Benth., Leura, between Sublime Point and the Golf Links, in peaty soil; *S. villosus* R.Br., (2), Lawson west to Eskbank; *S. brevifolius* R.Br., in a swamp on the southern side of the Bathurst Road, midway between Leura and Wentworth Falls; *S. melanostachys* R.Br., Nepean to Lawson.

Mesomelæna deusta Benth.,(2), Glenbrook to Bell; *M. sphærocephala* Benth., King's Tableland to Newnes Junction, in swamps.

Tricostularia pauciflora Benth., Woodford to Eskbank.

Lepidosperma lineare R.Br., (1), Wentworth Falls, Newnes Junction; *L. tortuosum* F.v.M., Leura, Clarence, the Zigzag; *L.*

flexuosum R.Br., Leura, Mt. Wilson, Eskbank; *L. filiforme* Labill., (1), Springwood, Leura; *L. Neesii* Kunth, Wentworth Falls, Woodford, Eskbank.

Gahnia Sieberi Bœck., Lawson, to west of Eskbank; *G. microstachya* Benth., Lawson to Eskbank.

Caustis pentandra R.Br.,(2), Woodford, Wentworth Falls.

Unicinia tenella R.Br., Katoomba (Nelly's Glen), an individual tuft growing in a crevice in the rocky wall of the Gorge, Mt. Wilson.

GRAMINEÆ.

Amphipogon strictus R.Br., var. *setifer*, (2), King's Tableland to Eskbank.

Panicum obseptum Trin., Hawkesbury-Nepean, Falconbridge, in waterholes.

Tetrarrhena juncea R.Br., Lawson to Bell.

Notochloë microdon Domin, (*Triodia microdon* F.v.M.), Hazelbrook to Blackheath, in swamps.

LYCOPODIACEÆ.

Lycopodium laterale R.Br., (2), Woodford, Mt. Tomah.

FILICES.

Leptopteris Fraseri (Hook. et Grev.) Presl., (2), Kurrajong Heights, Leura to Mt. Wilson.

Dicksonia antarctica Labill.,(2), Leura (Leura Falls), Blackheath (Blackheath Glen) [Allan Cunningham, in Barron Field's New South Wales, mentions examples of this species at Mt. Tomah thirty-five (35) feet high. The writer recalls a fine clump about two miles from Blackeath Glen, nearly under the Medlow Bath "Hydro," which was unfortunately burnt out some fifteen years ago.]

The following species were noted crossing the mountains at all elevations from the "Nepean" to west of Eskbank:—*Viola hederacea* Labill., *Bursaria spinosa* Cav., *Marianthus procumbens* Benth., *Billardiera scandens* Sm., *Comesperma ericinum* DC., *Portulaca oleracea* L., *Hypericum japonicum* Thunb., *Boronia floribunda*

Sieb., *Olax stricta* R.Br., *Stackhousia viminea* Sm., *Cryptandra amara* Sm., *Oxylobium staurophyllum* Benth., *Mirbelia reticulata* Sm., *Sphærolobium vimineum* Sm., *Phyllota phylicoides* Benth., *Pultenæa scabra* R.Br., *Dillwynia ericifolia* Sm., *Bossiæa heterophylla* Vent., *Hovea linearis* R.Br.; *Acacia juniperina* Willd., *A. suaveolens* Willd., *A. myrtifolia* Willd., *A. longifolia* Willd., *A. elata* A. Cunn., *A. discolor* Willd.; *Callicoma serratifolia* Andr., *Bæckea linifolia* Rudge; *Leptospermum parvifolium* Sm., *L. flavescens* Sm., *L. lanigerum* Sm., *L. arachnoideum* Sm., *L. pendulum* Sieb.; *Kunzea capitata* Reichb.; *Siebera linearis* Spreng., *S. Billardieri* F.v.M.; *Xanthosia pilosa* Rudge, *Pomax umbellata* Sol.; *Calotis cuneifolia* R.Br., *C. lappulacea* Benth.; *Vittadinia australis* A. Rich., *Helichrysum scorpioides* Labill., *H. apiculatum* DC.; *Candollea serrulata* Labill., *C. linearis* F.v.M.; *Dampiera Brownii* F.v.M., *D. stricta* R.Br.; *Goodenia bellidifolia* Sm., *Wahlenbergia gracilis* DC.; *Leucopogon lanceolatus* R.Br., *L. muticus* R.Br., *L. ericoides* R.Br., *Brachyloma daphnoides* Benth., *Epacris pulchella* Cav., *Mitrasacme polymorpha* R.Br., *Logania floribunda* R.Br., *Veronica calycina* R.Br., *Utricularia dichotoma* Labill., *Prunella vulgaris* L., *Petrophila pulchella* R.Br., *Isopogon anemonifolius* R.Br., *Conospermum taxifolium* Sm.; *Persoonia ferruginea* Sm., *P. salicina* Pers.; *Lambertia formosa* Sm., *Hakea dactyloides* Cav., *Lomatia silaifolia* R.Br., *Telopea speciosissima* R.Br., *Pimelia linifolia* Sm., *Leptomeria acida* R.Br., *Poranthera microphylla* Brongn., *Amperea spartioides* Brongn., *Phyllanthus thymoides* Sieb., *Dipodium punctatum* R.Br., *Hæmodorum planifolium* R.Br.; *Patersonia sericea* R.Br., and var. *longifolia*, *P. glabrata* R.Br.; *Smilax australis* R.Br., *Sowerbæa juncea* Sm., *Laxmannia gracilis* F.v.M., *Xerotes longifolia* R.Br., *Juncus communis* E. Mey., *Lepidosperma laterale* R.Br., *Gahnia psittacorum* Labill., *Caustis flexuosa* R.Br., *Ehrharta stipoides* Labill., *Echinopogon ovatus* Palis., *Selaginella uliginosa* Spreng.

NOTES AND EXHIBITS.

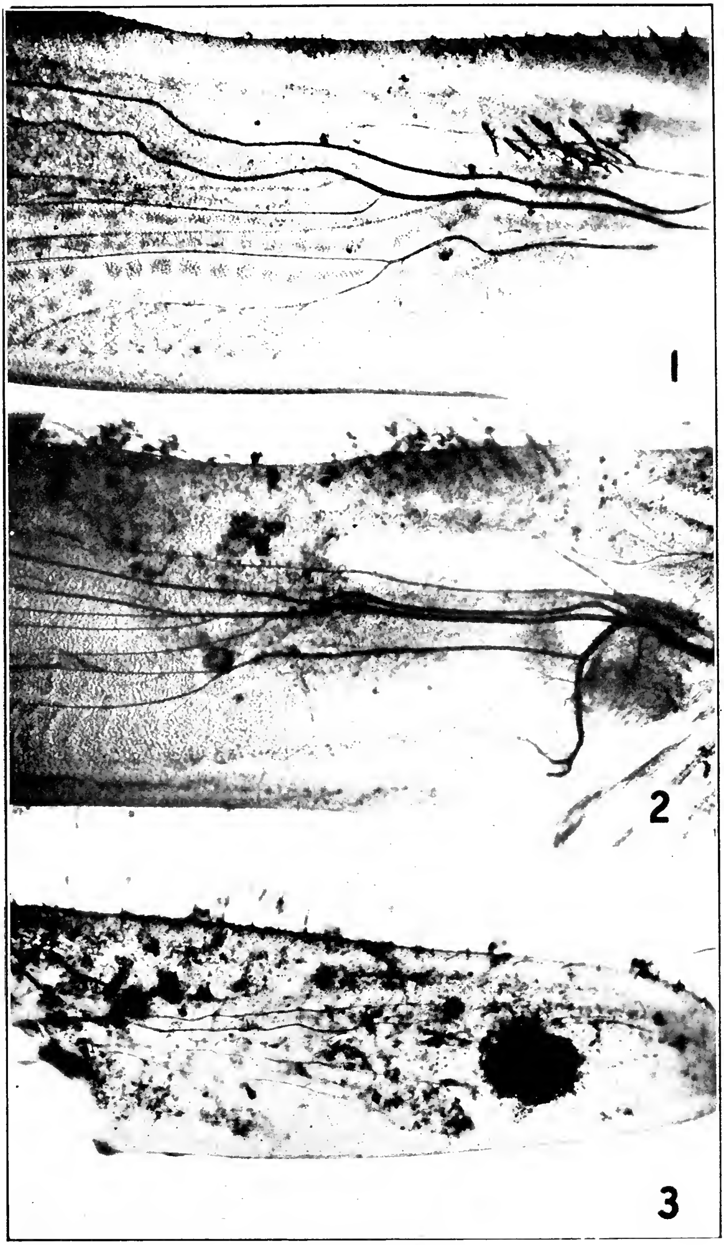
Mr. W. N. Benson exhibited a specimen considered by Professor Lawson to be a bundle of roots of a Pteridophyte with a sphenophylloid structure, and microphotographs of the same. The specimen has been rather imperfectly preserved in red jasper. It came from the Lower Carboniferous rocks at Currabubula, near Tamworth. Also, a specimen and section of a fern recognised by Drs. Kidston and Gwynne-Vaughan as *Osmundites*. The preservation is not sufficiently good to permit of specific determination, but it resembles a form found in the Mesozoic (?) of New Zealand. The specimen was found by the exhibitor on a basalt-hill at Oakey Creek, near Toowoomba.

Mr. A. A. Hamilton exhibited a series of specimens from the National Herbarium, Sydney, comprising—*Calendula officinalis* Linn.(Hort.), showing complicated prolification of the inflorescence accompanied by torsion. In the first stage, the peduncle is laterally dilated, and shows bundling; the involucral bracts have become irregular in radius and variable in size, the bases of the larger bracts showing a degree of torsion; the ligulate florets have increased in number at the expense of the tubular ones, and the symmetry of the whorls is disturbed; an intrusion of leafy bracts is seen in the centre of the tubular florets; attenuation of the ligulæ of the ray-florets is also to be noted. In the second stage, the majority of the florets have developed ligulæ, the few tubular ones remaining being in a transitory state; the stem under the flower is normal, the involucral bracts almost regular, and the general symmetry of the flower is maintained. In the third stage, a series of much reduced capitula, consisting chiefly of ligulate florets, are to be noted within a common involucre, of which the outer bracts are abnormal in size and partly united; the stem exhibits bundling, and is thrice the diameter of the normal stem; the floral leaves are twisted; frondescent buds are seen to issue from the axis of the inflorescence between the involucral bracts and the florets, the number of attenuated ligulate florets has increased, and they appear as a fringe to the compound head of flowers. In the final stage, the capitula within the involucral region are still further reduced, the common involucre is thrown into confusion, its bracts being irregular in size and contorted; the prolification of the inflorescence by miniature buds is increased, the strain on the axis causing an apparent reversion of their pedicels. The examples exhibited were taken from plants in the Sydney Botanic Gardens, grown from seeds presented by Mr. Greaves, of Bondi, who has for some years been growing this strain of Marigold, *e.g.*, the double-flowered example shown in the second stage. Modern workers have given a considerable amount of attention to the question of heredity as a factor in the production of these teratological mutations. The consensus of opinion is that heredity is admitted, but is largely controlled by external conditions conducive to forced growth, such as over-luxurious food, or a copious supply of water after prolonged dryness. *Celosia argentea* var. *cristata*, "Cockscomb," is cited by several authors as an example of a plant which requires a generous diet to enable it to sustain its fasciated "comb." As a modicum of evidence in favour of hereditability, it may be noted that a series of plants from unselected seeds of *Calendula officinalis* growing side by side with those from Mr. Greaves' strain, under similar cultural conditions, produced no abnormalities; while the majority of the plants grown from Mr. Greaves' seed were more or less affected. The specimens in the first three stages were collected by Mr. E. N. Ward from a single plant, and that in the fourth stage from a plant on which an example in the first stage was also growing.—*Platylobium formosum* Sm., (Wentworth Falls: A. A. Hamilton: January, 1915), showing leaf-variation resultant from environment. Example No.1, with small crowded leaves, was found growing on a dry ridge. No.2, with large, distant leaves, grew in a moist gully below; and those in the intermediate stages were collected on the slope between the ridge and the watercourse.—*Eriostemon hispidulus* Sieb., (Springwood; A. A. Hamilton; September, 1914), showing leaf-variation. The leaves are oblong, linear or spathulate; toothed or entire marginally; narrowed at the base into a petiole, or broadly sessile; and range from $\frac{1}{4}$ to $1\frac{1}{2}$ inches long. All the examples were growing on a sandstone ridge under apparently similar environmental conditions.—*Acacia implexa* Benth., (Glenbrook; A. A. Hamilton; December, 1914), exhibiting leaf-variation. The examples shown range from straight to semicircinate, and from linear to lanceolate; their apices are obtuse, acute to acuminate, and they are either abruptly or gradually narrowed into the petiole at the base. Some measurements are, 11 × $\frac{1}{4}$ inch, $8\frac{1}{2}$ × $\frac{7}{8}$, 6 × $\frac{1}{8}$, 6 × 1, 3 × $\frac{3}{16}$, $3\frac{1}{2}$ × $\frac{1}{2}$. A specimen was also exhibited, showing a juvenile leaf between phyllodes, occurring at a height of about 6 feet. All the examples were taken from a small colony of plants, 8-10 feet high, growing on a sandstone-ridge.

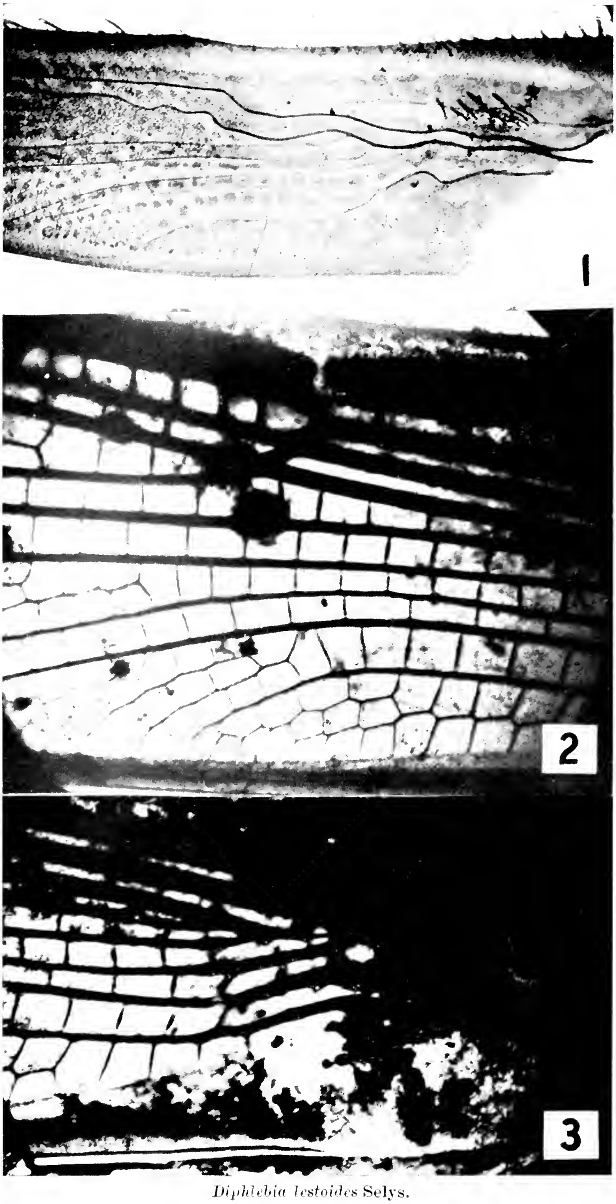
Mr. E. Cheel exhibited fresh specimens of the "Common Garden Geranium" (*Pelargonium zonale* L'Her.), collected at Beecroft by Mr. W. M. Carne; and at Gladesville, by Rev. W. W. Watts, badly attacked with a Rust, *Uromyces* sp.(?). Specimens of a "Wild Geranium" (*Geranium dissectum* L.), collected at Clifton Gardens by the exhibitor in June, 1911, were likewise shown, which were also badly affected, and it is quite probable that the cultivated plants may have been infected with the disease from some such source as this.—Specimens of *Acacia decurrens* Willd., var. *pauciglandulosa* F.v.M., collected at Pymble, were also shown; these were badly affected with a Rust which seems to belong to *Uromyces*.—Some specially interesting forms of the common "Couch Grass" (*Cynodon dactylon* Pers.) were exhibited from Centennial Park, having eleven spikes in the inflorescence instead of the usual four to five; and also specimens from the Bogan River, collected by Mr. W. F. Blakely, in October, 1912, with two perfect flowers in several of the spikelets. Previous records of these peculiar abnormal forms will be found in the Agricultural Gazette of N. S. Wales, iv., p.312; and in these Proceedings, 1908, p.290.

Mr. Tillyard exhibited the larvæ of two rare Zygopterid Dragonflies, the Calopterygid *Diphlebia lestoïdes* Selys, and the Agrionid *Neosticta canescens* Tillyard. The larvæ are characterised by the possession of large, swollen, caudal gills of the saccoid type—a very rare archaic type of gill. The gill of *Diphlebia* is a simple saccus, that of *Neosticta* is a constricted saccus of peculiar form, and probably developed from an originally two-jointed anal appendage.

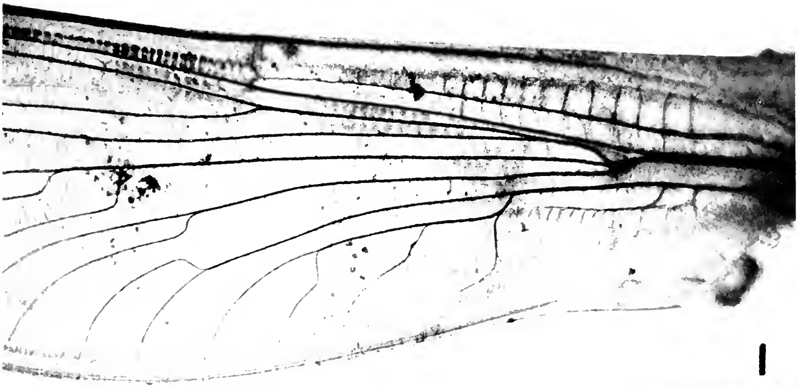
[Printed off, 11th September, 1915.]



Diphlebia lestoïdes Selys.



Diphlebia lestoides Selys.



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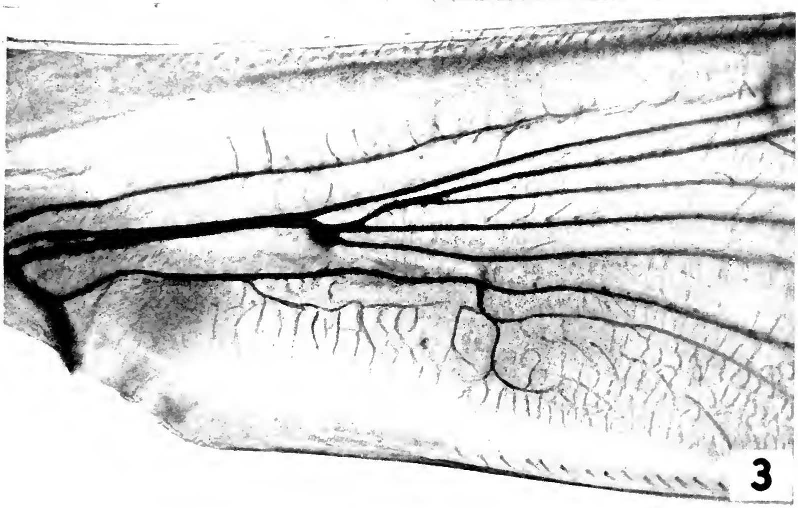
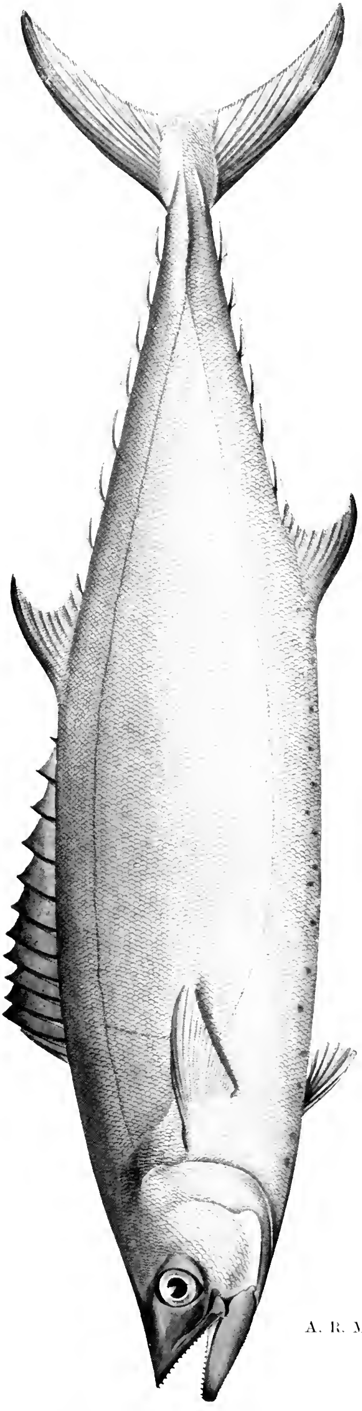
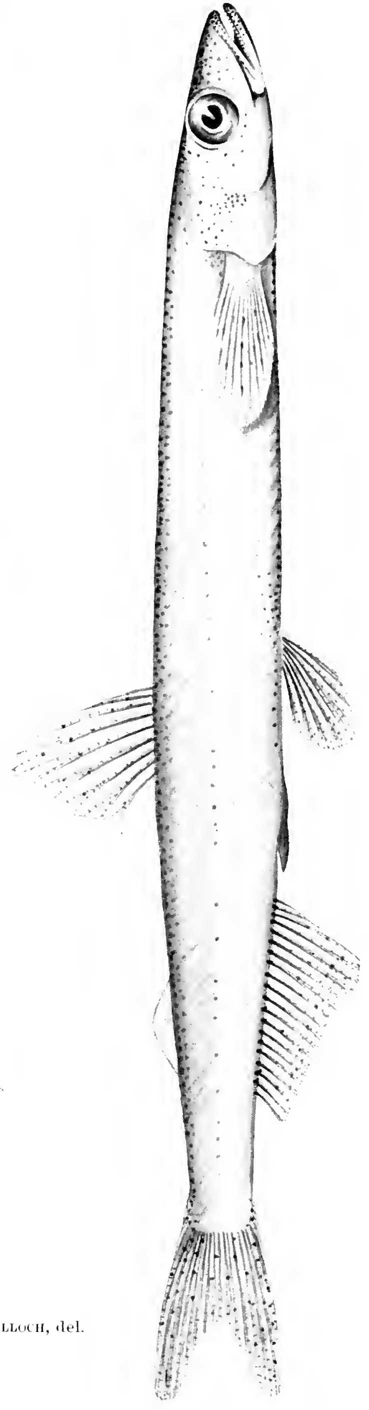


3

Calopteryx splendens Harris.

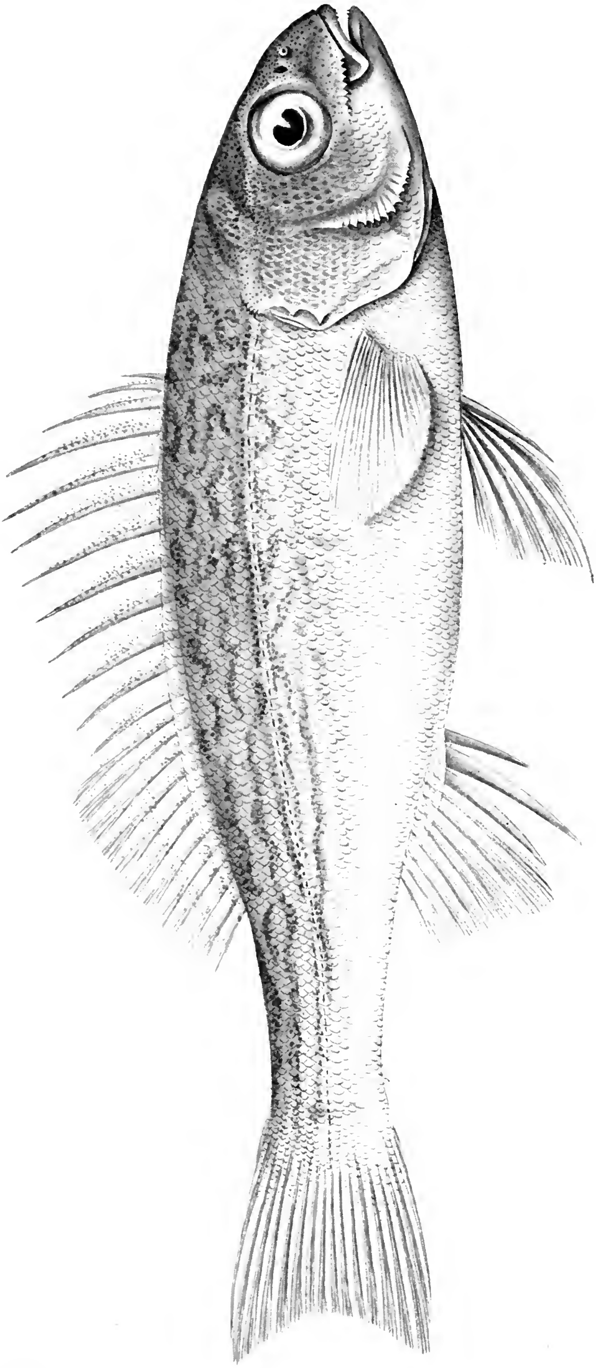


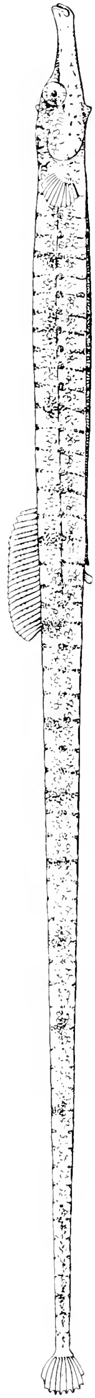


A. R. McCulloch, del.

1. *Grammatorycnus bicarinatus* Q. & G.

2. *Lovettia sealii* Johnstn.

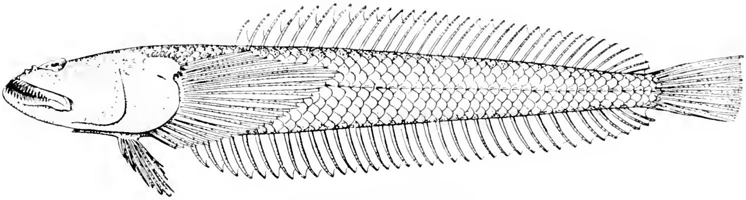




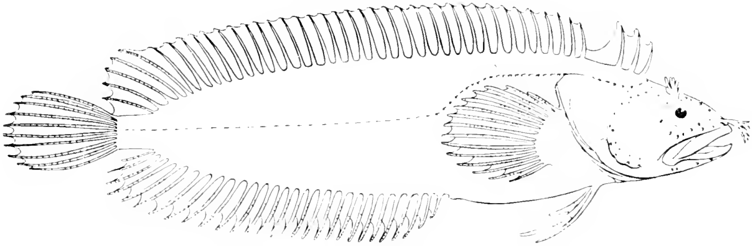
A. R. McCulloch, del.

1 *Therapon bidyana* Mitch.

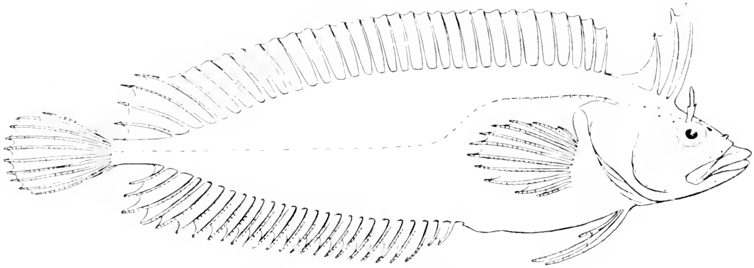
2. *Ichthyocampus scalaris* Gthr.



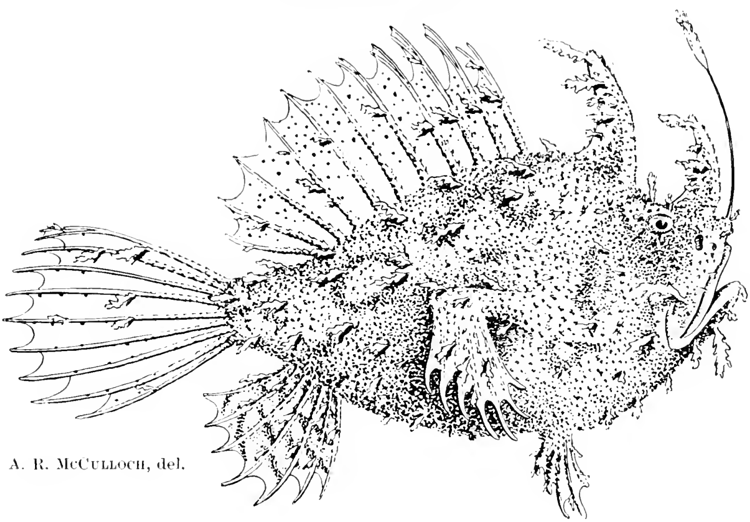
1. *Crapatalus arenarius*, sp. n.



2. *Clinus johnstoni* Kent.

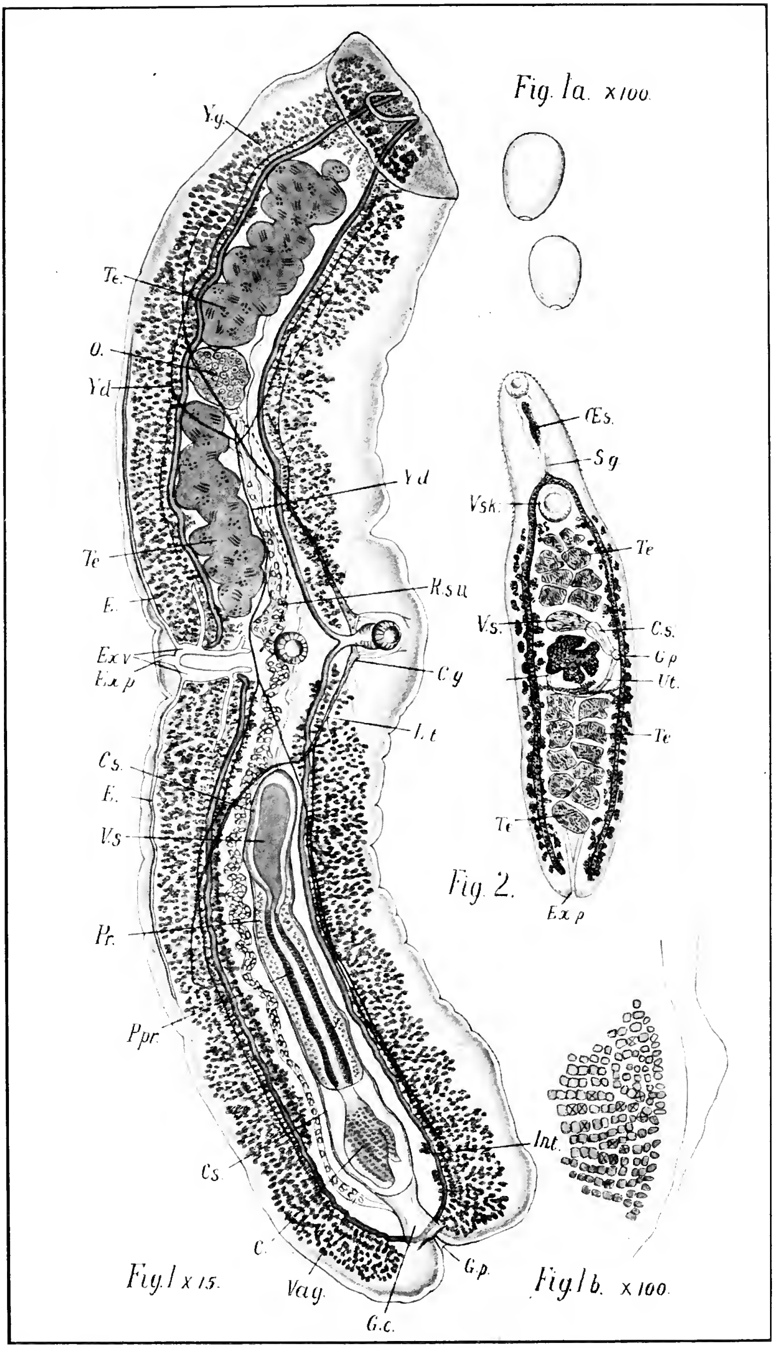


3. *Petraites incertus*, sp. n.



A. R. McCulloch, del.

4. *Tathicarpus muscosus* Ogilby.



1. *Moreauia mirabilis*, g. et sp. n. 2. *Hapalotrema constrictum* Leared.

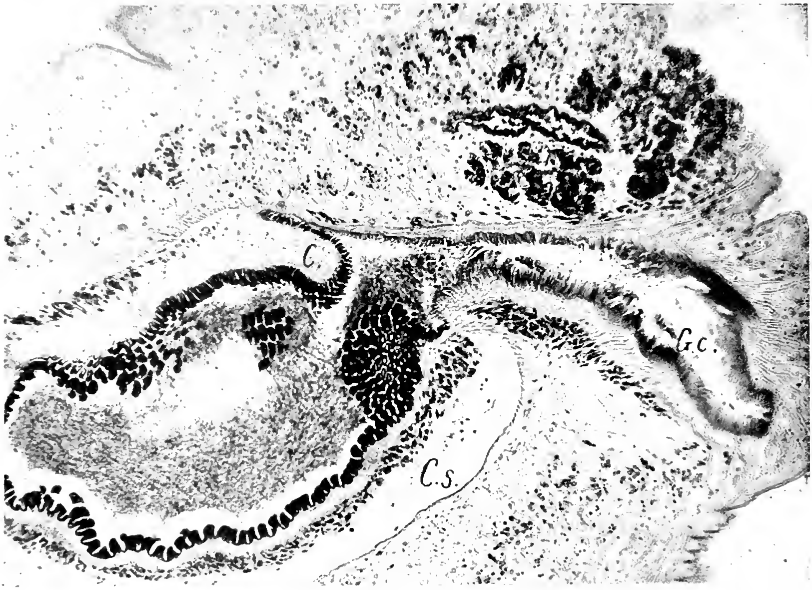


Fig. 3 (× 108).

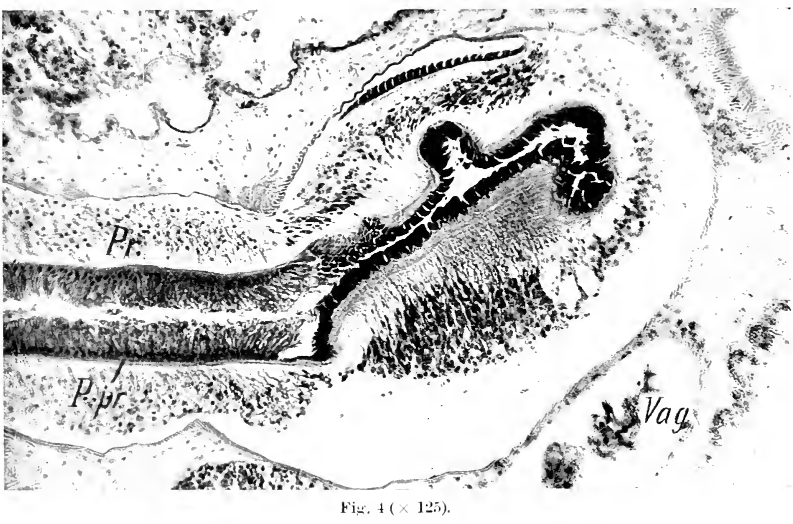
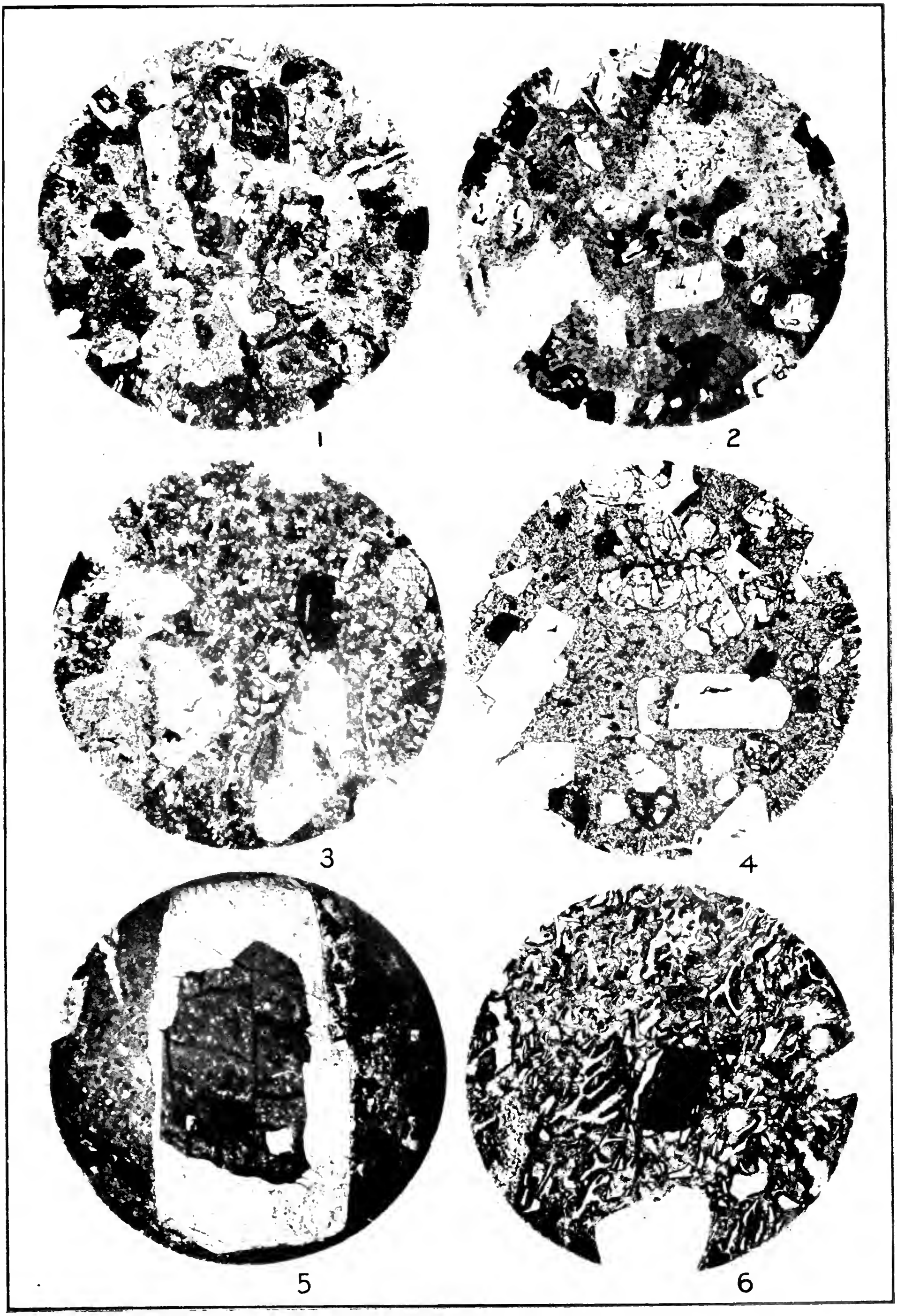
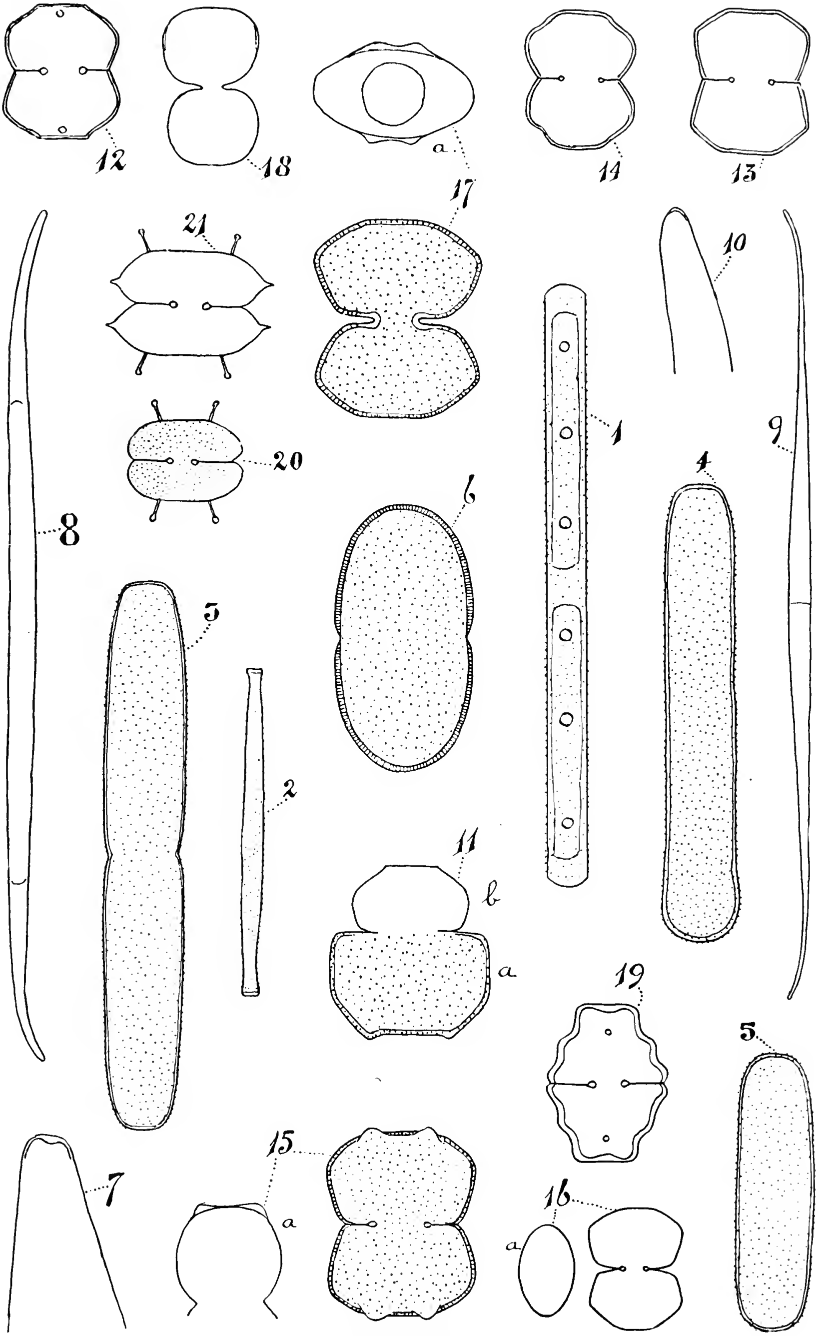


Fig. 4 (× 125).

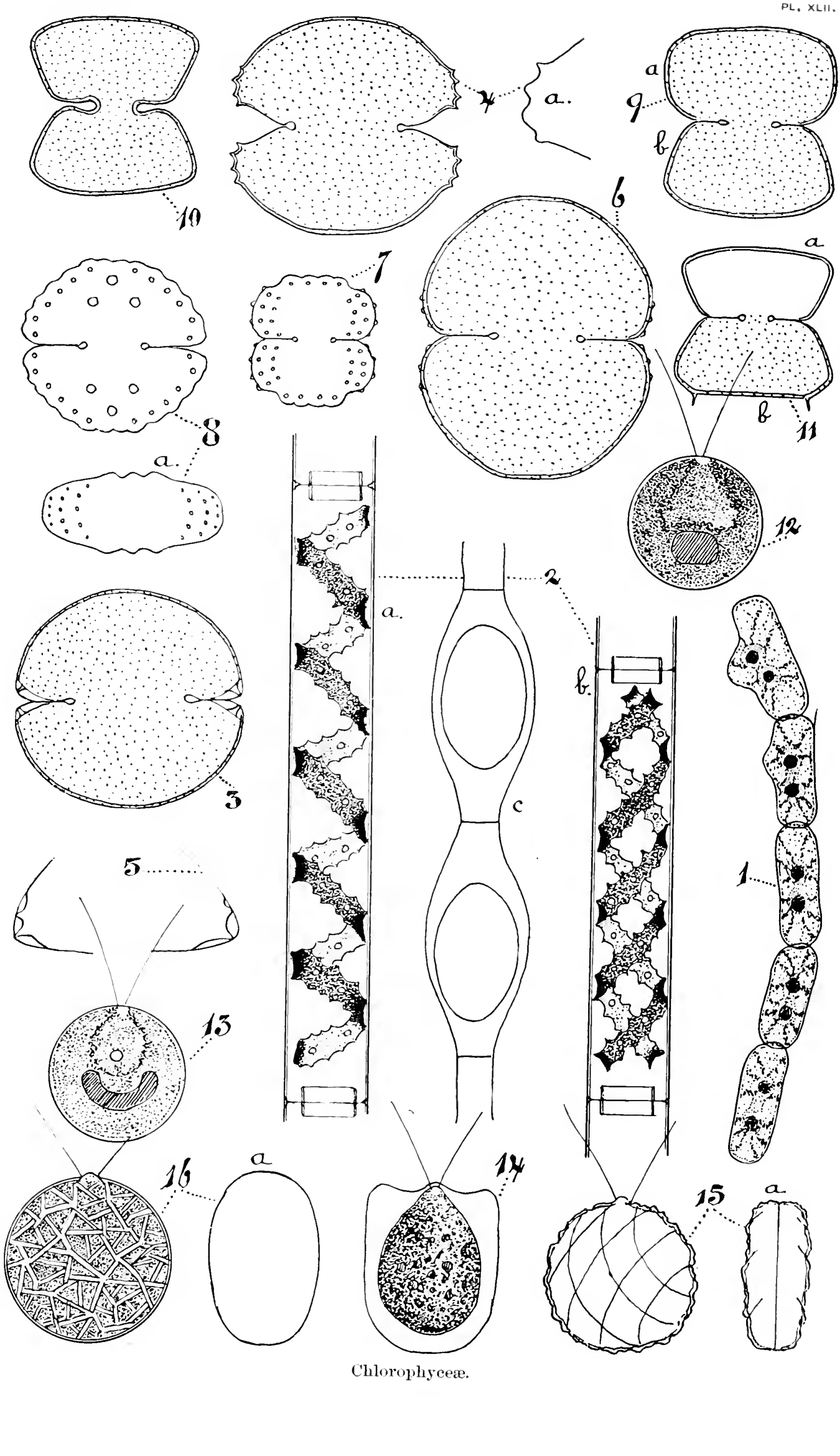
Moreania mirabilis, g. et sp. n.



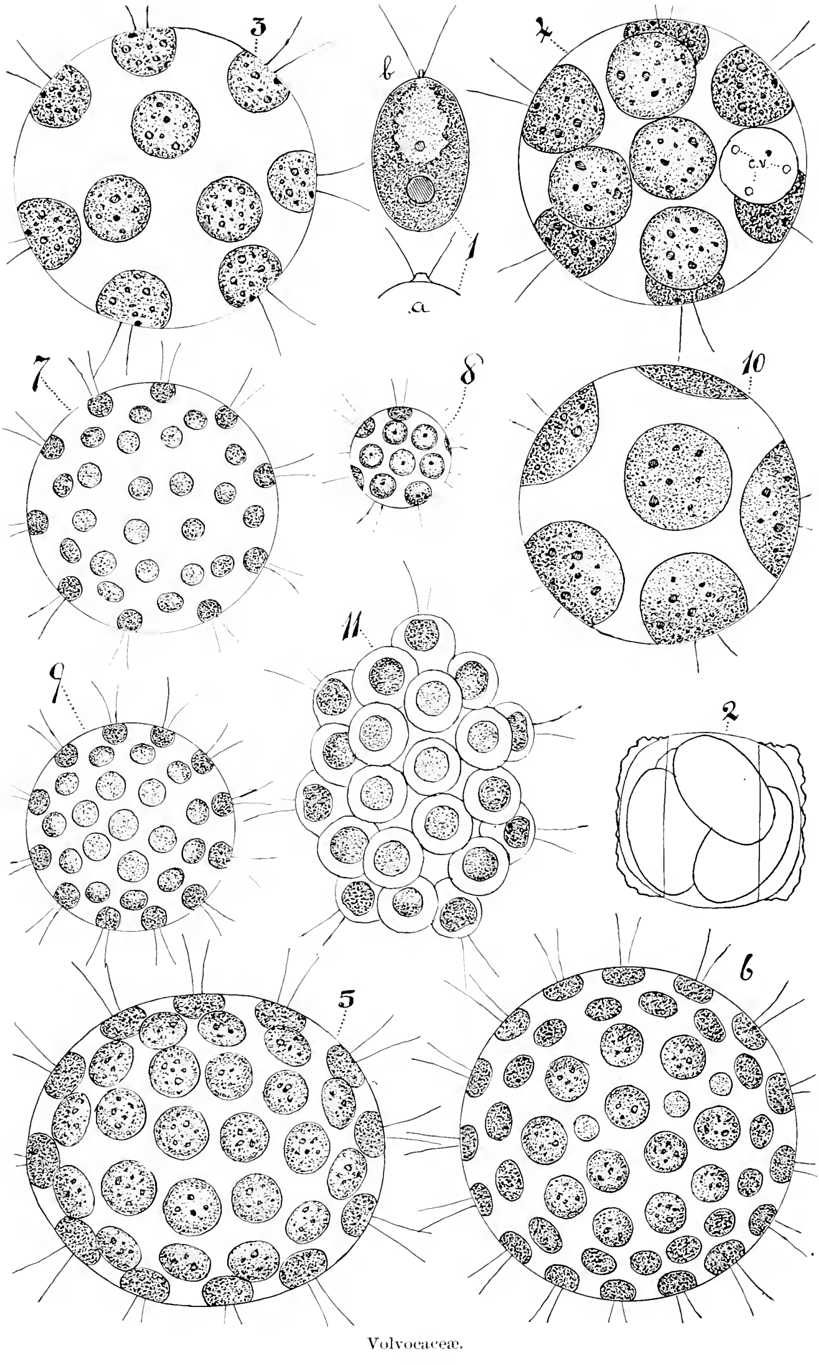
Igneous Rocks and Tuff from the Carboniferous of New South Wales.



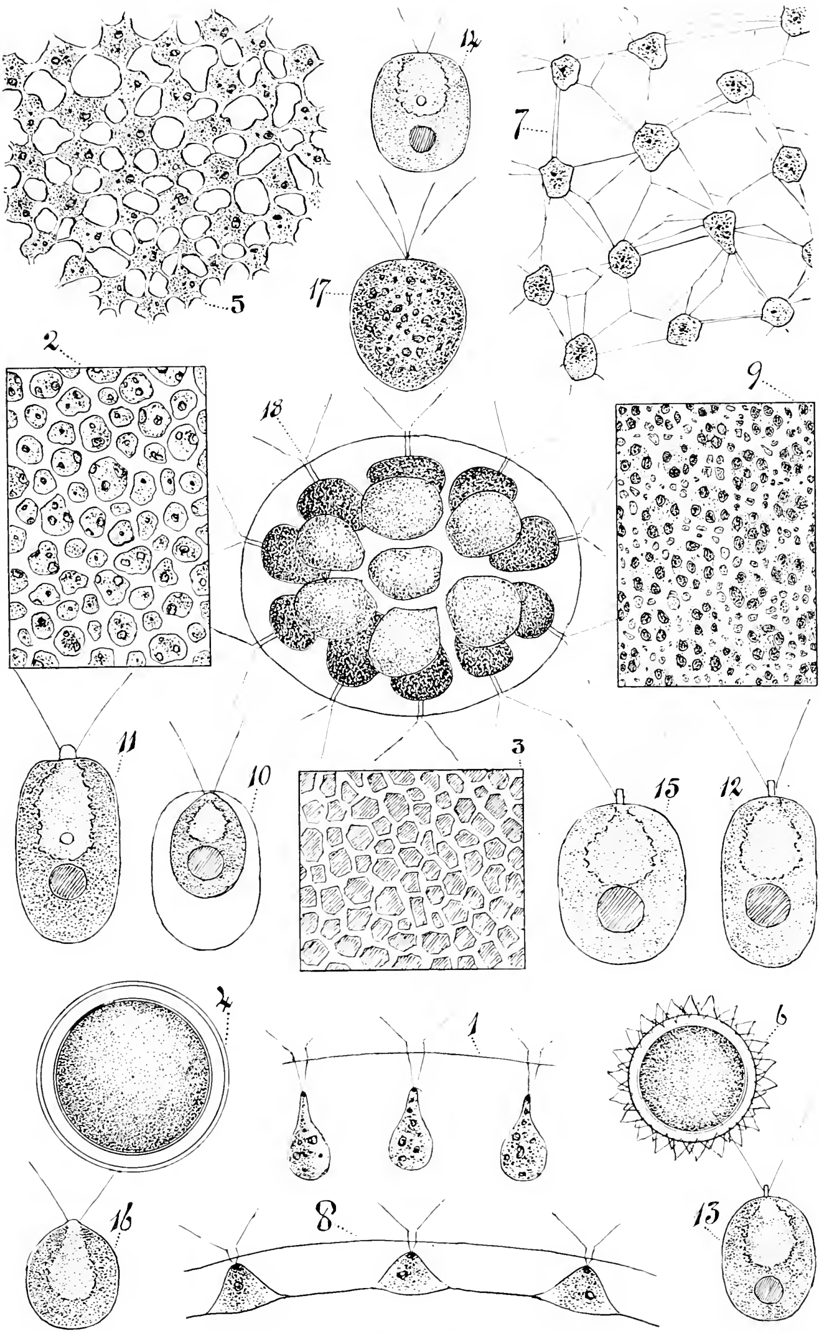
Desmidiaceæ.



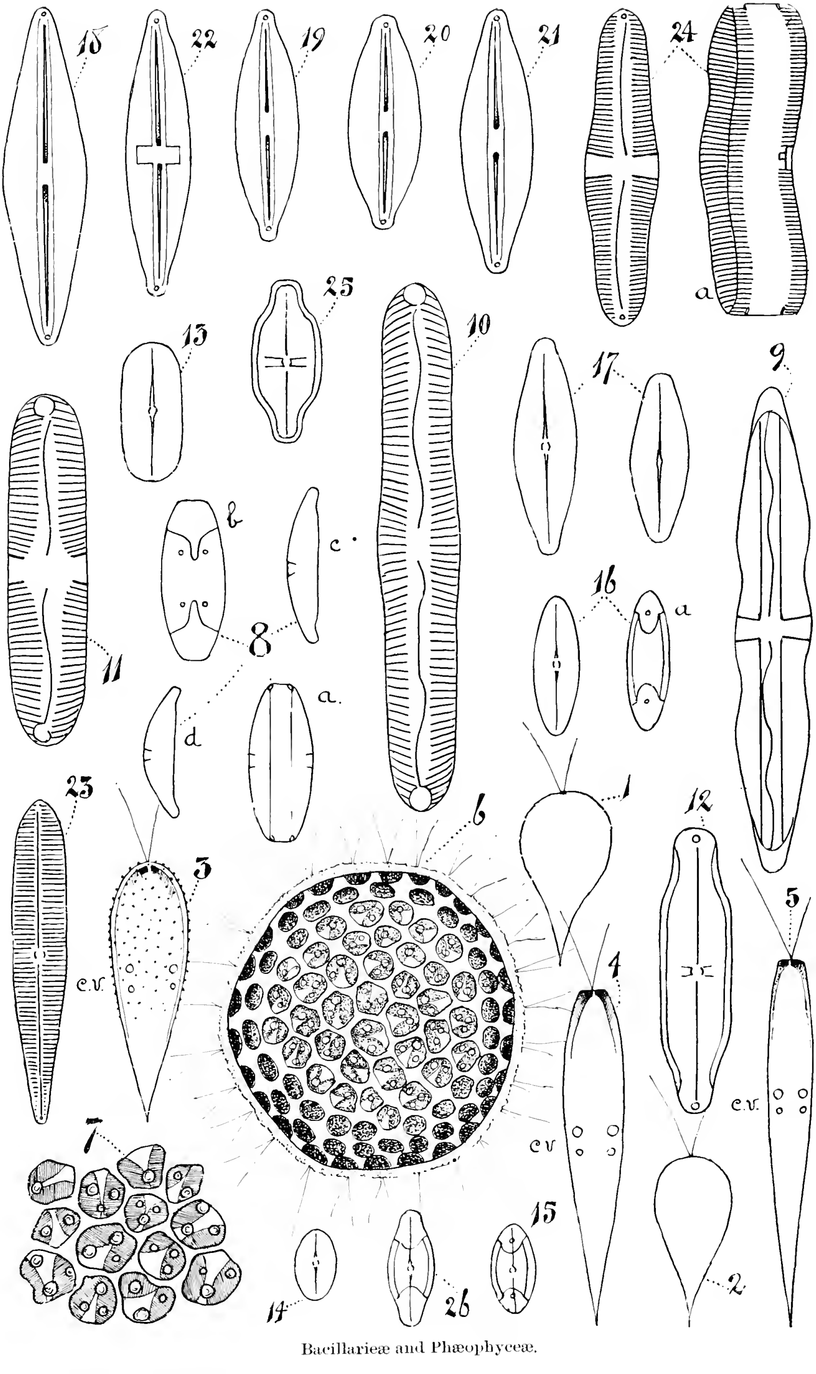
Chlorophyceæ.



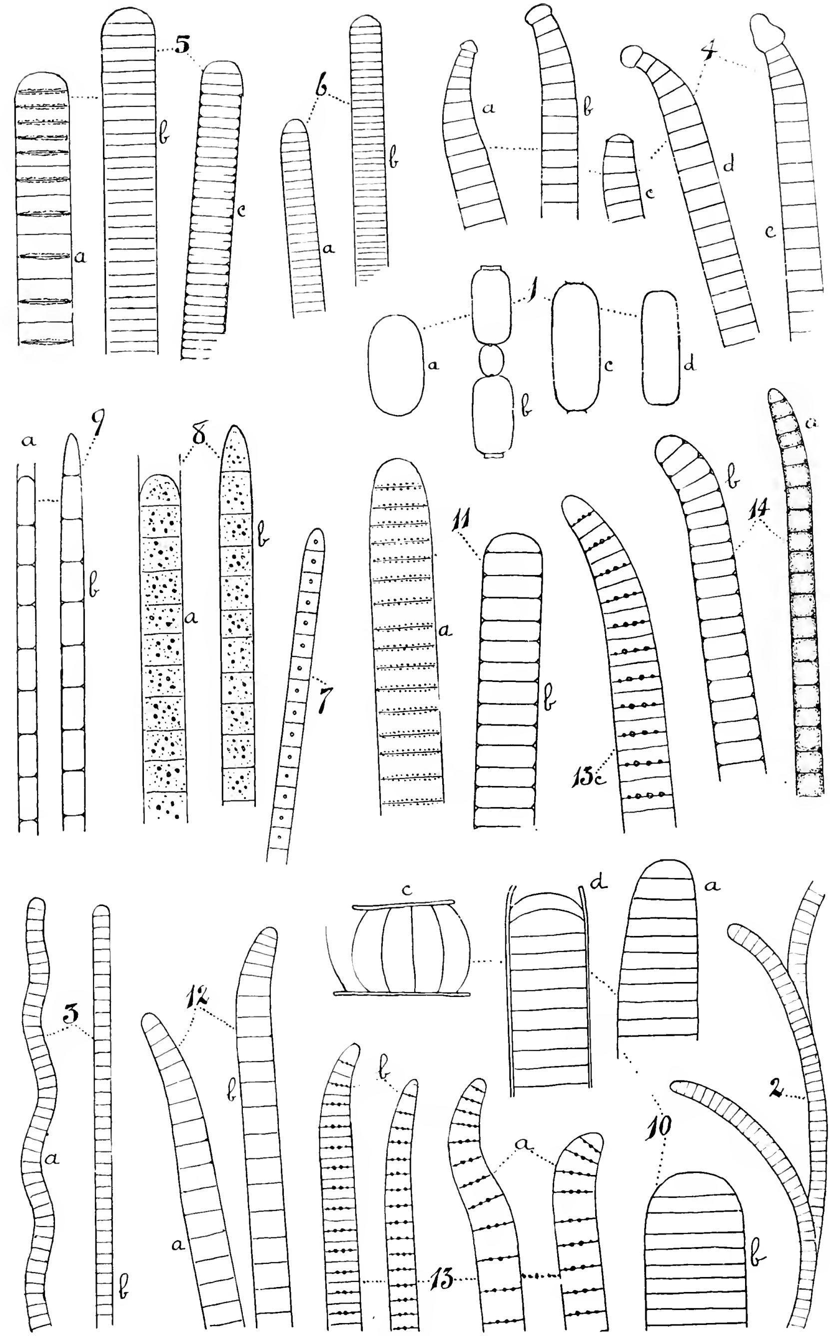
Volvocaceæ.



Volvocaceæ.



Bacillarieæ and Phæophyceæ.



Myxophyceæ.

ORDINARY MONTHLY MEETING.

August 25th, 1915.

Mr. A. G. Hamilton, President, in the Chair.

The Donations and Exchanges received since the previous Monthly Meeting (28th July, 1915), amounting to 7 Vols., 40 Parts or Nos., 10 Bulletins, and 2 Reports, received from 41 Societies, etc., were laid upon the table.

NOTES AND EXHIBITS.

Mr. Froggatt exhibited specimens of a small longicorn beetle, *Bethelium mundum* Blackb. At the Meeting of the Society in September, 1914, a number of branchlets of the Peppermint-Gums (*Eucalyptus* sp.), from near Uralla, N.S.W., cut off the trees by the larvæ of some unknown beetle, were shown. This year, at exactly the same time, the branches again began to strew the ground, all over the district. On examining infested twigs that had been kept in a breeding-cage throughout the interval, a number of the small longicorn-beetles exhibited, were found to be emerging from the dry twigs. The life-cycle is thus just about a year. The larva, falling to the ground with the severed branch, first gnaws its way into the nearest dead knot, and then feeds just under the surface of the bark; when full-fed, it bores into the hard wood and pupates.

Mr. A. A. Hamilton showed a series of specimens from the National Herbarium—*Pultenæa scabra* R.Br., (Mt. Wilson; Dr. J. B. Cleland; June, 1915), exhibiting fasciation and torsion. The stem, at first terete, exhibits dilation, followed by banding; and, eventually, its frequent concomitant torsion. Branches springing at various points from the verges of the stem, within the banded region, have more or less attenuated flowers in the axils of their upper leaves, together with a diminutive terminal cluster, denoting adherence to the normal floral arrangement, "Flowers sessile in the upper axils or three or four together at the ends of the branches" (Fl. Austr., ii., 116). At the summit of the banded portion, both in the principal stem and the subsidiary bifurcation, the torsional strain has suppressed the axial elongation of the branches, bringing together, in an apparently dense head, the whole of the flowers, which are represented by a series of calyces. It is to be noted that the membranous calyces and stipules, together with the rigid xerophytic leaves, are but slightly affected; and it is here suggested that, in each case, their texture is of a character calculated to enable them to maintain their integrity throughout the invasion.—*Podocarpus spinulosa* R.Br., (Woy Woy; A. A. Hamilton; June, 1915), showing spiral torsion of leaves due to mechanical injury. The plant, which has a decumbent habit, had allowed several of its branches to stray into a bush cart-track, where they were overrun by passing vehicles.—*Persoonia linearis* Andr., (Hilltop; E. Cheel; July, 1915), showing spiral torsion of leaves due to injury by insects. Though several stems are deflected, the leaf-contortion is inconsiderable, a slight curvature of the leaves of this species being not unusual under normal conditions.—*Acacia suaveolens* Willd., (Cowan; A. A. Hamilton; July, 1915), showing spiral torsion of leaves due to mechanical injury. A branch having been wrenched off, the injured portion of the stem has become dilated; two phyllodes situated within the injured region are abnormally enlarged and contorted; and the stem above the injury is fissured.—*Pisum sativum* Linn., (Pennant Hills; T. Steel; July, 1915), with a foliate tendril. The extremity of one of the tendrils is produced into an adventitious leaf, disclosing its foliar character; and offering confirmatory evidence of the already well established theory that the Pea-tendril is a modified leaf.—*Bossiœa heterophylla* Vent.; a series of examples illustrating ecological and xerophytic effects on the morphology of the foliage. No.1, growing on a bleak, exposed ridge, 3,500 feet; Newnes Junction (A. A. Hamilton; April, 1914); the stem is aphyllous to a height of 18 inches, the leafy portion occupying a relatively small area; the leaves are narrow-linear and crowded, ranging from under $\frac{1}{4}$ to barely $\frac{1}{2}$ inch long, and from $\frac{1}{2}$ to 1 line broad. No.2, from a dry claypan; Cook's River (A. A. Hamilton; August, 1914); leaves similar in shape and size to those of No.1, but distributed over a greater extent of the stem and branches, and distant. No.3, from a dry, elevated plateau in open forest-country, comparatively sheltered; Leura (A. A. Hamilton; April, 1914); plants diminutive in size ($3\frac{1}{2}$ to 5 inches high) and much branched; leaves heterophyllous; the narrow-linear form favoring the upper, and the ovate form the lower portion of the stem and branches, all under $\frac{1}{2}$ inch long. No.4, from a dry sandhill, Maroubra Bay (A. A. Hamilton; August, 1914); lower leaves rotundate, $\frac{1}{4}$ to $\frac{3}{4}$ inch long, gradually narrowing upwards on the stem (shrub 1 foot high). No.5, a bush of from 4-5 feet, from a sheltered gully on the bank of a watercourse; Waterfall (A. A. Hamilton; June, 1914); leaves heterophyllous, from rotundate and 1 inch long, to narrow-linear and 2 lines long; in some specimens, the rotundate leaves occupy the whole branch; in others, both forms are present on the same specimen. It is notable that the stems of the broad-leaved specimens are flattened; as this form of leaf becomes deciduous under dry conditions, the flattened stems are called upon to replace them, and perform their functions until the climatic conditions are favourable to a renewal of leaf-growth.—*Isopogon anethifolius* R.Br., (Maroubra Bay; A. A. Hamilton; August, 1914), exhibiting leaf-variation. The series of leaves exhibited comprised various stages of division, from simple to pinnatisect.

Also, for Mr. J. H. Maiden, on behalf of Mr. T. Steel, a supposed hybrid, *Boronia floribunda* Sieb., × *B. serrulata* Sm., from French's Forest (These Proceedings, 1906, p.566). Another example of this plant was received at the National Herbarium, from Deewhy (T. D. Mutch; 24/8/1915), which presented further evidence of hybridism. In habit and leaf-characters, the specimens from French's Forest resemble those of *B. serrulata*. The examples from Deewhy, both in habit and foliage, are rather those of *B. floribunda*, though the colour of the flowers approaches that of *B. serrulata*. Opposite leaves are characteristic of the Family (Rutaceæ), but, in this example, all the leaves on one of the branches are in whorls of three.

Mr. E. Cheel exhibited specimens of the common Garden-Geranium (*Pelargonium zonale* L'Her.) very badly attacked by a Rust, collected at Port Hacking, Ashfield, and Blacktown, which are additional localities to those recorded at the last Meeting. On closely examining the specimens, a few teleutosori were found, which had teleutospores agreeing with those of *Puccinia Morrisoni* McAlp. This species of Rust has previously been recorded only on the host plant *Pelargonium australe* Jacq., from Victoria and Tasmania, by McAlpine in the "Rusts of Australia" (p.180); and from Cowcowing, W.A., by the exhibitor (These Proceedings, 1909, p.500). He exhibited also a curious orange received from Mr. Hugh Dixson, of Summer Hill, which had five darker orange-coloured bands or ridges reaching from pole to pole, interpolated in the paler colour of the fruit. Mr. Dixson reported that the fruit was grown by his son at Killara, and that most of the oranges on the tree were marked similarly, though generally without so many of the ribs. A similar occurrence has been recorded by Kerner and Oliver (Nat. Hist. of Plants, p.569) in connection with the "Bizzaria"—a supposed cross between *Citrus medica* and *Citrus aurantium*, which, however, is regarded by some authors as a graft-hybrid.

Mr. Tillyard gave some particulars about a deposit of limited extent, recently discovered in the Upper Trias of Ipswich, which contained fossil insects of the greatest interest. The Government Geologist had taken steps to accumulate and preserve the material with a view to a thorough scientific investigation thereof.

Mr. North exhibited some type-sets of Australian birds' eggs from his private collection, most of which had been originally described at Meetings of this Society. Among them were eggs of—*Corvus bennetti*, *Æluraedus viridis*, *Sphecotheres maxillaris*, *Collyriocincla cerviniventris*, *C. parvissima*, *Edoliisoma tenuirostre*, *Rhipidura albicauda*, *Sisura nana*, *Erythrodryas rosea*, *Pœcilodryas capito*, *Smicrornis flavescens*, *Gerygone magnirostris*, *Malurus cyanochlamys*, *M. assimilis*, *Amytis textilis*, *A. modesta*, *Acanthiza uropygialis*, *A. zietzi*, *Sphenura broadbenti*, *Climac-*

teris superciliosa, *Aphelocephala nigricincta*, *Cracticus rufescens*, *Ptilotis notata*, *P. macleayana*, *P. keartlandi*, *Artamus melanops*, *Poëphila acuticauda*, *Halcyon sordidus*, *Mesocalius osculans*, *Calyptorhynchus banksi*, *Megaloprepia magnifica*, *Macropygia phasianella*, *Ardetta pusilla*, *Turnix maculosa*, *Dendrocygna arcuata*,* *D. eytoni*.† Also the following Cuckoo type-sets :—*Cuculus inornatus* with *Ptilotis lewini*; *Cacomantis flabelliformis* with *Origma rubricata*, ditto with *Malurus lamberti*; *Cacomantis variolosus* with *Rhipidura rufifrons*; two eggs of ditto with *R. albiscapa*, ditto with *Myiagra rubecula*, ditto with *Malurus lamberti*; *Lamprococcyx basalis* with *Acanthiza lineata*, ditto with *Malurus lamberti*, ditto with *M. callainus*, ditto with *Stictoptera bichenovii*, ditto with *Meliornis novæ-hollandiæ*, ditto with *Petrœca leggii*, ditto with *Zosterops lateralis*, ditto with *Smicrornis brevirostris*; *Lamprococcyx plagosus* with *Ægintha temporalis*, ditto with *Malurus lamberti*, ditto with *Cinnyris frenata*; *Mesocalius osculans* with *Acanthiza apicalis*; *Cacomantis flabelliformis*, *Lamprococcyx plagosus*, and *L. basalis* with *Acanthiza pusilla*.

Mr. Fletcher showed three racemes from a plant of the common, introduced Poke-weed (*Phytolacca octandra* Linn.), with pedicellate instead of sessile flowers; the lower ones represented by unfolded green masses; many of the upper ones exhibiting dislocation of the perianth enclosing the stamens, and the aborted ovary represented by a whorl of small leaf-like members, brought about by the extension of the axis.

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* Previously described by Gould from "Eggs brought to the Settlement by the Natives, and *said* to belong to this bird."

† Previously described by Dr. E. P. Ramsay from an immature egg taken from the oviduct.

ON THE PHYSIOLOGY OF THE RECTAL GILLS IN THE LARVÆ OF ANISOPTERID DRAGONFLIES.

By R. J. Tillyard, M.A., B.Sc., F.E.S., Linnean Macleay Fellow of the Society in Zoology.

(Plate xlvii.)

The physiology of respiration is one of the most difficult problems still awaiting a solution in the biology of the Insecta. Most insects breathe by means of *spiracles*, which are the apertures of a complicated system of air-tubes or *tracheæ* ramifying throughout the body, and ending internally in numerous excessively fine tubes or *capillaries*, which supply oxygen directly to all the cells concerned in the metabolism of the body-tissues. Such a system is known as an Open Tracheal System. There are, however, certain aquatic larvæ in which spiracles are either absent, or, if present, non-functional, except, perhaps, on very special occasions, such as when the larvæ leave the water just prior to metamorphosis. In these forms, the required oxygen is derived from the water either directly through the integument, or, more usually, by means of *tracheal gills*. To this latter group belong the larvæ of Mayflies, Stoneflies, and Dragonflies. This type of system is called a Closed Tracheal System.

It is not the purpose of this paper to discuss the various theories of respiration which have been put forward to meet the case of the Open Tracheal System. The question, whether expiration is performed through the spiracles, as well as inspiration, or whether the latter alone takes place there, does not enter into the problem which we have before us For the fact, that the tracheal system of the Dragonfly Larva is *physiologically* a closed one, cannot be disputed, though this closed system shows clearly a secondary derivation from an original open system, resembling that of the imago. Spiracles are present both on the thorax and the abdomen. Those of the thorax, at any rate, can, under certain circumstances, be made to function as orifices of inspiration *at any time that the larva chooses to leave the water.* But we are concerned here only with the problem of *aquatic* respiration, as carried on, day in and day out, throughout the whole life of the growing larva. The admitted facts that *certain* Dragonfly larvæ do occasionally crawl out of the water and breathe air directly through their spiracles, and that probably *all* Dragonfly larvæ also use their spiracles in this way for a short time just prior to metamorphosis, do not affect the general question, and cannot be used as an argument against the conclusions to be arrived at.

I have chosen to restrict the problem in two directions. Firstly, I shall deal only with the Suborder Anisoptera, *i.e.*, those dragonflies whose larvæ breathe by means of *rectal* gills, and shall not consider the somewhat different problem presented by the Zygoptera, whose larvæ breathe by means of *caudal* gills. This is done because our knowledge of the morphology of these latter organs is still in a very backward state, and does not as yet offer a sufficiently sound basis on which to build any general physiological conclusions. The morphology of the rectal gills of Anisoptera, on the other hand, is by now fairly well known, so that we are able to approach the physiological problem with some hope of success. Secondly, I do not intend to offer an explanation of the working of the whole respiratory system, including a detailed discussion of the elimination of nitrogen and carbonic acid gas from the body. The problem before us is to find a satisfactory explanation of the method of obtaining the oxygen, necessary for the metabolism of the larva, from the water, and its distribution to all parts of the body.

It will not be necessary to explain in detail the differences between the various types of rectal gills. I have already dealt very fully with these in a previous paper(8), to which I would refer anyone desirous of studying the comparative morphology of these beautiful and interesting structures. It will be sufficient here to state that the different forms can be classified primarily into two main divisions, the Simplex System and the Duplex System. In the former, the rectal wall is thrown into six main longitudinal folds, forming continuous gills from end to end of the branchial basket; each of these *main-folds* is supported at intervals, to right and left alternately, by smaller *cross-folds.* In the Duplex System, the main-folds are functionless or suppressed, and the cross-folds become separate gills, arranged in six double-rows. Further, the gills of the Simplex System may be classed as either of the Undulate or Papillate Type, while those of the Duplex System may be either of the Implicate, Foliate or Lamellate Type. Whatever be the type of gill, it remains essentially a delicate eversion of the rectal wall, projecting far into the rectal cavity, and bathed on all sides by the water drawn into that cavity. I have contented myself, therefore, with figuring only the gill of the larva of *Hemicordulia tau* Selys (Plate xlvii.). This belongs to the Lamellate Duplex Type, and is, at the same time, both one of the most highly organised, and one of the most easily understood of all rectal gill-types.

On opening the branchial basket (*i.e.*, the anterior portion of the rectum) of this larva, we find a very beautiful and regular arrangement of gills within. There are six, longitudinal, double rows of lamellate gills (Fig.1) of a beautiful pale mauve tint. Each single row contains twenty or more of these separate lamellæ, in the form of semiovals inserted on a broad base (Fig. 2*b*), placed obliquely, and overlapping one another from before backwards. Consecutive lamellæ are protected from rubbing against one another by the action of three small tubercles (Fig. 2, *ta*, *tp*), which also allow a sufficient space between them for a complete circulation of water around the gill.

On the outer anterior face of the base of each gill, there is a large rounded swelling, the basal pad(*bp*), very conspicuous, and of a semitransparent orange-colour. This pad is a turgid structure, apparently full of watery fluid. The boundaries of the cells forming it are obliterated, but their nuclei are large, and form centres from which very distinct fibrillar structures pass out to the borders of the pad. Beneath the pad, the space between the bases of the two walls of the gill-lamella is filled with a mass of *hypobranchial tissue* (*hb*), surrounding the region of the large efferent tracheæ of the gill. The nature of this tissue is not clearly understood, but it seems to be a derivative of the fat-body, and obviously lies in the hæmocœle. In fact, it practically blocks out the circulation of the blood from the gill, in which definite blood-spaces do not really exist, except around the larger tracheæ near the base. In the lamellæ itself, although the two walls of the gill can be slightly forced apart by the artificial injection of fluid (thus proving the continuity of the hæmocœle into this organ), yet no circulation of blood-corpuscles has ever been observed; and, so far as my own observations go, such circulation would be impossible, owing to the fact that the two walls of the gill are, in the natural state, practically in contact everywhere except at the base. In other forms, where tracheæ of considerable calibre penetrate some distance into the gill, blood-spaces are met with further in (*bs*) around these tracheæ. In the Papillate type, the blood-spaces follow the axial trachea of the papilla almost to its tip. But in no case is there any noticeable circulation of blood, and that fluid does not play any important part in the problem of oxygen-carrying.

The gill is covered everywhere by a very fine transparent *cuticle* (*cu*), representing the *intima* or chitinous lining of the undifferentiated rectal epithelium. Beneath the cuticle lies the gill-epithelium (*ep*). This is a thin layer of very flattened cells, all fused together into a syncytium in which the nuclei (nu_1) are clearly visible at somewhat irregular intervals, and placed rather far apart. The mauve colour of the lamellæ of *H. tau* is due to the presence of very fine granules of purplish pigment (*pg*) scattered in this syncytium.

The arrangement of the gill-tracheæ can be gathered from Fig.1. Almost the whole of the lamella proper carries only capillaries (*cap*). These are very numerous and excessively fine tubes, with no trace of a spiral thread. It is very important to note that each capillary forms a *complete loop*, passing up one side of the gill, crossing over beneath the rounded distal border of the lamella, and descending along the other side, finally joining up with other capillaries to enter a larger branch which unites, at last, with the branch from which the capillary took its rise. Under a high power, the capillaries can be seen to lie actually *within* the epithelial syncytium, *fairly close up to the cuticle* (Fig.5).

The capillaries are collected into bundles at the base of the gill, forming five or six, stouter, short tracheæ. These unite together to form the efferent trachea of the gill, termed a *secondary efferent(es)*. They are surrounded by the hypobranchial tissue at the base of the gill. The secondary efferents from the gills on one side of a double-row unite in pairs with those from the gills of the other side, forming a single longitudinal set of *primary efferents*, which enter one of the main longitudinal trunks of the body.

We can now attack our problem directly. There are clearly eight separate elements which go to form a single gill, viz., (1) the cuticle, (2) the epithelial syncytium, (3) the pigment, (4) the basal pad, (5) the hypobranchial tissue, (6) the blood-plasma in the narrow blood-spaces, (7) the capillaries, and (8) the larger tracheæ and efferents. We have to determine which of these are the essential elements in respiration, and which are merely accessory thereto.

We must class as accessories all those structures which are not present in all types of rectal gill. For if, in certain cases, the gill respires satisfactorily without them, it is clear that they have a function only accessory to respiration in those gills in which they are present.

It is also clear that the part of the gill, which is concerned with the extraction of oxygen, is the part which projects into the water in the rectal cavity. Structures which are present only at the base of the gill will, in general, therefore, be only accessories.

Thus we arrive at the following list of accessory structures:—

(1). *The pigment.*—Although developed all over the lamella in *Hemicordulia*, yet, in most forms, the pigment is confined to the basal part of the gill. In many genera (e.g., *Austrogomphus*, *Petalura*, *Cordulegaster*, *Dendroæschna*, *Austrophlebia*, *Orthetrum*) *no pigment is developed in any part of the gill.* Hence we may safely conclude that the pigment is purely an accessory element, so far as respiration is concerned.

(2). *The basal pad.*—Not only is this developed at the base of the gill, but it is either absent or very feebly developed in gills of the Implicate Duplex Type, as well as in the gills of the majority of *young* larvæ. Hence we may not only class it as an accessory, but we may gather that its chief function is that of a support for the gill. For, in the implicate duplex type, the gills overlap one another in the form of a series of concave tiles with rounded ends, these ends being connected together so as to form a continuous wavy ridge. Thus the two rows of gills in one double-row support one another, and no basal pad is needed. The fact that the basal pad is absent or vestigial in this type of gill points, therefore, to its functioning in general as a support for the gill.

(3). *The hypobranchial tissue.*—This also is absent or feebly developed in young larvæ, and also in gills of the Implicate Duplex Type, as well as being developed, in other forms, only at the extreme base of the gill. Hence we may class it as an accessory. It is possible, however, that this tissue may play some part in the physiology of respiration, apart from that of oxygen-extraction. It may, for instance, help in the removal of nitrogen or carbonic acid gas.

(4). *The blood-plasma.*—We class this as an accessory, partly because there is no definite blood-circulation in the gill itself, and no clearly defined blood-spaces except at its base, and partly because the blood of insects (except in a few very special cases) appears to be entirely lacking in oxygen-carrying elements. We must, however, accord to the blood an important part in the removal of carbonic acid gas from the body, and perhaps also portion of the nitrogen.

Thus, out of eight elements of the gill-structure, four are seen to be accessories. We must next remove from the problem a fifth, viz., the larger tracheæ, since these clearly function only as *receivers of oxygen from the capillaries*, *i.e.*, efferents to the main tracheal system. Thus the problem is now reduced to the consideration of three elements, viz., the *cuticle*, the *epithelial syncytium* (minus the pigment), and the *tracheal capillaries*. How do these three combine for the extraction of oxygen from the water in the rectal cavity?

An examination of Figs. 3, 5, will at once suggest the strong probability that the gas is obtained *by a simple process of diffusion through the slender wall of the gill into the underlying capillaries* The points in favour of this are : –

i. The thinness and delicacy of the cuticle.

ii. The alteration of the undifferentiated rectal epithelium (Fig. 6*b*) into a thin syncytium, with elimination of cell-boundaries.

iii. The extreme fineness of the walls of the tracheal capillaries, and the complete absence of the spiral thread.

iv. The fact that the capillaries, instead of running in a definite blood-channel, are embedded in the protoplasm of the epithelial syncytium, thus becoming arranged as close to the external surface of the gill as is possible under the circumstances.

v. The fact that all the capillaries form *complete loops*. For, if oxygen were extracted at any given point, or by any given localised organ, we should expect the capillaries to *end* in that point or organ. The fact that they form complete loops shows, however, that the extraction must take place at all points along the circumference, and pass inwards down both arcs of the capillary, to its junctions with the larger efferents. In other words, there is no *circulation* of gas in the capillaries in a definite direction round the circumference, but simply a passage of gas from all points inwards towards the efferent tracheæ.

Some such solution as this had evidently been in the minds of most of the earlier students of the subject, until certain apparently insuperable difficulties were pointed out. On that account, the Diffusion Theory, as I propose to call it, became unpopular, in spite of Lowne's advocacy(**3**), until Ris again recently reviewed it—without, however, clearing away the initial difficulty of the problem As I intend, in this paper, to support the view advanced by Lowne and Ris, it will be as well if I make their position clear by quoting a translation of the latter's own words(**5**):—The question becomes more difficult in the case of the Closed Tracheal System, of which our larvæ furnish a classical example. What is here wanting is the *vis a tergo* of the inspiration-organ, and we are driven to this, to assume purely chemical or, as the case may be, diffusion-forces as the motive agent ("rein chemische, resp. Diffusionskräfte als das bewegende Agens anzunehmen"). Lowne postulates for this, and also further on, for the function of the Closed System, at least a temporary opening of the thoracic stigmata, which certainly are not wanting in our instance. The difficulty lies here especially in this, that such a function of these stigmata is only concluded ("nur erschlossen"), but never positively observed.

On this ground, Ris rejects Lowne's theory on this single last point, and declares the problem not yet solved It seems quite clear that Ris is right, for the following reasons. Supposing we grant Lowne's contention concerning the thoracic spiracles, what then? In the case of aquatic larvæ, of what avail would the opening of these spiracles be, seeing that only water, and not air, could be drawn in through them? Or, if it be urged that, at any rate, the young larva might climb out of the water for a short time, and thus fill its tracheal system with air through its temporarily opened spiracles, the answer is very definite, viz., that no such action by the larva takes place, and that *the first filling of the tracheæ with air has been observed more than once to take place beneath the water.*

Thus the opposition to the Diffusion-Theory comes simply to this, that the main principle of the Theory is not even attacked, but is admitted to be exceedingly probable, were it not for the supposed insuperable difficulty attending the *starting of the process* in the newly-hatched larva. It is well known that the tracheæ of the embryo are filled, before hatching, with a pale fluid, generally supposed to be blood-plasma. How, it is asked, can this fluid be withdrawn, and diffusion of air or of oxygen follow at once from the water in the rectum into the tracheal tubes? The obvious answer to this is, that it cannot be done. And there the matter is allowed to rest, apparently with the overthrow of the Diffusion-Theory.

Now, I propose, in this paper, to show (1), that a solution of the above difficulty *does* exist, and (2), that the Diffusion-Theory rests on solid ground, with a good morphological basis for its support.

The method of filling the tracheæ with gas in the newly-hatched larva.—It has been usually stated that, soon after hatching, isolated globules of gas appear in the tracheæ at various points, and that these, by increase and coalescence, gradually drive the fluid out of the tubes. My own observations(**7**), which support, in their chief points, those previously made by Calvert(**1**), show that this is not so. In the case of *Anax papuensis* Burm., I found that the embryo, just prior to hatching, had its tracheæ filled with liquid, as is agreed by all observers. The emergence takes place very rapidly. Owing to the interpolation of a pronymphal stage, the larva has to escape not only from the egg-shell, but also from the pronymphal sheath almost immediately afterwards. Thus there is a period of at least half a minute during which observation of the changes going on in the tracheæ is exceedingly difficult, if not quite impossible. However, at the moment the larva becomes free, *gas can be seen travelling evenly down the two dorsal trunks from the region of the midgut backwards.* It is, of course, impossible to analyse this gas; but, as we shall see later, the point is immaterial. The importance of the observation lies in the fact that the gas *does not form in the rectal region, i.e.*, it does not, *at the start*, pass in from the rectal cavity to the tracheæ. As the gas only travels down the dorsal tracheæ, and not down the ventral or visceral trunks, it seems almost certain that it is derived from the head or thorax, since these portions are entirely supplied by the dorsal tracheæ. We might mention, in this connection, the head-vesicle and the cephalic heart as offering a probable solution to this difficult question. Certain it is, that the pulsations of the cephalic heart synchronise closely enough with the period of the filling of the dorsal trunks with gas, to suggest that there is more than a chance-connection between the two. But this problem cannot yet be definitely solved. It is sufficient, for removing the obstacle supposed to stand in the way of an acceptance of the Diffusion-Theory, that we have shown that this obstacle does not really exist. We can take it as proved that, within a minute or two after hatching, gas fills the tracheal system of the larva, and that it comes in, not viâ the rectum, but from somewhere in the anterior end of the animal.

Now let us follow the gas-flow along the dorsal trunks. It travels steadily backwards to the rectal region. The primary efferents are first filled, then the secondary, then the smaller branches, and, finally, with considerable rapidity, gas passes up around the capillary loops, completely displacing all the liquid. The gas also passes from the dorsal tracheæ by means of short connecting branches into the ventral and visceral trunks, so that the whole system is very soon filled. The process is very easy to follow, since the gas shows up like a black rod travelling along the colourless tubes.

The expulsion of the liquid from the capillaries and larger tracheæ, which can be clearly seen taking place, is not difficult to understand if we assume (as is generally agreed) that the liquid is blood. If so, it passes into the hæmocœle, and the connection between the dorsal tracheæ and the aorta must be sought for in the cephalic heart.

As soon as the filling of the tracheal system with gas is completed, *rectal respiration* begins. The rectal valves immediately come into play vigorously, so that the rectal cavity is soon strongly distended with water. For a short time, the action is exceedingly vigorous; then it settles down to the usual slow and somewhat irregular rate.

Thus, within a few minutes of the hatching of the larva, all the conditions necessary for the passage inwards of oxygen by diffusion are fulfilled. For, whatever be the proportion of oxygen to nitrogen in the gas in the tracheal system, it is quite clear that the partial pressures of both these gases must always tend to become equal on either side of the diffusion-membrane. We may take it that the water in the rectum is fairly well aërated, *i.e.*, contains oxygen and nitrogen dissolved in the ratio of one to two.* If, then, the proportion of oxygen to nitrogen in the tracheæ be originally greater than this, it will be lowered by the passage of nitrogen inwards from the water in the rectum.

* Or, more correctly, out of every 100 parts of gas dissolved, 35 are oxygen and 65 nitrogen. The result is obtained from the ratios of the products of the coefficient of solubility and the partial pressure of the gas at the water-surface.

If, on the other hand, (as seems more probable) the proportion be less, oxygen will pass in to a like extent. Or if, as may well be the case, the proportion is the same from the start (seeing that both egg and larva are, throughout the operation, immersed in water), equilibrium will be established from the start.

The Process of Diffusion during larval life.—Whatever be the composition of the original gas in the tracheæ, it is the oxygen in it which is required for the metabolism of the growing larva. There is, therefore, from the time that equilibrium is established, a *continuous drain* on the oxygen in the tubes. This gas is taken up at all points of the body by the cells of the developing organs, *by direct tracheal supply.* Thus there is a steady diminution of the partial pressure of oxygen going on on one side of the diffusion-membrane, while the partial pressure of the same gas on the other side of the membrane (*i.e.*, in the water) remains constant. Hence there must be a tendency for oxygen to diffuse from the water into the tracheal system *at all points where the two are brought into contact.* The problem is the same here for the integument as for gills placed in any position on the body. What we have now to see clearly is, that the suitable conditions are only set up, in our larvæ, to any appreciable extent, in the case of the rectal gills. In Fig.6, I offer a comparison between (*a*) the ordinary body-wall, (*b*) the undifferentiated rectal wall, and (*c*) the gill-wall of our larva. In (*a*), the cuticle is thick and many-layered, the hypodermis is also fairly thick, and composed of separate cells, and there is no special arrangement of tracheæ for the reception of the diffused gas (supposing that any were to pass through). In (*b*), the conditions are more favourable, in so far that the cuticle (intima) is thinner and single-layered, the epithelial cells flatter (though still separate), and the tracheal supply, on the whole, richer and finer than in the case of (i). In (*c*), finally, not only are the cuticle and epithelium reduced to the finest possible dimensions, and the cell-boundaries of the latter obliterated, but thousands of minute capillaries are actually sunk into the epithelial syncytium, so that they can receive directly the supply of diffusing gas. Could any arrangement possibly be simpler, or more perfect for the action of diffusion?

We have already alluded to the fact that these capillaries form complete loops. This is most important, since it points strongly in favour of the view that gas must enter equally readily at all points of the circumference of the capillary. We should note, further, that each capillary passes up one wall of the gill and down the other. Thus it is arranged to the greatest advantage for the reception of oxygen from the water, which bathes both sides of the gill. Finally, as there is no spiral thread in these capillaries, and their walls are excessively fine, they offer no obstacle to the free passage of gas into their cavities by diffusion.

It is well known that *chitin*, which is the substance forming the cuticle of the gill and the intima (endotrachea) of the capillary tube, is a colloid substance which admits of the passage through it of gases by diffusion, and is particularly partial to carbonic acid gas. It is generally supposed (and the experiments of Dewitz(**2**) support this view) that chitin possesses some special power of absorbing carbonic acid gas and giving it out again. Hence we might expect that a *thick* layer of chitin would facilitate the passage of this gas, whereas, for other gases, such as oxygen or nitrogen, a *thin* layer would be necessary. This is significant when we contrast the thickness of the body-cuticle, through which carbonic acid gas is now generally believed to pass outwards, with the delicate layer covering the gills, through which we claim that oxygen passes in by diffusion.

It may be urged that the arguments applied above, in favour of the Diffusion-Theory, would be just as applicable to a theory which would substitute some chemical means of extraction in place of diffusion. May not the gill-epithelium or its pigment be an active oxygenating agent? To this the reply is that, if the gill-epithelium possessed this power, (i.) it would be sufficient for the capillaries to lie in the hæmocœle beneath the epithelium, since the oxygen would be given out to them by the inner border of the epithelium; the fact, that they are pushed in towards the cuticle, speaks in favour of diffusion; (ii.) the thinning down of the epithelium, and the fusion of its cells into a single protoplasmic mass or syncytium, would not be an advantage in this case, since a thicker layer of separate, chemically-active cells would absorb and hold far more oxygen. The question of the chemical activity of gill-pigments(4) has been seriously entertained by a number of authors, but ought to be finally disposed of by the evidence given in the case of Anisopterid larvæ, where closely allied genera may have either pure white (unpigmented), or deep purple or black (heavily pigmented) gills, and both carry on respiration equally well.

The passage of the oxygen along the tracheal tubes.—Several authors have sought for elaborate explanations of the method by which the oxygen is carried along the tracheal tubes to the various parts of the body. It was thought possible that the larger tracheæ themselves might expand or contract in cross-section, and so drive the gas forwards. This has been shown to be impossible to any appreciable extent, except in the case of vessels with specially distensible walls, such as the air-sacs of certain insects. A very curious alternative explanation has been offered by Sadones(6). He showed that, by reason of the discontinuity of the spiral threads, the tracheæ can be pulled out longitudinally, and then let back again, like a concertina. From this, he seems to have concluded that such a concertina-like action actually takes place, and is the means whereby the gas was moved along the tracheæ. This conclusion, he admits, was arrived at only after cudgelling his brains for a long time ("nous nous frappions la tête depuis longtemps")! Now it seems clear that such a supposition is not only unnecessary, but is unsupported by any morphological evidence. For the tracheæ are devoid of muscle and elastic tissue, and any extension they are capable of is purely passive, and not active. If one watches the respiration of a transparent Anisopterid larva under a low power, it will be seen that the dorsal tracheæ move up and down in the body-cavity in connection with, and not independently of, the pulsations of the rectum. There does not appear to be any change in volume, but merely a change of position. Further, if the tracheæ forced the gas onwards in any way, one would naturally expect a considerable increase in pressure to take place within the tubes, as is the case in strongly-flying imagines. But, in the Dragonfly larvæ, the large tracheal trunks do not collapse for some hours after death or dissection. This seems to be clear proof that their contained gas is at a pressure equal to, or slightly lower than, that of the atmosphere. In any case, what more is needed as a driving force than the steady consumption of oxygen by the tissues? If this consumption is rapid, surely the play of the rectal pulsations will increase correspondingly; more water will pass over the gills, and more oxygen will pass into the tracheæ from it. If the consumption is slow, the rectal pulsations will slow down also. Here indeed we note a beautiful interplay of action. For the larva uses the expulsion of water from the rectum as a means of propulsion through the water, and thus economises its store of energy by utilising the very means which supply it with oxygen!

The elimination of Nitrogen.—Though this paper is not primarily concerned with this problem, it seems advisable to point out that the question offers little difficulty, if we accept the Diffusion-Theory. For this gas will only diffuse into the capillaries in sufficient quantity to keep its partial pressure equal on both sides of the gill-wall. As the free nitrogen in the body of the larva is used little, if at all, in the process of metabolism, very little of the gas, if any, will diffuse inwards. There is, therefore, no question of the elimination of immense quantities of this gas, such as puzzle our minds in the case of the Open Tracheal System.

The elimination of Carbonic Acid Gas.—There seems to be little doubt that this is chiefly dissolved in the blood, whence it passes to the exterior through the chitin of the integument. A small amount probably gets into the tracheæ by diffusion from the hæmocœle, but the quantity would never be sufficient to affect the steady diffusion of oxygen from the gills in a supply sufficient for all requisite purposes.

In conclusion, we may say that what is now wanted, in order to make this interesting problem clearer, is a careful and accurate analysis of the gas contained in the large tracheal trunks of an Anisopterid larva (care being taken to exclude the carbonic acid gas present in the blood). Analyses made of this gas, in the case of certain insects with an Open Tracheal System, show the nitrogen to be considerably in excess of its normal proportion in atmospheric air (partial pressure of N in tracheal gas = about 90% of total pressure). Further, the total pressure within the tracheæ of such an insect exceeds the atmospheric pressure very considerably (according to Lowne, it equals 810 mm.). Thus the partial pressure of nitrogen would be 90% of 810 mm., *i.e.*, 729 mm., against 600 mm. for atmospheric air. Is it likely that similar results would be obtained for our aquatic larvæ? I think not. We might rather expect that the proportion of nitrogen to oxygen in the tracheæ of these larvæ would more nearly approach the ratio of the amounts of these gases dissolved in the water. If a ratio approaching to this latter could be obtained by analysis, it would strongly support the Diffusion-Theory. So far, I have not succeeded in devising an apparatus suitable for the necessarily very delicate analysis required, but I hope to carry this out on some future occasion.

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EXPLANATION OF PLATE XLVII.

Reference Letters.—*b*, oblique base of gill—*bp*, basal pad—*bs*, small blood-space—*cap*, capillary—*cut*, cuticle of gill—*cut'*, cuticle of body-wall, showing several, outer, coloured layers, and an inner, clear (uncoloured) layer—*ep*, epithelial syncytium of gill—*ep'*, epithelium of rectal wall—*es*, secondary efferent trachea—*hb*, hypobranchial tissue—*hy*, hypoderm—*in*, intima of rectal wall—*lam*, gill-lamellæ—nu_1, nucleus of *ep*—nu_2, nucleus of *bp*—*pg*, pigment granules—*ta*, anterior tubercle—*tp*, posterior tubercle—*tr*, large trachea.

Fig. 1.—A single gill-lamella of *Hemicordulia tau* Selys,(well-grown larva); (×95).

Fig. 3.—Three gill-lamellæ of same, viewed in profile, to show the lamellar tubercles; (×95).

Fig. 3.—Section along the line *xx* (indicated by arrows) in Fig. 1, to show the histology of the gill; (×400).

Fig. 4.—Section along the line *yy* (indicated by arrows) in Fig. 1, to show region of large tracheæ; (×400).

Fig. 5.—A small part of the distal portion of Fig. 3, much enlarged, to show histology of the gill-lamella; (×2500).

Fig. 6.—Comparison of (*a*) the body-wall, (*b*) the undifferentiated rectal wall, and (*c*) the gill-wall in dragonfly larvæ; (all three ×750).

STUDIES IN AUSTRALIAN ENTOMOLOGY,

No.xvii. New Genera and Species of Carabidæ.

(Pamborini, Migadopini, Broscini, Cuneipectini, Nomiini, Pterostichini, Platynini, Oodini, Harpalini, and Lebiini.)

By Thomas G. Sloane.

(With one text-fig.)

(Continued from Vol. xxxv., p.406, 1910.)

Subfamily CARABINÆ.

Tribe **Pamborini.**

Genus Pamborus.

Pamborus elegans, n.sp.

♀. Oval, convex. Prothorax with marginal channel and lateral basal impression uniting in a concavity at each posterior angle; elytra with fifteen interstices, eighth interstice not catenulate on disc, edge of reflexed lateral border without any serrations. Black; head with a slight viridescent flush behind occipital transverse impression; prothorax margined with green; elytra bronzy, with lateral margin green.

Prothorax broader than long (6·3 x 7·8 mm.)*, wider across base (6 mm.) than apex (5 mm.). Elytra convex, striæ wide, strongly and closely punctate; interstices narrow, costate, interrupted on apical declivity, 1-11 not catenulate on disc, twelfth more or less interrupted; lateral channel wide. Length 25, breadth 10 mm.

Hab.—Queensland: Herberton District, southward from Atherton (Dodd); Coll. Sloane; two specimens, ♀.

This beautiful species was sent to me by Mr. F. P. Dodd, who found it in the scrub eastward from Herberton in North Queensland. It belongs to the section of the genus characterised by

* The length here given for the prothorax is measured in the middle; the length from anterior to posterior angle is 7 mm.

having fifteen interstices on each elytron, the other species being *P. guérini* Gory, and *P. pradieri* Chaud. From *P. guérini*, it is easily distinguished by the larger size, colour, reflexed border of elytra without serrations, etc. It requires comparison only with *P. pradieri*, from which it differs greatly by the more convex form; prothorax wider, with base wider than apex (in *P. pradieri* prothorax with base and apex of equal width, 4·9 mm.), basal angles wider and less strongly produced backwards (the base being less deeply emarginate than in any other species of the genus); elytra far more convex (more convex than in *P. viridis*), eighth interstice not catenulate, marginal channel much wider, etc.

Tribe **Migadopini.**

Genus STICHONOTUS.

It should be noted, that the genus *Stichonotus* has the head with the upper articulation-point of the mandibles with the head covered by the lateral edge of the clypeus, a feature that is rare in the family Carabidæ; metasternum without apparent epimera; four anterior tarsi in ♂ clothed with spongiose tissue beneath, anterior tarsi short, joints 1-4 spongiose beneath; intermediate tarsi with first joint stout, as long as the two succeeding joints together, a small tuft of spongiose tissue on lower side near apex, second and third joints lightly dilatate, and clothed with spongiose tissue beneath.

Table of Species.

1(4) Elytra with lateral channel simple. [Tasmanian species].

2(3) Elytra with striæ lightly impressed, interstices hardly convex; colour piceous, first interstice and a narrow lateral margin dull red...*S. piceus* Sl.

3(2) Elytra with striæ strongly impressed, interstices roundly convex; colour piceous, with wide lateral and apical margins testaceous (also some testaceous markings on interstices 5-7, first interstice piceous)..*S. leai* Sl.

4(1) Elytra with lateral channel crenulate. (Piceous-black, with testaceous lateral and apical margins). [Victorian species]. ....*S. limbatus* Sl.

STICHONOTUS PICEUS, n sp.

♂. Oval, convex. Piceous; lateral margins of prothorax (widely at base) and elytra (narrowly), first interstice, and legs reddish.

Head large (1·6 mm. across eyes), deeply set in prothorax. Prothorax transverse (1·6 x 3·3 mm.), widest at base, strongly narrowed to apex (1·8 mm.), lightly bifoveate near base; sides lightly rounded; apex widely emarginate; anterior angles pointed, strongly advanced; basal angles sharply triangular; border narrow and equal on sides, very narrow and entire along anterior margin, obsolete on base; median line lightly impressed. Elytra wide, short (4·5 x 3·4 mm.), convex, lightly depressed on disc behind scutellum; striæ entire, lightly impressed, especially towards apex, subcrenulate, second (counting at base) obsolete on apical declivity;* interstices hardly convex on disc, depressed on apical declivity, ninth (counting at apex) narrow, not crenulate, seriate-punctate (punctures wide apart in middle); marginal channel simple. Length 6·2, breadth 3·4 mm.

Hab.—Tasmania : Mount Wellington (Lea; unique).

Allied to *S. leai* Sl., but differing by size larger, colour different, striæ of elytra decidedly shallower, interstices not convex. From *S. limbatus* Sl., it differs by colour, elytra far less strongly striate, striæ far less strongly crenulate, lateral channel simple, etc.

STICHONOTUS LIMBATUS, n.sp.

♂. Oval, robust; elytra strongly striate. Piceous, prothorax and elytra with testaceous margins; elytra with first interstice piceous to apex, interstices 1-7 piceous on at least basal two-thirds, legs piceous-red, antennæ and palpi testaceous.

Head large (1·6 mm. across eyes). Prothorax transverse (1·6 x 2·95 mm.), widest at base, strongly narrowed to apex (1·7 mm.), lightly convex; sides narrowly angustate to anterior angles, subparallel to base; apex widely emarginate-truncate; anterior angles prominent, pointed; basal angles triangular, slightly

* I take the present opportunity to direct attention to an error in my description of *S. leai* (These Proceedings, 1910, p.380), where the second stria is said to be "obsolete on basal declivity"; this should read, apical declivity.

blunted at apex; border well developed and equal on sides, continuous along anterior margin. Elytra wide (3·7 × 3 mm.), convex; striæ decidedly crenulate, second (counting at base) obsolete on apical declivity, ninth (counting at base) curving inwards near base; interstices lightly convex on disc, more strongly convex towards apex, eighth wide, depressed, ninth rugose (the rugosity caused by closely placed, punctiform depressions along inner and outer sides of interstice). Length 6·5, breadth 3 mm.

Hab.—Victoria: Beech Forest, Otway Ranges (Dixon). Colls. National Museum, Melbourne, Dixon, and Sloane.

This species was found by Mr. J. E. Dixon, of Melbourne, its discovery adding another genus to the fauna of the mainland of Australia. It is closely allied to the Tasmanian *S. leai* Sl., and has the same elongate second stria on the elytra, which ends at the beginning of the apical declivity. *S. limbatus* differs from *S. leai* by form less convex, elytra more strongly striate, striæ more strongly punctate, lateral interstice catenulate, closely seriate-punctate along outer as well as inner side; testaceous margin narrower, confined on sides to lateral channel, ninth interstice, and outer side of eighth interstice.

DECOGMUS, n.gen.

Head stout, not narrowed behind eyes; one supraorbital seta opposite posterior fourth of eye on each side; eyes convex, not enclosed behind, a little distant from buccal fissure; gular sutures wide apart. *Labrum* truncate, 6-setose. *Clypeus* truncate; one seta on each side opposite base of mandibles. *Mandibles* light, elongate, sharply pointed (not strongly hooked); basal articulation-point with clypeus hardly concealed (not overlapped) by sides of clypeus. *Maxillæ* with outer lobe 2-jointed; inner lobe dentate (about six, strong, short, narrow teeth equally distant from one another), a few spinous bristles besides the teeth on basal half, apex sharp, lightly hooked. *Maxillary palpi* rather long; second joint stout; two apical joints narrow, equal, apical joint a little stouter than penultimate joint, truncate. *Labial palpi* rather long; two apical joints of equal length; penultimate slender, bisetose on inner side; apical joint shaped like a narrow truncate club. *Mentum* wide; lobes wide, obtuse at apex; sinus not deep.* *Prothorax* closely applied to elytra, subcordate, widely margined; lateral margin without setæ. *Elytra* ovate, bordered at base, strongly striate; second and third striæ uniting at base, second stria† deep, extending to beginning of apical declivity; third interstice impunctate, ninth seriate-punctate; margin not interrupted near apex. *Scutellum* short, almost covered by prothorax. *Prosternum* with anterior coxal cavities closed; intercoxal declivity narrow, abrupt. *Mesosternum* with intercoxal part wide, not channelled; mesepimera reaching coxæ. *Metasternal episterna* a little longer than broad, without apparent epimera. *Legs* light, long; posterior coxæ contiguous; tibiæ slender, anterior a little thickened at apex, inner side emarginate near apex, inner spur remote from apex; tarsi (♀) slender.

This strange genus is quite unlike any other of the tribe Migadopini. I have ventured to tabulate the genera of Australia and New Zealand below, but this has been done without having a representative of the genus *Nebriosoma* before me (only the type-specimen of *N. fallax* Cast., in the Howitt Coll., has been reported as yet).

Prothorax with narrow lateral border.
  Elytra seriate-punctate. (New Zealand). .... AMAROTYPUS.
  Elytra strongly striate. (Australia and Tasmania)... STICHONOTUS.
Prothorax with wide lateral border.
  Mandibles short. (Australia)............................. NEBRIOSOMA.
  Mandibles elongate, porrect. (Australia).............. DECOGMUS.

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* The mentum, examined *in situ*, does not show the outline of the bottom of the sinus clearly in my two specimens, owing to a gummy exudation; but it appeared to be somewhat sinuous, and evidently without a median tooth.

† This is a false stria, as in *Stichonotus*, representing the striole often found at the base of the second interstice in Carabidæ. In *D. chalybeus*, it is as strongly developed as the other striæ, and extends backwards an unusual distance (a character found only in the tribe Migadopini), with the result, that the elytra have ten interstices, if counted anywhere before the apical declivity, but only the normal number, nine, if counted near the apex.

The other genera known to me, as belonging to the tribe Migadopini, are *Monolobus* (Chile), *Migadops* (= *Brachycœlus* : Tierra del Fuego and Falkland Islands), *Lissopterus* (Falkland Islands), *Loxomerus* (= *Heterodactylus*: Auckland Islands), *Rhytidognathus* (Monte Video). Of these, only *Rhytidognathus* is known to me in nature; *R. ovalis* Dej., has the mandibles with a seta in the outer scrobe; and the elytra show the remarkable, elongate, false, second stria, as in the Australian genera. Waterhouse's figures of *Migadops virescens* and *M. ovalis* do not show whether this false stria is present in *Migadops* or not.

DECOGMUS CHALYBEUS, n.sp.

♀. Facies of *Nebria* (e.g., *N. kratteri* Dej., and *N. hemprichi* Klug). Upper surface chalybeous, sometimes purple towards sides of elytra; undersurface black; mandibles, palpi, and tarsi piceous-red.

Head wide between eyes (2·5 mm. across eyes), smooth; front with a wide, shallow impression on each side. Prothorax broader than long (2·7 x 3·5 mm.), widest a little before middle, subdepressed, widely margined, wider at base (2·8 mm) than apex (2·3 mm.); apex emarginate; anterior angles obtuse, subprominent; base lightly arcuate in middle, truncate on each side; basal angles rectangular, with summit rather obtuse; lateral basal impressions deep, wide, connected by a transverse impression; median line well marked; lateral border wide, reflexed, explanate towards base. Elytra much wider than prothorax (9·7 x 5·1 mm.), hardly wider across base than base of prothorax, roundly explanate on each side behind basal angles (these not marked), subdepressed, deeply striate; striæ simple, second (counting at base) obsolete on apical declivity; interstices convex, ninth (counting at apex) convex, feebly seriate-punctate. Mesepisterna punctate. Apical ventral segment unisetose on each side of apex. Length, 13-14; breadth, 4·8-5·1 mm. Type in Coll. Sloane.

Hab.—N. S. Wales: Comboyne. I found two specimens under the bark of a decaying tree fallen in the thick brush, by the side of the road on the Bulli Mountain (north-western slope), near the village of Comboyne, in July, 1914.

Tribe **Broscini.**

Genus Promecoderus.

Promecoderus viridiæneus, n.sp.

Elliptical-oval, lightly convex. Mentum with a strong obtuse tooth. Prothorax lightly rounded on sides; basal angles obtuse (3·6 x 3·8 mm.). Elytra oval (8 x 5 mm.), lightly striate; a continuous row of punctures along sides. Upper surface green, shining; undersurface black, with a chalybeous tinge on prosternum, metasternum, and apical ventral segment; legs black, femora with a chalybeous tinge; antennæ black.

♂. Anterior tarsi with the first four joints widely dilatate, and spongiose beneath; intermediate tibiæ with first two joints widely dilatate, and spongiose beneath; apical joint of posterior tarsi long, narrow. Length, 14; breadth, 5 mm.

Hab.—Tasmania: Mount Magnet (Lea). Type in Coll. Sloane.

A very distinct species, differentiated from all described species of the genus by colour, and by the continuous row of about eight, foveiform punctures along sides of elytra.

Genus Eurylychnus.

Eurylychnus ovipennis, n.sp.

Robust, oval, convex, nitid. Mandibles with a seta in scrobe; prothorax orbiculate; elytra short, oval, convex, faintly striate on disc, striæ obsolete on sides. Black; legs piceous, tibiæ reddish-piceous, tarsi and antennæ reddish.

Head not large (2·2 mm. across eyes); vertex with an impunctate transverse impression between bases of eyes; front and clypeus strongly biimpressed. Prothorax transverse (2·7 x 3·25 mm.), widest a little before middle, much wider at apex (2·35 mm.) than base (1·8 mm.), convex, transversely striolate; apex truncate; anterior angles rounded; sides rounded; lateral border narrow, even, reflexed, with a small subprominent juxtabasal protuberance; median line strongly impressed; four setigerous marginal punctures on each side, posterior seta distant from basal angle, anterior seta near anterior angle. Elytra shortly oval (5·5 x 3·8 mm.), convex, not depressed on disc; four or five inner striæ faintly marked, outer striæ obsolete; no scutellar striole; lateral border narrow, very shortly turned inwards on each side of base at humeral angles; seven or eight setigerous punctures along each lateral margin. Prosternum bordered along anterior margin. Length, 10; breadth, 3·8 mm.

Hab.—N.S.W: Dorrigo (Tillyard). Coll. Sloane; unique.

One specimen was found by Mr. R. J. Tillyard at Dorrigo. It is characterised by its smooth, faintly striate elytra. It is allied to *E. clivinoides* Cast., from which it differs by form shorter; transverse impression of head weaker and impunctate; prothorax similar in shape, juxtabasal protuberance of border less prominent, four (not three) marginal setæ on each side; elytra shorter, striæ obsolescent, lateral channel narrower; femora piceous (not red).

Eurylychnus kershawi, n.sp.

Convex. Head transversely impressed, strongly biimpressed between antennæ, one supraorbital seta on each side; mandibles with a seta in scrobe of outer side; prothorax cordate, strongly angustate to base without sinuosity; elytra lævigate; anterior femora swollen on lower side in ♂. Black, shining.

Head large (3 mm. across eyes), transversely impressed across vertex on a level with bases of orbits; front and clypeus strongly biimpressed. Prothorax broader than long (3·35 x 4 mm.), widest before middle, lævigate; apex projecting widely on each side of head, wider (3·2 mm.) than base (2·3 mm.); sides lightly rounded, lightly narrowed to apex, obliquely angustate to base; anterior angles widely rounded; basal angles obtuse; border narrow, equal, turned in at base to close lateral channel; a very slight prominence just before basal angles; median line strongly impressed; one setigerous puncture on each side at widest part. Elytra lightly convex, oval (7·2 x 4·7 mm.), truncate at base, lightly rounded on sides, lævigate; a row of punctures along sides, widely placed in middle. Prosternum not bordered along anterior margin. Length, 12·5-13; breadth, 4·5-4·75.

Hab.—Victoria: National Park, Wilson's Promontory (J. A. Kershaw; January and April). Colls. National Museum, Melbourne, and Sloane.

A very distinct species, remarkable for its lævigate elytra.

EURYLYCHNUS FEMORALIS, n sp.

Elongate, robust, convex, black, nitid. Head transversely impressed behind eyes, strongly biimpressed on front; one supra-orbital seta on each side; mandibles with a setigerous puncture near anterior extremity of external scrobe; antennæ moniliform; prothorax cordate, strongly sinuate on each side before base; elytra convex, smooth, substriate.

Head as in *Lychnus ater* Putz.,(3·1 mm. across eyes), convex. Prothorax broader than long (3·6 × 4 mm.), lightly convex; sides lightly rounded, decidedly sinuate near base; apex truncate, much wider (3·3 mm.) than base (2·5 mm.); anterior angles rounded; basal angles rectangular, sharply marked, with the summit rounded; lateral border narrow, reflexed, slightly prominent at basal angle; one lateral marginal seta on each side just before middle. Elytra oval (7·5 × 5 mm.), convex, smooth; striæ obsolescent; a row of widely-placed punctures along side. Prosternum finely bordered along anterior margin. Anterior femora strongly swollen at middle of lower side. Length, 14·5; breadth, 5 mm.

Hab.—Tasmania: Mount Horror. Type in Coll. Sloane.

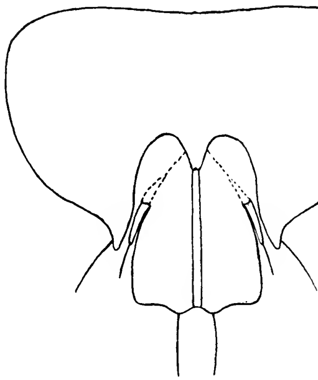
I owe a single specimen of this remarkable species to the generosity of Mr. A. M. Lea. In general appearance, it much resembles *Lychnus ater* Putz., but differs by smaller size; mandibles with a seta in groove of outer side; prothorax sinuate on sides posteriorly, and with sharply marked basal angles. It is allied to *E. kershawi* Sl., from which it is readily distinguished by prothorax sinuate before basal angles, which are sharply marked.

Tribe **Cuneipectini.**

Genus CUNEIPECTUS.

The following characters of the genus require stating. Head with one or two supraorbital setæ; body apterous; elytra connate. Labium: ligula corneous, with a mesial keel; paraglossæ corneous, small, triangular, not half the length of ligula, setigerous.

Mr. A. M. Lea has kindly drawn for me the subjoined figure of the labium, which is quite unique amongst the Carabidæ.



Labium of *C. foveatus* Sl.*

CUNEIPECTUS FOVEATUS, n.sp.

♂. Robust, convex. Elytra with foveate sulci and costate interstices. Black.

Head large (6·3 mm. across eyes), convex; front and clypeus minutely punctate; vertex finely reticulate; two supraorbital punctures on each side. Prothorax broader than long (7·5 x 11 mm.), widest a little before middle, a little wider across base (7·5 mm.) than apex (6·5 mm.); disc widely and lightly convex; lateral margins explanate, widely reflexed towards base; apex truncate behind head; anterior angles lightly advanced, wide, roundly obtuse; sides arcuate, roundly obliquely narrowed to base and apex; base widely truncate across peduncle; angles produced decidedly backwards, wide, rounded; posterior marginal seta on border near edge just before basal angle. Elytra oval (21·7 x 14·2 mm.), sulcate; disc convex; apical curve strongly sinuate on each side; sulci wide, deep, foveate; interstices costate, summits narrow (especially towards apex); space between summit of eighth interstice and lateral border forming a wide channel,

* Mr. Lea's figure shows only one seta at the apex of the paraglossæ; but my observations show that, in a specimen in good order, there are six or seven setæ, three at the apex, the others along the side.

with the bottom roughly rugose-foveate. Tarsi with the first joint of the four posterior spinulose on outer side above the usual lateral row of spinules. Length, 34·5; breadth, 14·2 mm.

Hab.—West Australia: Onslow District. Type in National Museum, Melbourne.

♀. A second specimen, taken by Mr. Horace Brown, between Mullewa and Yalgo, is in my collection; it has the prothorax more rounded on the sides, anterior and posterior angles less produced. Length, 32 mm.

This species is very distinct from *C. frenchi* Sl., the conspicuous differences being the shape of the prothorax, and the convex elytra with costate interstices and wide foveate sulci. Comparing it with a specimen (♂) of *C. frenchi*, given to me by Mr. F. P. Spry, the following differences are to be noted—head with two supraorbital setæ; prothorax with greatest width further back, sides narrowed to both base and apex in an oblique curve (in *C. frenchi*, the prothorax is widest at anterior third, sides roundly narrowed to apex, and obliquely narrowed to base, so that it is widely truncate-cordate); elytra far more convex, not depressed on disc, the interstices costate, sulci foveate (in *C. frenchi*, the interstices are wide and lightly convex; and the foveæ of the striæ are smaller and punctiform), lateral channel wide and deep, lateral and apical declivities much more declivous.

Tribe **Nomiini.**

Genus MEONIS.

MEONIS AMPLICOLLIS, n.sp.

M. niger Sloane (non Castelnau), Proc. Linn. Soc. N. S. Wales, 1910, xxxiv., p.827.

♀. Elongate-oval. Prothorax broader than long, roundly ampliate on sides, very strongly sinuate posteriorly, basal angles rectangular; elytra strongly 4-striate (fifth stria obsolete). Black, nitid.

♀. Head ordinary (2·5 mm. across eyes), strongly transversely impressed behind; eyes very prominent. Prothorax cordate (3·5 × 3·7 mm.); base and apex of equal width (2·5 mm.); sides strongly rounded, strongly sinuate posteriorly, and meeting base at right angles; median line strongly impressed; lateral basal impressions deep, narrow, elongate. Elytra oval (7·5 × 5 mm.); sides strongly rounded; base emarginate; humeral angles obtusely raised; apex strongly sinuate on each side; first stria strongly impressed, not reaching base; striæ 2-4 deep, not reaching apex; interstices 2-4 convex; a row of punctures along lateral margins. Length, 14·5; breadth, 5 mm.

Hab.—N.S.W.: Tweed River (Carter and Lea). Type in Coll. Sloane.

Two specimens (♂♀) have been examined: the description has been founded on the one in best condition. Formerly, I took this species to be *M. ater* Cast.; but, having compared it with specimens of that species in the Howitt Collection, in the National Museum, Melbourne, which are ticketed "Brisbane," I find my identification was wrong. *M. ater* Cast., is a species closely allied to *M. angulicollis* Sl. I have not made any comparative note on the differences between these species. *M amplicollis* differs from *M. niger* Cast., by prothorax wider, sides more ampliate and more strongly rounded, more strongly sinuate to base; elytra with only four striæ on disc, fourth stria not reaching apex, fifth obsolete; it differs also from *M. convexus* Sl., by almost the same characters.

Genus MECYCLOTHORAX.

MECYCLOTHORAX LÆVICOLLIS, n.sp.

Elliptical-oval. Head convex, lævigate, front feebly biimpressed; prothorax transverse, wider at base than apex, not punctate near base; elytra fully striate, striæ 1-7 on disc formed by rows of punctures. Black, nitid; legs reddish; antennæ with the two basal joints testaceous, the other joints sometimes slightly infuscate.

Eyes convex, not prominent. Prothorax transverse (1·1 × 1·6 mm.), depressed on disc and across base, lævigate (without punctures near basal margin), bordered (except on middle of base); sides lightly rounded; anterior angles obtuse; base truncate on each side, lightly sinuate on each side of peduncle; basal angles rounded; lateral border narrow, not reflexed at basal angles; basal impressions obsolete; median line feebly marked; two marginal setæ on each side; anterior seta before middle at widest part, posterior on a depressed lateral space considerably before basal angle. Elytra ovate, convex, with disc rather depressed; sides subparallel in middle; humeral angles rounded; striæ formed by rows of small punctures on disc (these punctures becoming obsolete towards apex); interstices depressed; striole at base of first interstice short, punctate; third interstice with two punctures on disc along course of third stria; eighth interstice not carinate near apex. Length, 4·3; breadth, 1·7 mm.

Hab.—N.S.W.: Kosciusko (Carter). Type in Coll. Sloane.

Allied to *M. laticollis* Sl., but differing by size larger; eyes less prominent; prothorax less convex, not so evenly rounded on sides, not punctate along basal margin, basal angles not so widely rounded; elytra less strongly striate, the punctures in the striæ smaller and not so deep.

Mecyclothorax australis, n.sp.

Elliptical-oval. Head convex, lævigate, front biimpressed; prothorax transverse, wider at base than apex, not punctate near base; elytra fully striate, striæ 1-7 formed on disc by rows of punctures. Black, nitid; legs piceous-red; antennæ reddish.

Front and clypeus with a narrow, well-marked impression on each side; eyes small, convex. Prothorax transverse (1·15 × 1·65 mm.), lightly convex, lævigate, without punctures near basal margin, bordered all round; sides lightly rounded; anterior angles obtuse; base truncate, lightly sinuate on each side of peduncle; basal angles widely rounded; median line obsolete on disc, marked by a deep elongate fovea near base; two marginal setigerous punctures on each side, anterior at widest part, posterior on a depressed space a little before basal angle. Elytra ovate, convex; humeral angles rounded; striæ well-marked, formed by rows of rather strong punctures on disc, strongly impressed and impunctate on apical declivity; interstices convex on apical declivity, eighth interstice not carinate towards apex. Length, 5; breadth, 2·1 mm.

Hab.—W.A.: Manjimup District (Sloane). Type in Coll. Sloane.

One specimen was found under a log in the thick Karri Forest, 14 miles south-westward from Manjimup, in January. Closely allied to *M. lævicollis* Sl., but differing by form more robust and convex; front more strongly biimpressed; eyes more convex; prothorax more convex, especially near base; lateral basal impressions feebly marked; elytra more convex, more strongly declivous to sides and apex, inner striæ more decidedly marked, more strongly punctate, deeper on apical declivity, interstices convex on apical declivity. I have not been able to discern any dorsal punctures on the third interstice of the elytra in my single specimen.

MECYCLOTHORAX OVALIS, n.sp.

Oval, convex. Prothorax transverse, wider at base than apex, not punctate near base; elytra fully striate, striæ formed by rows of punctures, these punctures reaching apex, eighth interstice not carinate towards apex. Reddish-brown.

Head wide, convex; front lightly biimpressed; eyes round, convex. Prothorax transverse, convex, lævigate, wide and smooth across base; sides rounded; basal angles widely rounded; base lightly sinuate on each side of peduncle; median line obsolete on disc, marked near base; two marginal setigerous punctures on each side, anterior a little before middle, posterior in marginal channel a little before basal angle. Elytra oval, convex; humeral angles rounded; striæ well-marked, punctate; interstices depressed, narrow and convex near apex, eighth not carinate near apex. Length, 3·2; breadth, 1·6 mm.

Hab.—W.A.: Manjimup (Sloane). Type in Coll. Sloane.

I found one specimen of this distinct species beneath a log, near the township of Manjimup, in the heavy, south-western forest of Western Australia. It differs much from all others by its colour; robust, convex form; wide prothorax (not much narrower than elytra), without any basal puncturation, sides strongly rounded; elytra oval, convex, strongly punctate-striate, striæ well marked near apex, the puncturation continuous to apex, though becoming finer on apical declivity.

Genus BRACHYDEMA, n.gen.

Oval, compact. Head with two supraorbital setæ on each side. Mandibles with a seta in scrobe of outer side. Clypeus unisetose on each side. Mentum with sinus oblique on sides; a short, triangular, median prominence; lobes pointed. Labial palpi short; penultimate joint stout; apical joint thick at base, compressed (a concavity on outer side), pointed at apex. Maxillary palpi with two apical joints short; penultimate joint stout, wide at apex, setigerous; apical joint triangular, pointed, a concavity on lower side. Prothorax one-half wider at base than at apex; two marginal setæ on each side, posterior seta just within basal angle. Elytra oval, bordered on base; sutural striole wanting; third interstice bipunctate on disc; eighth shortly carinate towards apex; ninth obsolete and impunctate in middle of its course. Tarsi setose on upper surface.

Though closely allied to *Oopterus*, a new genus is required for the two small beetles described below, one from Victoria, the other from Tasmania. Their compact, oval, Oodes-like form is very different from that of *Oopterus*.

BRACHYDEMA TASMANIÆ, n.sp.

Oval, compact, piceous, nitid.

Head wide, short, convex; frontal impressions feeble, short. Prothorax transverse, wide across base (1·5 mm.), roundly narrowed to apex (1 mm.), smooth; a feeble impression on base at each side of peduncle; base truncate; basal angles marked, obtuse; lateral border narrow, extending along base on each side to basal impressions; median line obsolescent. Elytra truncate-oval, convex, substriate, wide across base; basal border slightly raised above lateral border at humeral angles; first stria entire, out-turned at base, rising from an umbilicate puncture; second and third marked; 4-7 obsolete; eighth well marked and punctate towards apex. Length, 4-4·5; breadth, 2·1 mm.

Hab.—Tasmania: Mount Wellington (Lea). Sent by Mr. A. M. Lea, ticketed "Mount Wellington, in moss."

BRACHYDEMA VICTORIÆ, n.sp.

Oval, compact; piceous, margins of prothorax and elytra dull red.

Head wide, short, convex; frontal impressions hardly marked. Prothorax transverse, wide across base, strongly roundly narrowed to apex, smooth; a well marked, wide, basal impression on each side; base truncate; basal angles marked, obtuse; lateral border narrow; median line obsolescent. Elytra truncate-oval, convex, substriate; base wide; basal border slightly raised above basal border at humeral angles. Length, 4-4·3; breadth, 2-2·1 mm.

Hab.—Victoria: Warburton (Sloane).

This species occurred to me not uncommonly under wood in the damp, densely wooded gullies of the Yeathan Creek, near Warburton, in January. It is very closely allied to *B. tasmaniæ* Sl., which it resembles in sculpture of elytra, but I have thought it distinct; it differs by the prothorax slightly narrowed to base, strongly impressed on each side of base; elytra more convex, more declivous to sides and apex.

Tribe **Pterostichini.**

SARTICUS DIXONI, n.sp.

Elongate-oval, nitid. Elytra oval, strongly striate: striæ finely crenulate; interstices lightly convex on disc, strongly convex on apical declivity, third with four or five punctures near third stria; mes- and metepisterna punctate; ventral segments punctate. Tarsi: first joint of four posterior longitudinally canaliculate externally; penultimate joint of posterior narrow, very little widened to apex; onychium glabrous. Black; antennæ, tarsi, and reflexed border of prothorax reddish-piceous.

Head convex (2·3 mm. across eyes); eyes prominent. Prothorax broader than long (3·15 × 3·65 mm.); sides evenly rounded; apex very lightly emarginate, bordered; lateral border narrow and reflexed anteriorly, very wide and strongly reflexed posteriorly; basal foveæ deep; median line fine. Elytra oval (7·1 × 4·4 mm.); inner humeral angle marked; lateral apical sinuosities moderately developed; striæ shallow and finely crenulate on disc, deep on apical declivity, seventh and eighth each formed by a row of closely placed distinct punctures (these striæ hardly or not impressed along sides), eighth and ninth interstices depressed on sides; lateral channel wide; border strongly reflexed. Prosternum with anterior margin bordered. Mesosternum punctate in concavities to receive femora; metepisterna bearing a few punctures. Ventral segments all punctate towards sides; punctures of three apical segments in a transverse row along anterior margin. Length, 11·3-13; breadth, 3·75-4·4 mm.

Hab.—North-Western District of Victoria (Dixon).

Found by Mr. J. E. Dixon at Sea Lake, and other places in the North-West of Victoria.

Allied to *S. cycloderus* Chaud., but at once distinguishable from that species, and from the other allied species, *S. iriditinctus* Chaud., *S. ischnus* Chaud., and *S. obscurus* Blkb., by its larger size, etc. Compared with *S. dampieri* Sl., with which it agrees in size, it differs by form less robust; elytra quite black, not with a virescent tinge; eyes more convex; elytra narrower, striæ finer and less strongly punctate, interstices less convex on disc, lateral apical sinuosities less strongly reflexed. From *S. habitans* Sl., it differs by smaller size; less robust form; prothorax longer; elytra with inner humeral angle more marked, eighth stria far less strongly impressed along sides, third with four or five punctures; posterior tarsi with fourth joint narrower and less triangular, fifth joint glabrous beneath. From *S. monarensis* Sl., and *S. cooki* Sl., it differs by colour black (elytra not sericeous in ♀); more elongate and less robust form; longer, narrower, and less triangular fourth joint of posterior tarsi, etc.

Notonomus johnstoni Sloane.

A single specimen (♀) of *N. johnstoni* occurred to me near Craven railway-station (12 miles south from the town of Gloucester), and Dr. Ferguson took it at Camden Haven. Evidently its habitat is the country drained by the Manning River. Only the female of the typical form is known to me. It is worthy of notice that, in this species, the apical ventral segment has a well developed, triangular process fitting into the lateral, apical sinuosity of the elytra. In other species of *Notonomus*, a similar slight, lateral process of the apical, ventral segment may be seen, but not nearly so marked as in *N. johnstoni*; this can be observed by comparing *N. excisipennis* Sl., the most nearly allied species, with *N. johnstoni*.

Var. PARVULA, n var. This is evidently an upland form of *N. johnstoni*, which merits a varietal name. It differs from the typical form by smaller size; prothorax proportionately a little wider (3·3 × 4 mm.); sides lightly but evenly rounded to base, not subsinuate just before basal angles, posterior marginal seta a little nearer base, lateral border less reduced between this seta and basal angle; elytra more flushed with purple. Length, 13-15; breadth, 3·8-4·3 mm.

Hab.—N.S.W.: Comboyne (Sloane).

Six specimens occurred to me near the village of Comboyne, at an altitude of 1500 feet, in July.

NOTONOMUS DIVES, n.sp.

Robust, oval, convex. Prothorax transverse-cordate, posterior marginal seta on border at basal angle; elytra deeply striate, interstices convex, third 5-punctate, eighth convex, wider than ninth towards base, tenth short, feebly developed, humeral angles dentate; intercoxal declivity of prosternum flat, of mesosternum flat. Head, prothorax, and elytra æneous; pronotum with bright golden reflections near basal impressions; elytra sometimes slightly golden; undersurface black.

♂. Head large (5 mm. across eyes). Prothorax broader than long (5·8 × 7·7 mm.), wider across base (5·8 mm.) than apex (5·3 mm.); sides rounded, hardly subsinuate just before basal angles; base lightly emarginate in middle, lightly arcuate on each side; basal angles subrectangular, rather prominent; border wide, reflexed, reaching basal impressions; median line well marked; lateral basal impressions strongly impressed. Elytra truncate-oval (14 × 9 mm.); basal border strongly raised and prominent at humeral angles; lateral border strongly reflexed; lateral basal sinuosities strongly developed; striæ deep; crenulate at bottom.

♀. Differing from ♂ by slightly less massive proportions; prothorax not so wide (5·6 × 6·9 mm.), more narrowed to base (apex and base of equal width, 5·1 mm.); elytra a little narrower, more rounded on sides, more narrowed to base (14 × 8·6 mm.).

Length, 24; breadth, 8·6-9 mm.

Hab.—N.S.W.: Comboyne (Sloane). Four specimens, found on the lower slopes of Mount Bulli, near the Thorne River.

Differs from *N. australis* Cast., and its var. *N. lapeyrousei* Cast., by its broader and heavier form: colour (upper surface wholly æneous); prothorax more transverse, more rounded on sides, less narrowed and less sinuate to base, border wider.

LITARTHRUM, n.gen.

Oval, subdepressed, apterous. *Head* small, smooth: front not impressed; two supraorbital punctures on each side. *Eyes* small, distant from buccal fissure. *Antennæ* slender, lightly compressed; three basal joints cylindrical, glabrous, first stout, as long as second and third together, second small, third a little longer than second, shorter than fourth. *Labrum* truncate. *Maxillæ* narrow, curved and strongly hooked at apex. *Palpi* slender. *Mentum* with a short, obtusely rounded, median tooth. *Prothorax* transverse, depressed, much wider at base than apex, lightly rounded on sides; basal impressions obsolete; border narrow, not reflexed, obsolete only in middle of base and apex; basal angles not marked; two marginal punctures on each side, posterior on border at basal angle. *Elytra* wide, rather convex, lightly striate, bordered at base; humeral angles not dentate: striæ finely crenulate; interstices depressed (except seventh and eighth towards apex); scutellar striole obsolete: interruption of border on each side of apex obsolescent, inner plica not apparent. *Sterna* smooth; metasternum small, very short between intermediate and posterior coxal cavities; metepisterna short, wide. *Ventral segments* not transversely sulcate; ♂ with a large, submarginal, setigerous puncture on each side of apex. *Tarsi*(♂): anterior with three basal joints widely dilatate, basal joint oblique at apex, second and third cordate, fourth very small; four posterior tarsi slender, first joint very long; in intermediate tarsi, as long as the three succeeding joints together; in posterior tarsi, longer than the next three joints together (about as long as the remainder of tarsus).

The insect, on which the genus *Litarthrum* is founded, resembles a wide *Simodontus*, but the nonsulcate ventral segments, and impunctate third interstice of elytra at once and decidedly distinguish it. The prothorax resembles that of *Cosmodiscus* and *Ephnidius* in shape. It belongs to the central group of the tribe Pterostichini, but I am not sure of its exact position: provisionally, I would place it beside *Pediomorphus*. I know of no other genus in the tribe, in which the first joint of the four posterior tarsi is as long in proportion to the next three joints.

Litarthrum browni, n.sp.

♂. Reddish-piceous; prothorax, inflexed margins of elytra, and legs redder than elytra; antennæ reddish-testaceous.

Head small (1·75 mm. across eyes), convex. Prothorax transverse (2·1 x 3 mm.), wider across base (2·6 mm.) than apex (1·9 mm.), depressed, lævigate, rounded on sides; apex widely and lightly emarginate; anterior angles wide, distant from head; base wide, lightly emarginate above peduncle; basal angles widely rounded; border narrow, extending round angles along each side of apex and base, bearing posterior marginal puncture at basal angles; median line linear, feebly impressed on disc. Elytra ovate (4·7 x 3·2 mm.), lightly convex, lightly rounded on sides, lightly striate; apical curve even; base wide; basal border joining lateral border at humeral angle in an open curve; striæ 1-6 lightly impressed, finely crenulate, seventh and eighth strongly impressed towards apex; interstices depressed, except eighth on apical third. Ventral segments finely punctate towards sides. Length, 8; breadth, 3·2 mm.

Hab.—W.A.: Cue (H. W. Brown). Unique in Coll. Sloane.

Prosopogmus yarrensis, n.sp.

Elliptical, depressed. Prothorax subquadrate; basal angle rectangular, one basal impression on each side; elytra striate, interstices unequal, depressed, shagreened, third with three foveiform punctures, often interrupting the stria. Æneous; coxæ, trochanters, and base of femora brown; apical half of femora testaceous; tibiæ, tarsi, and antennæ reddish-brown.

Head large (1·5 mm. across eyes), convex; front strongly biimpressed. Prothorax broader than long (1·6 x 2 mm.), wider at base (1·6 mm.) than apex (1·35 mm.), depressed, more or less rugulose towards base; sides lightly rounded, straightened before base, finely bordered; base truncate; lateral basal impressions elongate; lateral basal spaces flat; posterior marginal puncture just within basal angle Elytra narrow, truncate-oval (4 x 2·4 mm.); apex lightly sinuate on each side; striæ narrow; interstices depressed, fifth, sixth, and seventh a little convex at their apices, second, fourth, and sixth wider than the others, eighth wider than seventh and ninth on basal half, ninth seriate-punctate along eighth stria, and defined by a distinct ninth stria externally; basal border a little raised at humeral angles; lateral border and channel narrow. Length, 7; breadth, 2·4 mm.

Hab.—Victoria: Warburton. Several specimens occurred to me near the Yeathan Creek at Warburton, on the Upper Yarra.

A very distinct species, at once distinguishable from all others by its small size; æneous colour; strongly shagreened, unequal, depressed interstices of elytra, and foveiform punctures of third interstice interrupting the interstice.

GASTROGMUS, n.gen.

Head convex, front obsoletely biimpressed. *Labrum* truncate. *Palpi* slender. *Mentum*: sinus oblique on sides; median tooth wide, short, emarginate. *Prothorax* subquadrate, rounded on sides; basal angles rectangular; a deep, biimpressed, punctate fovea on each side of base; two marginal setigerous punctures on each side, posterior at basal angle. *Elytra* convex, bordered at base, striate; scutellar striole at base of first interstice elongate; third interstice 3-punctate near third stria; lateral border interrupted, and with inner plica apparent before apex. *Metasternum* punctate on each side; episterna longer than broad, punctate. *Ventral segments* 1-3 punctate, 4-6 transversely sulcate. *Femora* wide; intermediate tibiæ bent inwards, thickened at apex; posterior trochanters very long, apex obtuse, and not applied closely to femora. Anterior tarsi in ♂ lightly dilatate and biseriately squamulose beneath.

Belongs to the central body of the tribe Pterostichini, but thoroughly distinct from all other Australian genera. The sulcate ventral segments place it beside *Simodontus;* from which, it is readily distinguishable by prothorax convex, deeply foveate on each side of base; elytra with scutellar striole at base of first interstice; undersurface punctate; posterior trochanters very long. The elytra are not soldered together, therefore it seems a winged form, but the underwings have not been seen.

GASTROGMUS ISCHIALIS, n.sp.

Robust, oval, piceous-black. Head convex (2·1 mm. across eyes); front faintly biimpressed; eyes large, convex, not distant from buccal fissure. Prothorax convex, subquadrate(2·5 x 3mm.), lightly rounded on sides (obliquely to base), wider across base (2·5 mm.) than apex (2·2 mm.); anterior angles not marked; base truncate; basal angles subrectangular; a deep, wide, biimpressed fovea on each side of base; a few punctures on inner side of these foveæ; border lightly reflexed on sides, entire (wide in middle) on apex, obsolete on middle of base; median line linear, lightly impressed. Elytra oval (5·7 x 3·7 mm.), convex, declivous to base on each side of peduncle, striate; inner striæ crenulate, seventh very faint, eighth obsolete except towards apex; interstices depressed, first bearing at base an elongate crenulate striole, third interstice 3-punctate along course of third stria, sixth, seventh, and eighth interstices united in middle, eighth narrow and convex on apical curve, ninth wide towards apex, its punctures widely interrupted in middle; basal border finely dentate at humeral angles; lateral border and channel narrow. Length, 9·5; breadth, 3·7 mm.

Hab.—W.A.: Albany (Sloane). Unique in Coll. Sloane.

A single specimen occurred to me on December 27th, 1914, under a log, in a very damp place, beside a swamp, 2½ miles west of the town of Albany.

DARODILIA CURTA, n.sp.

Robust, oval. Front bifoveate; prothorax orbiculate, biimpressed on each side of base; elytra truncate-oval, fully striate on apical half, sixth and seventh striæ obsolete towards base, humeral angles prominent; prosternum with episterna longitudinally striolate Black, nitid.

Head convex: front punctate on each side at ends of clypeal suture; vertex lightly, transversely impressed; eyes convex. Prothorax broader than long (2·5 x 2·75 mm.), widest at middle, convex; base and apex of equal width (1·75 mm.); sides rotundate; apex emarginate; anterior angles obtuse; base lightly rounded; lateral basal impressions short. Elytra short, ovate (4·5 x 3·2 mm.); base wider than base of prothorax, truncate on each side of peduncle; sides lightly rounded; apex strongly sinuate on each side; striæ strongly impressed (excepting sixth and seventh towards base), eighth strongly impressed; interstices lightly convex on disc, more strongly so towards apex; ninth narrow, convex, seriate-punctate, the punctures widely interrupted in middle; basal border a little raised above lateral border at humeral angles; inner humeral angle sharply marked. Metepisterna (with epimera) longer than broad. Ventral segments transversely impressed, punctate towards sides. Length, 7·8; breadth, 3·2 mm.

Hab.—Queensland: Herberton District (Dodd); Coll. Sloane.

A single specimen was sent to me by Mr. F. P. Dodd. It can be readily distinguished from its described congeners by its short, robust form; subdentate humeral angles, etc. According to the table of species given by me in these Proceedings, 1899, p.579, its position is beside *D. robusta* Sl.; from which it differs by its smaller size, shorter shape; elytra with five inner striæ fully impressed, inner humeral angle sharply marked; pro-episterna decidedly striolate, metepisterna shorter, etc.

Tribe **Sphodrini.**

PLATYNUS CARTERI, n.sp.

Winged, depressed. Prothorax subquadrate, wider across base (2 mm.) than apex (1·5 mm.); elytra truncate-oval, strongly striate, eighth interstice lightly convex at apex. Tarsi in ♂ stout, depressed; anterior tarsi with three basal joints wide, biseriately squamose beneath, fourth joint not greatly narrower than third, subcordate, subemarginate at apex; posterior tarsi with basal joint finely and sparsely biseriately setose on upper surface, fifth joint setulose beneath. Piceous-black: tarsi, antennæ, and anterior part of head reddish-piceous.

Head elongate, convex (1·9 mm. across eyes): eyes distant from prothorax. Prothorax hardly as wide as head with eyes, broader than long (1·85 x 2·4 mm.), widest a little before middle: disc very finely transversely striolate; apex widely emarginate; base truncate; lateral margins wide, explanate towards basal angles: border reflexed at anterior angles; median line deeply impressed, extending from the deep, arcuate, anterior impression to the wide, basal impression. Elytra much wider than prothorax (6·9 x 4·3 mm.), lightly convex, declivous to base; humeral angles rounded; apex of each elytron shortly oblique; striæ deep, crenulate; interstices convex, third 3-punctate (first puncture near third stria, opposite the end of the scutellar striole of first interstice; second puncture about middle, third puncture about 1·1 mm. from apex), eighth interstice wider than ninth, ninth not narrow, seriate-punctate, the punctures widely separated in middle of course, a more decided, marked puncture outside the others, and touching the lateral channel about 1·2 mm. behind shoulder. Length, 15·5; breadth, 4·3 mm.

Hab.—N.S.W.: Dorrigo. Sent to me by Mr. H. J. Carter as from Dorrigo. Coll. Sloane.

Allied to *P. porphyriacus* Sl., but distinct by colour; prothorax and elytra wider; elytra more strongly striate, etc. It is very distinct from any other Australian species.

Tribe **Oodini.**

COPTOCARPUS PARVUS, n.sp.

Elliptical, convex. Labrum 6-setose; prothorax with a light basal impression on each side; elytra lightly striate, striæ minutely crenulate, first interstice without a striole at base. Black, nitid; prothorax reddish on sides towards base; undersurface piceous-red; legs reddish; tarsi, antennæ, and palpi lighter-coloured than legs.

Head ordinary; eyes round, convex. Prothorax subconvex, depressed on each side towards basal angles (this depressed area reddish), narrow at apex, wide at base; sides lightly rounded; apex emarginate; basal angles triangularly obtuse. Elytra narrow, convex; sides parallel towards base; apex widely rounded; three inner striæ reaching base; interstices equal, finely shagreened:

humeral angles marked, but not dentate. Mesepisterna punctate; metepisterna broader than long. Two basal, ventral segments punctate; apical segment in ♂ with two widely placed, small, setigerous punctures; in ♀ with four, setigerous punctures near apical margin. Length, 7; breadth, 2·75-3 mm.

Hab.—Western Australia: Manjimup. Type in Coll. Sloane.

I found this species in the Karri Forest, 14 miles from Manjimup Railway-Station; it is the smallest species of the genus. Its position is beside *C. gibbosus* Chaud., from which it differs by smaller size, narrower and less convex form, etc.

Genus Phorticosomus.

Before describing any new species, it is necessary to review the described species of the genus *Phorticosomus*. *Ph. rotundipennis* Cast., *Ph. lateralis* Cast., and *Ph. minutus* Cast., do not belong to the genus. *Ph. rotundipennis* seems to be a species of *Simodontus*, which may be identical with the species I named *S. mandibularis;* but this cannot be settled, till specimens from the Paroo River can be examined. *Ph. lateralis* is a species of *Mecyclothorax*. *Ph. minutus*, from the Paroo River, has been examined by Chaudoir, who referred it to *Simodontus;* but the description seems, to me, to have been founded on a species of *Mecyclothorax* closely allied to *M. fortis* Blkb.

Ph. grandis Cast., length 9 lines, from Cooper's Creek, has the prothorax with the anterior angles advanced, and the posterior angles sharply rectangular. I have identified this species as one found by Mr. Zietz at Lake Callabonna. Specimens, given to me by Mr. French, as from Onslow, N.W. Australia, seem to be conspecific.

Ph. edeli Cast., I identify as a large species given to me by Mr. H. M. Giles, who found it on the Strelley River, N.W. Australia. Prothorax somewhat similar in shape to that of *Ph. grandis* Cast., but basal angles obtuse (though marked), apex (5·6 mm.) wider than base (5 mm.). Length, 19·5 mm. It seems widely spread; specimens in my collection, from Kalgoorlie, W.A., and Barrow Creek in the Northern Territory, on the overland telegraph-line, cannot be regarded as different from the specimen from Strelley River.

Ph. nuytsi Cast., = *Ph. calcaratus* Blkb.—Specimens which I identify as *Ph. nuytsi*, have been given to me by Mr. C. French as from the Kimberley District, W.A. It is a large, black species, with prothorax broad (3·5 x 6, apex 4·6, base 4·85 mm.), wider across base than apex, anterior angles advanced, posterior subrectangular (obtuse at summit); elytra with humeral angles sharply marked; anterior tibiæ with three or four, distinct, small teeth externally, above the prominent apical one Mr. F. P. Dodd has sent me specimens from North Queensland (Kuranda and Chillagoe) which are conspecific with *Ph. nuytsi* from N. W. Australia; these agree so closely with the description of *Ph. calcaratus* Blkb., that there seems no room for doubt that it is synonymous. Length, 13-16 mm.

Ph. mucronatus Blkb.—My specimens are from Barrow Creek, N.T., and Cunnamulla, Q. It is very closely allied to *Ph. edeli* Cast., of which it is, perhaps, the eastern form.

Ph. robustus Blkb., is unknown to me in nature. It seems intermediate between *Ph. grandis* and *Ph. mucronatus*; it is described as having the anterior angles of the prothorax "not at all produced forward as in *Ph. mucronatus*."

Ph. similis Blkb., is in my collection, from Kalgoorlie, W.A. In general appearance, it much resembles *Ph. grandis;* but is smaller; prothorax similar in shape, but with the lateral margin narrower, anterior angles far less advanced.

Ph. brunneus Blkb.—Mr. A. M. Lea has sent me a specimen ticketed *Ph. brunneus*, in the handwriting of the late Rev. T. Blackburn. I cannot differentiate it from *Ph. felix* Schaum, the type-species of the genus.

Ph. randalli Blkb.—I identify, as of this species, specimens taken at Adelaide by Mr. Griffith It has the facies of *Ph. felix*, but has the posterior angles of the prothorax quite rounded off.

Ph. horni Sl., is widely spread. My collection contains specimens ticketed Bourke, N.S.W.; Winton, Q.; Onslow and Broome, W.A. It can be recognised easily by the form of the posterior trochanters, straight on external side, widely truncate at apex. Length, 18-22 mm.

Ph. zabroides Sl., differs from all others by its compact, convex form, the striole at base of second interstice of elytra long and deep, etc.

PHORTICOSOMUS CRASSUS, n.sp.

Robust, convex. Eyes not prominent; prothorax transverse, finely punctate on each side of base, basal angles not marked, base biimpressed; elytra truncate-oval, strongly striate, interstices convex, third impunctate; anterior tibiæ wide at apex, and with a strong, internal spur; intermediate tibiæ wide at apex, and with outer angle produced into a prominent, triangular process. Black, legs reddish-piceous.

Head convex (2·7 mm. across eyes); eyes round, lightly convex, not prominent; front shortly impressed on each side at ends of clypeal suture. Prothorax convex, wide (3 × 4·2 mm.), wider across base (3·7 mm.) than apex (3 mm.); sides very lightly rounded; anterior angles widely obtuse, not prominent; posterior angles widely rounded, not marked; lateral margins a little wider and punctate near basal angles; lateral basal impressions deep, short, narrow, punctate; median line faintly impressed. Elytra short (7 × 4·75 mm.), convex, rounded at humeral angles; lateral apical sinuosities obsolete; striæ deep; interstices light, convex on disc; lateral interstices less convex than inner ones, these narrower and more convex on apical declivity; punctures of ninth interstice widely interrupted in middle. Intercoxal part of prosternum setose Metasternum punctate on each side. Ventral segments 3-5 setigero-punctate on each side; third segment punctate between coxæ; fourth and fifth with a row of punctures along anterior margin. Anterior coxæ not punctate; intermediate coxæ closely punctate; posterior trochanters reniform, smooth (two or three punctures near base); posterior femora punctate along lower external margin. Anterior tibiæ with two, small but decided teeth on outer side, above the larger apical tooth. Length, 11·4; breadth, 4·75 mm.

Hab.—Queensland: Chillagoe District (Dodd). Coll. Sloane.

From *Ph. felix* Schaum, which it resembles in general appearance, it can be readily distinguished by eyes less convex; prothorax wider at base, sides less narrowed to base, base strongly biimpressed: four anterior tibiæ with a strong, spur-like, apical prominence externally; anterior tibiæ with two well marked teeth on external side, etc.

Var. BREVIPENNIS, n.var. A specimen in the National Museum, Melbourne, is smaller and of shorter form, particularly the elytra; prothorax more rounded on sides, margins not so wide at basal angles, lateral basal impressions less strongly impressed; elytra shorter (5·3 x 4 mm.), interstices more convex, especially towards sides and apex; ventral segments far less punctate. Length, 9·7;. breadth, 4 mm.

In other respects, it resembles the type-form; it is, perhaps, a distinct species, but having only one specimen of each form before me, it has seemed better to consider the island-form as a variety of the larger species of the mainland.

Hab.—Melville Island (Spencer).

PHORTICOSOMUS PICEUS, n.sp.

Robust, oval, convex. Prothorax wide, subcordate, anterior angles not advanced, lateral margin not explanate at basal angles, these subrectangular; elytra striate, third interstice unipunctate above apical declivity, humeral angles obtuse; anterior tibiæ wide at apex, outer angle very prominent. Piceous; legs reddish-piceous; antennæ and palps reddish.

Head ordinary (3·75 mm. across eyes); eyes small, not prominent. Prothorax smooth, transverse (4 x 5·6 mm.), widest before middle, convex, declivous to base; sides rounded, roundly narrowed to apex (4·15 mm.), obliquely narrowed to base (4·1 mm.); anterior margin truncate; anterior angles obtuse; base truncate; basal angles well marked, obtuse at summit; lateral marginal channel rather narrow, a little wider, but not explanate, near basal angles; border lightly reflexed near basal angles; a light basal impression on each side; median line light. Elytra broader than prothorax (9·6 x 6·4 mm.), lightly declivous to base; sides subparallel; lateral apical sinuosities obsolete; interstices depressed, narrowed and more or less convex near apex; striole at base of second interstice short; border narrow, not raised at humeral angles; lateral channel narrow. Anterior tibiæ with outer angle produced into a strong, triangular spur, outer edge crenulate above apical spur; posterior trochanters reniform, external side arcuate, several punctures on basal half. Length, 14·5-16; breadth, 5·8-6·1 mm.

Hab.—S.A.: Nooriootpa. Type in Australian Museum. Six specimens have been examined, one is now in Coll. National Museum, Melbourne, and one is in my collection.

From description, it seems to resemble *Ph. robustus* Blkb., (unknown to me in nature) but is larger, and has not the sides "strongly sinuated before hind angles." From *Ph. horni* Sl., it differs decidedly by the smaller size; more sharply marked, posterior angles of prothorax; elytra with border less raised at humeral angles; posterior trochanters with posterior side not straight, apex not widely truncate. From *Ph felix* Sch., and *Ph. randalli* Blkb., it differs, *inter alia*, by size larger, basal angles of prothorax more strongly marked. From *Ph. grandis* Cast., *Ph. nuytsi* Cast., and *Ph. mucronatus* Blkb., it differs in various ways, but from all of them by prothorax with anterior angles not prominent, lateral margins not wide and flat at basal angles.

Mr. H. W. Brown brought, from Cue, a species which has the prothorax almost exactly as in *Ph. piceus*, though the posterior angles are a little more obtuse; it is probably conspecific with *Ph. piceus*.

PHORTICOSOMUS CASTELNAUI, n.sp.

Robust, convex. Prothorax subcordate, narrower across base (4·5mm.) than apex(5·5mm.), anterior angles strongly advanced, basal angles rectangular; elytra truncate at base, humeral angles marked. Black, antennæ piceous.

Prothorax transverse (4 × 6·7mm,), strongly narrowed to base, depressed along posterior margin; apex truncate between anterior angles, these prominent, obtuse; sides lightly rounded, subsinuate just before base; basal angles rectangular, obtuse at summit; base emarginate above peduncle; margins wide, explanate near basal angles, depressed; basal area shagreened and minutely punctate. Elytra wide (9·8 × 7 mm.), convex; apical curve hardly sinuate on each side; interstices lightly convex, third unipunctate before basal declivity; basal border with posterior margin straight beyond fourth stria, raised but not angulate at humeral angle. Posterior trochanters reniform, external side arcuate, apex obtusely rounded. Length, 15-17; breadth, 6-7 mm.

Hab.—Q.: Gulf of Carpentaria (type); Winton District. Four specimens (♂♀) were given to me by Mr. C. French. Type in Coll. Sloane.

Allied to *Ph. nuytsi* Cast., from which it differs by form more robust and convex; prothorax longer proportionately to its breadth, more strongly narrowed to base (which is evidently narrower than apex); elytra more convex, more declivous to sides and apex, more strongly striate, humeral angles less sharply marked; mandibles with outer side evenly arcuate, right mandible especially with the anterior, external bend far less marked; anterior tibiæ wide at apex, but not with external apical angle produced into a long spur-like process, outer edge not with several well marked denticles above apex.

Phorticosomus gularis, n.sp.

♂. Subparallel, rather depressed. Head large, left mandible elongate, and strongly hooked at apex; labrum deeply triangularly excised; *submentum bicornute;* prothorax transverse, anterior angles prominent, basal angles rectangular; elytra strongly striate, humeral angles marked; prosternum setigero-punctate before coxæ; ventral segments 3-5 punctate along anterior and posterior margins. Piceous-brown.

Head large (4·5 mm. across eyes), convex and minutely punctate posteriorly; front depressed, a wide irregular fovea on each side; a carinate ridge above each eye; a transverse impression on each side behind eyes; depressed frontal part well defined by a rounded, oblique ridge, extending from inner side of postocular impressions to outer angle of clypeus. Horns of submentum separated, but united at bases to fill all the space between posterior extremities of buccal fissures, pointed obliquely backwards and outwards, obtuse, a setigerous puncture at apex, and one or two long setæ on outer side. Prothorax broader than long (3·3 x 6 mm.), widest before middle, wider across base (4·8 mm.) than apex (4·5 mm.); sides lightly rounded anteriorly, sinuate before base; anterior angles obtuse, prominent; basal angles rectangular; lateral margins wide, widely explanate towards base. Elytra broader than prothorax (10·5 x 6·8 mm.), subparallel on sides, truncate at base; interstices depressed; border slightly raised, and angulate at shoulders. Legs light; anterior tibia wide at apex; external angle dentate, not prominent. Length (with mandibles), 18·5; breadth, 6·8 mm.

♀. Differs from ♂ by head smaller; front less depressed; elevation bounding this depression on the sides short, less defined, less oblique; postocular impressions of head hardly marked; submentum unarmed (lower edge widely emarginate in middle, and with a slight prominence near each side). Length, 15·5: breadth, 6·2 mm.

Hab.—W. A.: Cue (H. W. Brown); Strelley River (H. M. Giles) —N.T.: Barrow Creek (from Mr. French).

This species is at once separable from all others by its deeply cleft labrum, the enlargement of the left mandible, and the strange processes of the submentum in ♂. It is noticeable, under a lens of high power, that there are some minute punctures on the outer side of the mandibles, near the ante-apical bend. A similar development of processes on the submentum is met with in the Asiatic harpalide genus *Dioctes*, in which the outer side of the mandibles is plentifully beset with setigerous punctures. The description is founded on specimens from Cue (given to me by Mr. Brown). A specimen (♂) from the Strelley River (given to me by Mr. Giles) has the processes of the submentum greatly reduced in size (forming pyramidal tubercles), showing that this character (as is usual with secondary sexual characters) is variable. Two female specimens examined (from Cue and Barrow Creek) have a puncture on the third interstice of elytra above the apical declivity; in one male specimen alone is this puncture present, and then only on one side.

PHORTICOSOMUS MACLEAYI, n.sp.

Robust, oval. Prothorax transverse, sides sinuate posteriorly, basal angles rectangular; elytra strongly striate, humeral angles rounded, interstices lightly convex, third interstice unipunctate above apical declivity; anterior tibiæ with outer edge even, apical angle not armed. Anterior tarsi in ♂ with joints 2-4 widely dilatate, spongiose beneath: intermediate tarsi with joints 2-4 lightly dilatate, spongiose beneath. Piceous; legs and undersurface piceous-red.

Prothorax rather depressed, broader than long (2·5 × 3·7 mm.), widest a little before middle, wider across base (3 mm.) than apex (2·65 mm.), sides rounded, roundly narrowed to apex, sinuate posteriorly, and meeting base at right angles; apex emarginate; base truncate; median line lightly impressed. Elytra truncate-oval (6·5 × 4·6 mm.); apical sinuosity lightly developed; apex of each elytron rather pointed. Metasternum punctate on each side. Posterior femora with a row of piliferous punctures along posterior side; posterior trochanters reniform; fourth joint of anterior tarsi transverse, emarginate; of intermediate tarsi turbinate, lightly emarginate; posterior tarsi narrow, first joint not as long as the two succeeding joints together; fourth joint small, simple. Length, 10·5; breadth, 4·6 mm.

Hab.—Q.: Cooktown (Olive), Chillagoe (Dodd)—W.A.: King's Sound and Roebuck Bay (*fide* French).

I believe this to be the species which Macleay took to be *Ph. nuytsi* Cast.; at least, I have specimens, received from Mr. C. French, which I have compared with the *Ph. nuytsi* of the Macleay Coll., and found to be similar; but I cannot differentiate these from specimens sent to me by Mr. Olive from Cooktown. It has seemed better to found the species on the Cooktown specimens, which are in better order, and from an exact locality. *Ph. nuytsi* Cast., is another species; it is larger, with the basal border of the elytra raised at the humeral angles, which are decidedly marked.

Tribe **Lebiini.**

XANTHOPHŒA FASCIATA, n.sp.

Elongate. Head oblique behind eyes; prothorax with sides sinuate, basal angles acute; elytra depressed, lightly striate, third interstice unipunctate about posterior fourth. Testaceous; elytra with a black fascia across middle, this fascia diamond-shaped on inner interstices, narrow externally from third interstice, uniting with a black marginal vitta, this interrupted at posterior fourth; border testaceous on sides.

Prothorax depressed, as wide as head, a little broader than long (1·4 × 1·6 mm.), wider across base than apex, widely margined laterally; sides lightly rounded on anterior three-fourths, sinuate posteriorly; base cut sharply and squarely on each side; position of anterior marginal seta at widest part indicated by a minute prominence; median line deep. Elytra much wider than prothorax; striæ shallow, finely crenulate; interstices depressed, very minutely shagreened. Length, 9 mm.

Hab.—Q.: Cairns District. Two specimens, collected by Mr. A. M. Lea, ticketed "Malandra, beaten from foliage."

A very distinct species, differing from all other described species by the pattern of the elytra.

Genus NOTOTARUS.

The species of this genus are found in dry forest-lands under fallen boughs and débris. In January, I found *N. australis* Chaud., in the Park at Perth; and *N. chaudoiri* Sl., and *N. interstitialis* Sl., var. *picea*, at Cunderdin and Kellerberrin, on the railway from Perth to Southern Cross.

NOTOTARUS INTERSTITIALIS Sloane.

Var. PICEA, n.var. Elytra with interstices punctate as in *N. interstitialis*, but differing by head and prothorax narrower; head more convex, more finely punctate, eyes less convex; prothorax smaller, less strongly narrowed to base, sides less strongly sinuate just before posterior angles, these less prominent, juxtabasal sinuosity (behind posterior angles) shorter, and more decidedly marked. Length, 4·8; head, 1 across eyes; prothorax, 0·9 × 1·05; elytra, 2·6 × 2 mm.

Hab.—W.A.: Cunderdin and Kellerberrin (Sloane; January).

NOTOTARUS MOROSUS, n.sp.

Oval, depressed. Head wide (1·15 mm. across eyes), subdepressed, minutely punctate; eyes prominent; prothorax wide, hardly narrower at base than apex, punctate, base widely lobate; elytra punctate-striate, interstices lightly convex. Piceous-black; legs testaceous; antennæ, mandibles, and mouth-parts reddish, (antennæ, after second joint, a little darker).

Head finely punctate, not rugulose in middle, lightly longitudinally rugulose on each side near eyes; front depressed; eyes convex, prominent, strongly enclosed behind; postocular part of orbits protuberant, about one-half size of eyes. Prothorax decidedly wider than head (1·2 x 1·5 mm.), subnitid on disc, finely punctate, widely rugulose-punctate towards margin; sides lightly rounded, very little narrowed (not sinuate) to posterior angles, these small, dentate; basal curve rather short, sinuate on each side; lobe rounded; median line strongly impressed. Elytra truncate-oval (3 x 2·3 mm.); base emarginate; humeral angles rounded; striæ narrow, deeply impressed, distinctly punctate; interstices lightly convex, finely shagreened, third with a puncture at basal third; striole at base of first interstice well developed, punctate. Length, 5; breadth, 2·3 mm.

Hab.—N.T.: Port Darwin (Dodd). Unique in Coll. Sloane.

A distinct species, differing from the other, small, described species by head wider, less punctate; prothorax less narrowed to posterior angles, these less prominent. *Cymindis crassiceps* Macl., is a species of *Nototarus*, but is much larger.

Nototarus angusticollis, n.sp.

Depressed. Head long, convex; prothorax narrow; elytra wide, truncate-oval, striate, interstices punctate. Black; legs and undersurface piceous; mouth-parts, tarsi, and trochanters reddish.

Head narrow (1·7 mm. across eyes), convex; vertex punctate; sides lightly swollen behind eyes; postocular prominences about two-thirds length of eyes, less prominent than eyes; two supra-orbital punctures on each side, posterior considerably behind eyes; eyes distant from prothorax, small, round, convex. Mentum edentate. Labial palps securiform. Base of maxillæ prominent. Prothorax narrow (1·7 x 1·8 mm.), wider at apex (1·7 mm.) than base (1·4 mm.), broadest a little before middle, narrowly depressed along sides; upper surface punctate; anterior angles rounded, not marked; base truncate above peduncle, sinuate on each side. Elytra truncate-oval (5 x 3·7 mm.), rounded on sides, and on each side of base: external apical angle not marked; apical truncature obliquely sinuate on each side, rounded at apex of three inner striæ, triangularly excised at suture; striæ strongly impressed, interstices lightly convex, strongly punctate; third with three dorsal punctures, and one at apex; eighth interstice wider than seventh and ninth, closely punctate (the punctures in about four irregular rows); ninth interstice narrow, finely punctate, with a row of widely placed larger punctures; marginal channel punctate; inflexed margin punctate. Prosternum punctate; metepisterna quadrate, punctate. Anterior tarsi in ♂ narrow; three basal joints biseriately squamulose in middle of under side. Apical ventral segment unisetose on each side of apex. Length, 9-10; breadth, 3·5-3·7 mm.

Hab.—W.A.: Cue (H. W. Brown). Type in Coll. Sloane.

A very distinct species, differing from the others known to me by its large size; long, narrow head and prothorax; wide, oval elytra, with strongly punctate interstices. It is evidently an apterous species, with the elytra soldered together; in comparison with *N. chaudoiri* Sl., the lateral palps are much less widely securiform.

Physoderides.*

Lachnoderma foveolatum, n.sp.

Oval; elytra rugose-foveolate. Head, prothorax, and undersurface red; elytra blue-black; legs and antennæ, after third joint, black.

Head convex, setiferous between eyes; clypeus with a setiferous fovea on each side near anterior angle, a few setiferous punctures on each side behind these clypeal foveæ; eyes prominent; labrum bifoveate, setose in foveæ. Antennæ, after third joint, pubescent; three basal joints sparsely setiferous (about three long setæ on

* *Lachnoderma* has been referred to a group, Physoderides, by Bates, when referring Asiatic species to the genus. I do not know the true position or value of this group.

basal joint). Prothorax subcordate, widest before middle, strongly sinuate-angustate to base; anterior angles not marked; sides rounded at widest part; posterior angles sharply marked; base rounded in middle, cut obliquely forward to basal angle on each side; lateral margins explanate; upper surface punctate-setose, sparsely so on middle of disc. Elytra subquadrate, much wider than prothorax; striate; striæ foveolate; surface generally rugose-striolate. Tarsi setose. Length, 8·8; breadth, 3·75 mm.

Hab.—Q.: Cairns District (Dodd). Unique, in Coll. Sloane.

I received a single specimen from Mr. F. P. Dodd, taken by him in the Cairns District. It differs from *L. cinctum* Macl., by colour prothorax red, not brownish with lateral margins bluish; elytra wholly of a black-blue colour—; head, prothorax, and elytra less hairy; head stouter, with more prominent, hemispherical eyes. The shape of the prothorax, and the sculpture of the elytra are similar in both species.

DESCRIPTIONS OF NEW AUSTRALIAN LEPIDOPTERA.

By Oswald B. Lower, F.L.S., F.E.S.

GEOMETRIDÆ.

Pseudoterpna xenomorpha, n.sp.

♀. 36 mm. Head, palpi, antennæ, and thorax whitish-grey finely mixed with ashy-grey. Abdomen ashy-grey, mixed with fuscous. Legs fuscous, tibiæ and tarsi narrowly banded with white. Forewings elongate-triangular; termen waved, rounded; pale whitish-grey, finely irrorated with fuscous and blackish scales, so as to appear ashy-grey: a narrow oblique transverse fuscous fascia, from costa at one-quarter to dorsum at middle; a similar fascia from costa at about three-fifths to dorsum before anal angle, gently curved inwards on lower two-thirds; a narrow fuscous line from costa to very near angle of preceding fascia; a sharply defined direct white streak from costa at five-sixths, reaching nearly half across wing; a very obscure fuscous line parallel to termen; a waved black line along termen. Hindwings with termen faintly waved; colour as in forewings; an obscure narrow fuscous fascia, from costa at about three-quarters to termen before anal angle; line along termen as in forewings; cilia of both wings ashy-grey-whitish. Underside of both wings as above; markings reproduced; a short transverse streak of white on costa of hindwings at five-sixths, followed by a broad light fuscous, somewhat suffused, band before termen throughout.

Pinnaroo, South Australia; one specimen taken by Mr. R. S. Lower, in March.

Probably nearest *P. ocultaria* Don. The absence of any well defined markings on the underside is peculiar.

MONOCTENIADÆ.

DICHROMODES PERINIPHA, n.sp.

♀. 25 mm. Head, palpi, and thorax whitish, palpi three, thorax with a pale ochreous anterior bar. Antennæ fuscous. Abdomen ochreous-grey. Legs grey-whitish (posterior pair broken). Forewings elongate, triangular, termen gently rounded; whitish; all veins, except subcostal, obscurely outlined in pale ochreous; markings dark fuscous; a small suffused basal spot on fold; a more distinct spot just beyond; a moderately thick line, from beneath costa to dorsum at one-third, with a slight projection on fold: a large quadrate discal spot; a moderately thick line from costa at three-quarters to dorsum near anal angle, dentate throughout, and with a bidentate projection in middle; a dull fuscous subterminal shade: a fine waved black line along termen; cilia whitish-grey, basal half irrorated with fine black scales. Hindwings with termen unevenly waved; grey-whitish; a faint fuscous discal spot; a fine waved pale fuscous submedian line; an obscure fuscous line along termen; cilia whitish.

Pinnaroo, S.A.; one specimen taken by Mr. R. S. Lower, in October.

Allied to the previous species, but differs by pale colouring, longer palpi, and waved termen of hindwings

DICHROMODES FULVIDA, n.sp.

♂♀. 22-26 mm. Head, palpi, and thorax fuscous, thickly irrorated with whitish and ochreous-ferruginous; head in female wholly ochreous, palpi two, thorax anteriorly edged with whitish scales. Antennæ fuscous, pectinations four. Abdomen grey-whitish, sprinkled with fuscous. Legs grey-whitish, tibiæ and tarsi fuscous, banded with whitish. Forewings elongate, triangular, termen faintly waved, rounded; fuscous, densely irrorated with dull whitish; veins, except costal branches, marked with rather thick ochreous streaks, interrupted by lines; a rather thick fuscous fascia, obscure in female, from costa at one-fifth to dorsum at one-fifth, edges tolerably straight; a broad fuscous median band, edges dentate, anterior edge from costa at two-fifths to dorsum at one-third, anteriorly edged throughout with a fine whitish line, indented in middle; posterior edge nearly straight, from costa beyond middle to just beyond middle of dorsum, slightly deflected inwards near costa and edged throughout finely with white; a tolerably broad transverse fascia, from costa at five-sixths to anal angle, anterior edge slightly waved, posterior edge irregularly dentate with a broad obtuse median projection; a fine waved black line along termen; cilia grey, basally whitish. Hindwings with termen rounded, faintly waved; fuscous; two or three short white lines from dorsum near anal angle; a fine waved blackish line along termen; cilia as in forewings.

Pinnaroo, S.A.; three specimens, taken by Mr. R. S. Lower in November.

Apparently near *D. ioneura* Meyr., (from West Australia), but the form of the lines and colouring are quite distinct.

Dichromodes cirrhoplaca, n.sp.

♂♀. 26-28mm. Head, palpi, and thorax fuscous, thickly irrorated with whitish, palpi two and one-half, thorax sometimes with a central ferruginous spot. Antennæ fuscous, pectinations six. Abdomen grey-whitish. Legs grey-whitish, tibiæ and tarsi obscurely banded with white. Forewings elongate, triangular, termen rounded; silvery-grey-whitish, minutely and irregularly irrorated with dark fuscous; a short blackish streak on fold near base; a similar, but much longer, streak on fold beyond; a broad, inwardly oblique transverse ferruginous fascia, from beneath costa at one-quarter to fold at one-quarter, anterior edge suffused, posterior edge nearly straight, and edged by a narrow streak of white throughout, beyond which is a narrow waved black line, sinuate inwards below middle; a rather large quadrate fuscous discal spot; a fine blackish nearly line, from or just below costa at three-quarters, with a slight projection below middle, which touches discal spot; a broad ferruginous transverse fascia, only separated from blackish line by a narrow streak of whitish, anterior edge nearly straight, from costa at three-quarters to just above dorsum at two-thirds; posterior edge strongly suffused with blackish, with three obtuse projections below costa, in middle, and above anal angle; a fine, waved, black line along termen; cilia grey-whitish. Hindwings with termen rounded; light greyish-fuscous; a very obscure fuscous discal spot; an obscure whitish line beyond middle; dorsum obscurely irrorated with whitish; cilia as in forewings.

Pinnaroo, S.A.; three specimens, taken by Mr. R. S. Lower, in November.

Nearest *D. orthozona* Low., but the form of the lines, etc., is totally different.

SELIDOSEMIDÆ.

CHLENIAS CYCLOSTICHA, n.sp.

♂. 40 mm. Head, palpi, and thorax light smoky-fuscous, basal joint of palpi somewhat loosely haired. Antennæ light fuscous, pectinations 10, ochreous. Legs fuscous, anterior coxæ grey, middle and posterior tibiæ banded with ochreous. Abdomen dull grey. Forewings elongate, triangular, termen evenly rounded, oblique; ochreous-fuscous, minutely irrorated throughout with black; all veins outlined with light ochreous; a suffused blackish transverse discal spot, at posterior end of cell; an outwards-curved row of elongate black spots on veins, from costa at three-quarters to dorsum before anal angle, slightly sinuate inwards below middle; a black streak on subcostal nervule at one-third from base; a similar streak on vein one, at about one-third from base; cilia ochreous-fuscous. Hindwings with termen unevenly rounded; dull grey-whitish, fuscous-tinged, except on basal third; cilia as in forewings, but with a fuscous basal line.

Broken Hill, N.S.W; one specimen; June (at light).

Bombycina.

LIMACODIDÆ.

SUSICA ÆROGRAMMA, n.sp.

♂. 35 mm. Head, thorax, and abdomen pale greyish-fuscous. Palpi orange. Antennæ whitish, pectinations orange. Legs greyish, tibiæ and tarsi orange, banded with black. Forewings pale greyish-fuscous; costal edge narrowly orange throughout;

an oblique, strongly dentate black line from middle of dorsum to just below costa at five-sixths; cilia grey, with a dull ochreous basal line. Hindwings grey-whitish; cilia as in forewings.

Pinnaroo, S.A.; two specimens, taken by Mr R. S. Lower, in March.

OCNERIADÆ.

ORGYIA ANELIOPA, n.sp.

♂. 25 mm. Head and thorax fuscous, thorax with an obscure ochreous posterior spot, face orange, thorax beneath mixed with orange. Palpi orange. Antennæ fuscous, pectinations eight, dull orange. Abdomen fuscous; almost wholly clothed with orange hairs. Legs fuscous. Forewings elongate-triangular, costa nearly straight, termen gently rounded, oblique; light fuscous; an inwardly fuscous discal spot at end of cell; a somewhat suffused, fuscous, rather thick line, from costa near apex to dorsum just before anal angle; cilia fuscous, with a darker basal line. Hindwings with colour and cilia as in forewings.

Pinnaroo, S.A.; four specimens, taken in March by Mr. R. S. Lower.

I have every reason to believe that the female of this insect will prove to be apterous.

ZEUZERIDÆ.

ZEUZERA(?) PENTASEMA, n.sp.

♂. 30 mm. Head and thorax greyish-fuscous, mixed with dull ferruginous. Palpi fuscous, second joint with a few white scales at apex. Antennæ fuscous, base beneath sharply white. Legs light fuscous, tarsi obscurely banded with dull white. [Abdomen broken]. Forewings elongate, moderate, costa straight, termen oblique, little rounded; ashy-grey-whitish, irregularly mixed with ferruginous-brown; groundcolour between base and middle of wing, suffused with whitish, except a moderately broad costal streak; veins on whitish portion sharply outlined with black; a rather large roundish patch of light ochreous-ferruginous, occupying median portion of wing, not reaching margins, containing several roundish spots of lighter groundcolour, outlined in black, median spots smallest; veins beyond patch outlined in black, the interspaces filled in with five well defined streaks of whitish; cilia ochreous-fuscous, sharply barred with white, being the continuation of the interneural streaks. Hindwings dark fuscous, with a fuscous subterminal line, tips dull whitish.

Dalby, Queensland; one specimen, in November.

Zeuzera perigypsa, n.sp.

♂. 44 mm. Head fuscous-whitish. Palpi whitish, base of second joint black. Antennæ whitish, pectinations dull orange. Thorax dark fuscous, anteriorly mixed with whitish scales. Abdomen dark fuscous, laterally somewhat mixed with whitish. Legs grey-whitish, posterior tibiæ and tarsi ochreous-tinged. Forewings elongate, costa gently arched, termen very obliquely rounded; dull white, finely reticulated throughout with short, waved, transverse lines, which accumulate more thickly along costal portion of wing; costal edge obscurely dull whitish throughout; cilia fuscous. Hindwings pale whitish-grey, with a few very obscure scattered light fuscous reticulations; cilia as in forewings, becoming darker at extremities of veins.

Broken Hill, N.S.W.; one specimen, in March.

Pyralidina.

PYRAUSTIDÆ.

Metallarcha grammetalla, n.sp.

♀. 24 mm. Head, palpi, and thorax orange-yellow, palpi infuscated laterally and beneath. Antennæ fuscous. Abdomen orange-yellow. Legs dark fuscous, posterior pair yellow, tibiæ obscurely banded with fuscous. Forewings elongate, moderate, triangular, costa straight, termen oblique, gently rounded; bright yellow, markings dull leaden-metallic; a moderate costal streak, thickest on basal fourth, at base continued to fold; a moderately thick transverse fascia, strongly indented anteriorly above middle, from costa just before middle to middle of dorsum; a similar fascia parallel to termen, from costa just before apex direct and almost reaching vein two, thence strongly curved inwards so as to nearly reach first fascia, thence continued to dorsum before anal angle; a short fascia from costal streak at about two-thirds joint curve of previous fascia; a fine line along termen; cilia pale yellow. Hindwings dull purplish-fuscous, becoming pale yellow on costa and basal fifth; a fine line of yellow on upper third of termen; cilia pale greyish-ochreous, becoming yellowish at apex and around anal angle.

Pinnaroo, S.A.; three specimens, in November; taken by Mr. R. S. Lower.

Tineina.

ŒCOPHORIDÆ.

Philobota mitoloma, n.sp.

♂. 26 mm. Head orange. Palpi fuscous, internally orange. Antennæ pale yellow. Thorax yellow, anteriorly with purplish-fuscous band. Abdomen orange, two basal segments dull purplish-fuscous. Legs dull purplish-fuscous, posterior pair orange-yellow. Forewings elongate, moderate, costa gently arched, termen rounded, oblique; orange-yellow; a moderately narrow purplish-fuscous streak along costa, from base to five-sixths, extremities somewhat attenuated; a round purplish-fuscous discal dot, just beyond posterior end of cell; cilia fuscous-grey. Hindwings fuscous; cilia as in forewings, but becoming mixed with ochreous towards base.

Pinnaroo, S.A.; two specimens, taken by Mr. R. S. Lower, in November.

Philobota eremosema, n.sp.

♂. 24 mm. Head, palpi, antennæ, and thorax white, second joint of palpi fuscous externally, except apex, antennæ annulated with fuscous, thorax anteriorly narrowly fuscous, patagia fuscous anteriorly. Abdomen whitish, segmental margins ochreous-fuscous, anal tuft ochreous. Legs silvery-white, posterior pair pale whitish-ochreous. Forewings elongate, moderate, costa hardly arched, termen obliquely rounded, 7 to immediately below apex; white; costal edge narrowly fuscous, from base to one-quarter; a moderate, fuscous, longitudinal streak from base to apex, slightly above middle, slightly indented at its upper edge at two-thirds, and tending to emit a streak from its lower edge at two-thirds; basal portion of the longitudinal streak somewhat attenuated; cilia white, with some fuscous scales at base along termen. Hindwings and cilia pale whitish-grey, cilia at base yellowish.

Broken Hill, N.S.W.; one specimen, in November.

I should have referred this species to *Nephogenes*, but the general facies appears to indicate *Philobota* as its true generic position.

Nephogenes maculisarca, n.sp.

♀. 24 mm. Head and palpi fleshy-white, second joint of palpi externally fuscous. Antennæ fuscous. Thorax dark fuscous, mixed with a few white scales. Abdomen ochreous-fuscous, laterally becoming whitish. Legs fuscous, tarsi ringed with white, posterior pair whitish-grey. Forewings elongate, moderate, costa slightly arched towards base, thence straight, termen oblique, little rounded; dark fuscous, mixed with scattered white scales, which coalesce more thickly along dorsum, and median basal third of wings; costa very narrowly white, from base to five-sixths, obsolete in one specimen; markings flesh-colour; an irregular suffused streak along fold, from base to one-quarter; a round spot at extremity of this; a longitudinal series of three spots just above middle of wing, first at anterior edge of cell; second narrow, in middle of cell; third largest, at posterior extremity of cell; an oblique transverse row of six confluent spots, near and parallel to termen, upper largest, all more or less edged with black; groundcolour between these, and last longitudinal spot mixed with white; cilia fuscous, with some blackish scales. Hindwings and cilia fuscous.

Broken Hill, N.S.W., and Pinnaroo, S.A., (R. S. Lower); two specimens, in October.

Linosticha(?) stichoptis, n.sp.

♂. 26 mm. Head, palpi, antennæ, and thorax fleshy-white, antennæ at base and patagia white. Abdomen silvery-grey, segmental margins white. Legs ochreous-grey. Forewings elongate, moderate, costa evenly arched, apex somewhat prominent, termen sinuate beneath apex, thence obliquely rounded; seven to below apex; fleshy-white, becoming whitish on costal third of wing; all veins neatly outlined with clear white, and more or less finely edged on either side with dull fuscous, especially beyond cell; cilia light fuscous. Hindwings grey-whitish; cilia ochreous-whitish.

Broken Hill, N.S.W.; one specimen, in July.

I should be inclined to propose a new genus for the reception of this species, but for paucity of material. The type was beaten from *Casuarina*, twelve years ago, and I have not met with a second specimen. The termination of vein 7 of forewings is at variance with the characters of *Linosticha*.

Linosticha sericopa, n.sp.

♂. 16 mm. Head, palpi, antennæ, and thorax dark fuscous. Abdomen greyish-ochreous. Legs dark fuscous, posterior pair yellow-ochreous. Forewings elongate, moderate, costa gently arched, termen rather strongly oblique; dark fuscous, faintly coppery-tinged; markings obsolete; cilia dark fuscous, mixed with grey at anal angle. Hindwings pale ochreous-fuscous; cilia pale yellow, terminal half mixed with fuscous towards apex.

Broken Hill, N.S.W.; one specimen, in November (at light).

Not unlike some species of *Scieropepla* (*Xyloryctidæ*).

Trachyntis mimica, n.sp.

♂. 25 mm. Head and thorax fuscous, patagia mixed with grey-whitish. Palpi fuscous-whitish, becoming white internally on basal joint. Antennæ and legs fuscous, posterior tibiæ and tarsi tinged with ochreous. Abdomen ochreous, segmental margins whitish. Forewings elongate, moderate, costa gently arched, termen rounded, oblique; dull bronzy-ochreous, more or less minutely irrorated throughout with fuscous, which is more dense on upper half of wing, except towards termen; two fuscous discal spots, placed longitudinally, at one-third and two-thirds from base, both edged posteriorly with a spot of ochreous-whitish;

a row of more or less confluent fuscous spots along termen and apical fifth of costa; cilia ochreous-fuscous, becoming ochreous around anal angle. Hindwings greyish-ochreous, becoming fuscous-tinged on costal area, and more ochreous along termen; cilia ochreous, at apex mixed with fuscous.

Broken Hill, N.S.W.; one specimen, in March.

Closely allied to *P. argocentra* Low., but apparently distinct; a longer series may unite them.

Guestia delosticha, n.sp.

♂. 24 mm. Head and thorax fuscous. Palpi whitish, basal joint with a fuscous apical band. Antennæ fuscous, obscurely annulated with greyish. Legs fuscous, mixed with white. Abdomen dull ochreous, segmental margins grey. Forewings elongate, moderate, costa hardly arched, termen rounded, oblique; light fuscous; all veins more or less outlined in white, interspaces appearing dark fuscous; a white line along termen, anteriorly edged with darker groundcolour, and interrupted by blackish streaks ; cilia greyish, mixed with fuscous and black scales. Hindwings grey; cilia grey-whitish, with a fuscous basal line.

Broken Hill, N.S.W.; one specimen, in June.

Guestia symmadelpha, n.sp.

♂. 25 mm. Head, thorax, and palpi light fuscous, head mixed with some ochreous scales, palpi internally white. Antennæ whitish, annulated with fuscous. Legs fuscous, posterior pair grey-whitish, all tarsi banded with white rings. Abdomen grey-whitish. Forewings elongate, moderate, costa hardly arched, termen very obliquely rounded; cinereous-grey; costal edge narrowly white throughout; a well marked narrow streak of white in middle of cell, posterior termination marked by a narrow transverse fuscous mark, below which is a dull white transverse spot; veins towards termen obscurely outlined with white scales; cilia ashy-grey, paler at base, and with some fuscous sub-basal scales. Hindwings pale fuscous; cilia greyish-ochreous.

Broken Hill, N.S.W.; one specimen, in May.

Probably allied to *G. actinipha* Low., but distinct.

Pauronota lasioprepes, n.sp.

♂. 22 mm. Head, palpi, thorax, and antennæ rather dark fuscous, internally mixed with whitish. Legs dark fuscous, hairs of posterior pair ochreous-grey, all tarsi ringed with whitish. Abdomen ochreous, anterior segments whitish, segmental margins grey. Forewings rather narrow, elongate, costa hardly arched, termen rounded, oblique; ashy-grey-fuscous; cell and all interneural spaces neatly outlined in white, giving the appearance of alternate fuscous and white streaks; a small fuscous dot in anterior end of cell, followed by a narrow elongate fuscous streak to near end of cell; cilia greyish-ochreous, mixed with fuscous and dark fuscous scales. Hindwings pale greyish-ochreous; cilia greyish-ochreous.

Broken Hill, N.S.W.; one specimen, in May.

This species is extremely like *Nephogenes crassinervis* Low., but the fuscous head and stalking of veins 2 and 3 of forewings are sufficient to prevent confusion of the species. I have taken *P. crassinervis* only in August, September, and October.

XYLORYCTIDÆ.

Xylorycta amaloptis, n.sp.

♀. 28 mm. Head, thorax, palpi, and antennæ pale whitish-grey, [terminal joint of palpi imperfect]. Legs grey-whitish. Abdomen grey-whitish, second segment dull orange Forewings elongate, costa gently arched, termen rounded, oblique; pale whitish-grey, somewhat flesh-tinged, all markings obsolete; a fuscous-ferruginous line along termen and apical fifth of costa, obscure on costa and minutely dentate internally on termen; cilia dull ochreous-grey. Hindwings light fuscous, becoming whitish towards base; cilia grey.

Broken Hill, N.S.W.; one specimen, in February.

Cryptophaga citrinopa, n.sp.

♀. 40mm. Head and face white. Thorax fleshy-pink, patagia orange-ochreous. Antennæ and palpi fleshy-white, palpi more whitish externally, at base. Legs fleshy-ochreous. Abdomen dull ochreous, second segment obscurely orange. Forewings elongate, costa tolerably arched, termen hardly rounded, faintly sinuate below apex; 2 from four-fifths; orange-yellow, faintly dusted with dull reddish on basal half; a moderately broad, silvery-white, costal streak from base to middle, attenuated posteriorly, and edged beneath throughout by a fine fuscous line; two dark fuscous discal spots, transversely placed in middle of wing at three-fifths from base; cilia dull orange. Hindwings with veins 6 and 7 from a point; 3 and 4 short-stalked; orange-yellow; cilia as in forewings, at base with a ferruginous line.

Broken Hill, N.S.W.: one specimen, in November.

ORDINARY MONTHLY MEETING.

SEPTEMBER 29th, 1915.

Mr. A. G. Hamilton, President, in the Chair.

The Donations and Exchanges received since the previous Monthly Meeting (25th August, 1915), amounting to 8 Vols., 78 Parts or Nos., 17 Bulletins, 2 Reports, and 3 Pamphlets, received from 42 Societies, etc., and one private donor, were laid upon the table.

NOTES AND EXHIBITS.

Mr. A. A. Hamilton exhibited specimens from the National Herbarium, with notes thereon:—*Boronia ledifolia* Gay,(Hilltop; E. Cheel; June, 1915) showing meiophylly of the calyx, corolla, and andrœcium. This species has, normally, four sepals, four petals, and eight stamens. In the example exhibited, one sepal, one petal, and three stamens are suppressed. In many cases of meiophylly, the regularity of the axial alternation of the floral organs affected is disturbed, but, in this case, the whorls, though reduced, retain their symmetry. The characteristic callosity at the summit of the filaments is not produced. Dr. Masters ("Vegetable Teratology," p.397), notes that meiophylly of the calyx is less common (in dicotyledonous plants) than in the case of either corolla or stamens.—Photographs of a triple cone of *Macrozamia Perowskiana* Miq., grown in the Sydney Botanic Gardens, illustrating syncarpy. Three cones are to be noted, adhering by their axes, the central cone larger than the two lateral ones, both of which exhibit a degree of curvature. The line of divergence is marked by the size, and placentation of the scales, those of the outer cones being much larger than those of the central cone. No example of syncarpy is noted in the Family *Cycadeæ* by Dr. Masters, in his work on "Vegetable Teratology."—*Cardiospermum Halicacabum* Linn., (Petersham; T. Steel; March, 1911) showing multiplication of carpels. The fruit of this plant is tri-carpellary, each carpel containing a single seed. One example discloses an abortive attempt to form a fourth carpel. In a second example, an extra, perfect carpel has been produced, containing a fertile seed.—*Pelargonium* (*Geranium*) Hort., (Ermington; Miss M. Flockton; July, 1915) showing fission of the stem An unusual acceleration of the growth of the plant has caused fission, the stem separating into a number of abbreviated branches. The inability of the plant to sustain these multiple stems resulted in a much reduced length of their internodal spaces, the prolification of their apices by dwarfed shoots bearing miniature leaves, and their generally attenuated growth. Striæ indicative of fasciation are absent.—*Persoonia myrtilloides* Sieb., showing the effect of environment on the foliage. Plants growing under luxuriant conditions at Leura (Leura Falls), have broad, comparatively soft leaves; an example from Mt. Victoria (Fairy Bower), was growing in the shade of closely packed, brush trees, and has elongated leaves; a specimen from Newnes Junction, growing on a dry ridge, has the small, harsh leaves of the xerophyte. It was noted that plants of this species, on the higher elevations of the Blue Mountains, remained green and apparently unscathed, after a bush fire had passed through, and devastated the surrounding vegetation.—*Lomatia longifolia* R.Br., (Springwood; A. A. Hamilton; September, 1914) showing leaf-variation. The leaves range from 1-9 inches long, with acuminate, acute, obtuse, emarginate to bifid apices, and are either gradually, or abruptly, narrowed into the petiole at the base; the petiole is from nearly sessile to 1 inch long; the margins are from almost entire to deeply toothed, and there is a considerable divergence shown in the relative proportion of length to breadth. —*Angophora cordifolia* Cav., (National Park; A. A. Hamilton; August, 1914): showing leaf-variation, from oblong to rotund, with obtuse to obovate apices, and cordate to reniform bases, the margins of the oblong leaves occasionally exhibiting constriction immediately above the base, similar to that shown by the "Fiddle Dock" (*Rumex pulcher* Linn.).—*Persoonia ferruginea* Sm., (Cook's River; A. A. Hamilton; December, 1914); leaf-variation is exhibited by this species, from oblong-lanceolate to rotund, apices acute, obtuse, obovate to orbicular, and ranging from 1-5 inches long. Some measurements are:—$4 \times 2\frac{1}{4}$, $3\frac{1}{2} \times \frac{3}{4}$, 3×2, $3 \times \frac{3}{4}$ inch.

Mr. North, by permission of the Curator of the Australian Museum, exhibited an example of the now extinct Phillip Island Parrot, *Nestor productus* Gould, its then restricted habitat being about five miles away from Norfolk Island. The specimen forms part of the "Old Collection," and nothing is known of its history beyond that recorded in the Register for 1875, No. 2933, "*Nestor productus* (extinct) Phillip Island." It was at that time a mounted specimen in the Exhibit Collection, but has since been reduced to a skin, and placed in a glass-jar. Formerly it was in spirits, which caused the dull yellow and red plumage of the underparts to fade so much as to render the specimen almost a uniform brown. This species is the smallest of the genus *Nestor*, the wing-measurement of the present specimen being only 9·6 inches. For comparison, the skin of an adult male of *Nestor meridionalis*, its nearest living ally, obtained at Titirangi, ten miles north-west of Auckland, North Island, New Zealand, on the 27th April, 1877, was shown. One of the best life-histories of the Phillip Island Parrot will be found in the folio edition of the "Birds of Australia," written by Gould, who originally described it, in 1836 (Proc. Zool. Soc. London), under the name of *Plyctolophus productus.* According to the late Professor A. Newton, M.A., of Cambridge, the last Phillip Island Parrot known to have lived, Gould saw in a cage in London, about the year 1851. The species became extinct about the middle of last century, and not more than a dozen specimens are believed to exist in collections. So far as is known, the present specimen is the only one in Australia. Mr. North also referred to the increasing scarcity, and danger of extinction of the Chestnut-shouldered Grass-Parrakeet, *Neophema pulchella* Shaw, restricted in its range to New South Wales and Victoria. In former years, this beautifully plumaged species was comparatively common in the neighbourhood of Sydney, being specially numerous in 1875, about Ashfield, Bankstown, and Rope's Creek. It has now, however, entirely disappeared from the environs of the Metropolis, nor had he heard of its having been found elsewhere; the last specimen received by the Trustees of the Australian Museum, being a young bird procured by the late Mr. J. A.

Thorpe at Hornsby in June, 1886. To show the scarcity of this species of recent date, Mr. A. S. Le Souëf, Director of the Zoological Gardens, Sydney, had informed him that, on 14th February, 1914, he paid the sum of £7 to a local bird-dealer, for the last living example in the possession of the Society; and that this was disposed of a few months later to an aviculturalist at the same figure. Many factors contribute to a decrease of bird-life in Australia, but the prime cause is the introduction of foreign mammals and birds. In the attempts to eradicate rabbits and foxes, it has, at a low estimate, cost the country many hundreds of thousands of pounds, and likewise a corresponding loss of bird-life. This is due to the birds partaking of poisoned baits, laid for rabbits, and the wholesale destruction of ground-frequenting birds by the wily fox, an introduced scourge, which is rapidly increasing in numbers and extent of range over the eastern half of the Australian Continent.

Mr. Musson and Mr. Fletcher exhibited a few botanical specimens from three localities close to the boundary between the Counties of Cumberland and Cook, of interest because the localities mentioned approximate to the western limit of some coastal species, and to the eastern limit of some Blue Mountain species. (*a*) *Acacia glaucescens*, *Persoonia oblongata*, and *Stypandra glauca*, growing in company by the roadside between Wilberforce and Sackville Reach (County of Cook). (*b*) *Angophora cordifolia*, *Grevillea buxifolia*, *Lasiopetalum Baueri*, *Acacia trinervata*, *Eucalyptus eximia*, *Persoonia oblongata*, *Grevillea mucronulata*, and *Stypandra glauca*, from the summit of a ridge overlooking the Hawkesbury at Sackville Reach (County of Cook). On the southern, sheltered aspect of this ridge, there was, formerly, a very interesting, semi-brush plant-community, of limited extent, now reduced to a narrow fringe on each side of the road. (*c*) *Persoonia lanceolata*, *Grevillea buxifolia*, *G. punicea*, and *G. mucronulata* growing in company by the roadside, on the Wiseman's Ferry Road to Windsor, between Marootta and Cattai Creek (County of Cumberland). The district indicated is rather inaccessible for visitors, except by motor-car, but botanically very interesting. The time available was far too short for any satisfactory collecting.

DESCRIPTIONS OF NEW SPECIES OF AUSTRALIAN COLEOPTERA. Part xi.

By Arthur M. Lea, F.E.S.

(Plate xlviii.)

Family SCARABÆIDÆ.

Bolboceras inconsuetum, n.sp. (Plate xlviii., fig.1).

Castaneous. Undersurface densely clothed.

Head irregularly concave; between antennæ subtriangularly elevated, the middle of the elevation triangularly notched in middle; with shallow feeble punctures, absent from basal portion; canthi acutely margined; mandibles evenly rounded. *Prothorax* (excluding the sublateral foveæ, which are rather larger than usual) with four not very large foveæ, two near the front margin immediately behind the eyes, and two behind these almost in the middle, the two median ones separated by a distinct transverse obtuse ridge, but each feebly connected with the one in front of it; a short subconical tubercle in line with the ridge and almost halfway between it and the side; sides with fairly dense but almost obsolete punctures, with some larger distinct ones irregularly scattered about. *Scutellum* impunctate. *Elytra* striate-punctate, thirteenth and fourteenth striæ irregularly conjoined towards base. Front *tibiæ* with five teeth; hind ones with two carinæ, between the subapical and base a row of small tubercles on each side. Length, 17 mm.

Hab.—Western Australia.

I have seen no species approaching this, except the following one, and am somewhat doubtful as to the sex of the specimen, despite the presence of prothoracic tubercles, which would certainly appear to be masculine; but the transverse ridge between these appears to be feminine. In any case, it is not likely to be confused with any other species. The two foveæ at the apex of the prothorax are not very large, but they are not small and deep as in Group 1; and since the clypeus and hind tibiæ are as in Group 2, it is better referred to the same. Regarding it as a male, it would, in Blackburn's table, be associated with *B. ingens*, from the description of whose head it differs very considerably; if regarded as a female, it might be added to Blackburn's table by a line as follows:—

BBB. Clypeal elevation furnished with two median angular projections.. *inconsuetum.*

The front of the clypeus is oblique and not traversed by a carina.

BOLBOCERAS VARIOLICOLLE, n.sp. (Plate xlviii., fig.2).

♂. Rather dark castaneous. Undersurface densely clothed.

Head with an obtuse semidouble tubercle between antennæ; front of clypeus vertical, the face surmounted by a narrow ridge truncated in its middle, each side with a somewhat curved ridge from behind canthus to in line with median tubercle, then directed towards middle of facial ridge but not joined to same; with dense and rather coarse punctures, but almost impunctate on a narrow space between eyes; canthi moderately concave and with coarse punctures; mandibles evenly rounded. *Prothorax* with four small subconical tubercles, placed in a somewhat crescentic form; sides with dense punctures, larger and more irregular about sublateral foveæ than elsewhere, with numerous, round, well-defined punctures irregularly scattered about, but denser on front margin than elsewhere. *Scutellum* impunctate. *Elytra* conspicuously striated but without punctures (or, at most, with very feeble ones) in the striæ, thirteenth and fourteenth conjoined towards base. Front *tibiæ* with five teeth; hind ones with two transverse carinæ, between the subapical one and base a row of small subtriangular tubercles on each side. Length, 18 mm.

Hab.—Queensland: Cunnamulla (H. Hardcastle).

The clypeus, hind tibiæ, and absence of frontal prothoracic foveæ are as in Group 2, Subgroup 1; of the species referred to that subgroup by Blackburn, it appears closest to *B. tenax*, but differs strikingly in the size of the cephalic and prothoracic projections, and in the absence of the four, large, prothoracic foveæ. The carina, called the clypeal elevation by Blackburn, is completely free from the ones he called the frontal margins, but this may not be constant. The tubercles on the prothorax are small, the two median ones are placed almost in a line with the inner edge of the eyes, and are about one-fourth from the apex, the space in front of them is almost vertical, but between them is sloping; the other tubercles are smaller, almost in a line with the front angles, and rather more distant from the apex; the margins are more conspicuously serrated than is usual; there are two small depressions between the sublateral foveæ and the median tubercles, and slightly nearer the latter than the former.

Bolboceras interruptum, n.sp. (Plate xlviii., fig.3).

Light castaneous. Undersurface densely clothed.

Head with two, small, isolated tubercles between base of antennæ, frontal margin* on each side conspicuously bisinuate and with a small tubercle almost in a line with the others, the apical ridge rather strongly curved, and the two conjoined at the middle of the apex, which is slightly overhanging; canthi rather strongly concave, outer apex conspicuously angulate; mandibles somewhat sinuous; with dense and rather coarse punctures almost throughout. *Prothorax* with a large median excavation having a central pit, with a moderately large marginal fovea behind each eye, a subconical obliquely placed medio-apical tubercle; with a conspicuous, strongly curved ridge, commencing inwards from the sublateral foveæ and almost in a line with the front angles, its middle slightly more distant from the base than the length of the scutellum; in front of it a strong ridge on each side abruptly terminated within the excavation; with dense and rather coarse punctures on most of the surface, and mixed with much smaller ones. *Scutellum* with dense and somewhat irregular punctures. *Elytra* punctate-striate, thirteenth and fourteenth striæ irregularly conjoined near base. Front *tibiæ* with six teeth, hind ones with six transverse carinæ. Length, 11-14 mm.

Hab.—Queensland: Cunnamulla (H. Hardcastle).

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* For the explanation of some of the phrases used for the head, see Blackburn, Proc. Linn. Soc. N. S. Wales, 1904, pp 485-486.

The four specimens before me, if males, would be associated with *B. bainbridgei*, but the sculpture of the prothorax is very different from that of this species. If females (they probably are such), they would be associated with *B. laticorne*, but the female of that species has the clypeus very different. The elevated parts of the head and the tibial teeth are black. The frontal margins are continued so far in front, that they actually meet in the middle of the front face of the clypeus, so that the clypeal elevation consists of a tubercular prominence instead of a carina; the middle area of the clypeus is practically absent, and the lateral areæ considerably enlarged, the frontal elevation is replaced by the small tubercles. The serration of the prothoracic margins is very feeble. The conspicuous ridges or carinæ of the prothorax may be regarded as remnants of concentric circles, of which a complete half of the outer one remains, and two fragments of the inner ones, the outer edges of the latter being obliterated, but the inner ones are abruptly interrupted and vertical, so that, from certain directions, the prothorax appears to be trituberculate, although in a very different way from *B. trituberculatum.*

POLYSTIGMA VITTICOLLE Macl. (Plate xlviii., fig.4).

There are two specimens of this species in the Macleay Museum; the markings are identical, and each is a female.

ABLACOPUS TÆNIATUS Schoch., var. MELANOPTERUS, n.var.

The varietal name is proposed for the form of which one was recorded* as having been taken by the late Mr. H. Elgner. There are two other females (from the Coen River) in the Macleay Museum, one of which agrees absolutely with Mr. Elgner's specimen, except that the pale patches on the clypeus are scarcely traceable; the other also agrees well except that the clypeus is entirely dark, that the spot on the mesosternal process is absent, and that the basal and apical markings of the pygidium are connected along the middle. The variety may be readily distinguished from the typical form by its entirely dark elytra and scutellum.

* Trans. Roy. Soc. S. Aust., 1914, p.170.

Family RHIPIDOCERIDÆ.

ENNOMETES RUFICORNIS Gray, var. RAMOSUS, n.var.

I cannot satisfy myself that a male from Cairns (E. Allen) represents more than a variety of *E. ruficornis*, but the antennal rami are much longer than in any specimen of that species before me. Thus, if the ramus of the third joint was pressed close to the rest of the antenna, it would extend to about the middle of the eleventh joint; in *E. ruficornis*, I have not seen it extending to the tip of the eighth joint, and it is usually much shorter; its angle with the joint is also different.

Family MALACODERMIDÆ.

ATYPHELLA OLIVIERI, n.sp.

♂. Whitish-flavous; head shining black; a large prothoracic blotch, a wide stripe on each elytron, metasternum, three basal segments of abdomen and appendages blackish. Finely pubescent.

Head mostly invisible from above; eyes occupying more than two-thirds of the entire surface. *Prothorax* more than twice as wide as long, sides rounded, front angles not defined, apex gently rounded, base distinctly wider than apex, disc somewhat unevenly convex; with a fairly distinct median line; with dense, and clearly defined, but rather shallow punctures. *Scutellum* rounded at apex, densely punctate. *Elytra* gently increasing in width to about the middle, and then gently decreasing; disc of each with four costæ, of which three are entirely within the black area, the fourth being partly outside it, and rather feeble; with dense punctures, smaller but deeper than on prothorax. Length, $6\frac{1}{2}$-$8\frac{1}{2}$ mm.

Hab.—Queensland: Cairns (E. Allen), Little Mulgrave River (H. Hacker).

In general shape, resembling *A. brevis*, but each elytron with a solid black vitta, in which the costæ are conspicuous only by their elevation; the vittæ are produced to the extreme base, but not to the apex, sides, or suture, so that the elytra appear to have two, wide, black stripes, and three, narrow, whitish ones.

The blotch on the prothorax extends across about one-fourth of the surface, and is subtriangularly produced in front. The two apical segments of the abdomen are uniformly whitish, except that the sides have a somewhat watery look. The legs vary somewhat in intensity of colour, and appear to be never quite black. There are 69 males before me, but no females.

Luciola majuscula, n.sp.

♂. Black ; prothorax, scutellum, sterna, coxæ, and base of femora flavous-yellow; two apical segments of abdomen white. Finely pubescent.

Eyes occupying about two-thirds of the surface of the head; the space between them with dense and rather small, but clearly defined punctures. *Prothorax* more than twice as wide as long, sides distinctly rounded, front angles rounded off, apex very obtusely produced in middle, base distinctly wider than apex, bisinuate, and with the hind angles subacute; surface somewhat uneven, and densely and coarsely punctate. *Scutellum* rounded and densely punctate. *Elytra* gently increasing in width to about the middle, and then gently decreasing; each with three strong costæ, and traces of a fourth, suture also raised; with very dense punctures, somewhat smaller than on prothorax. Apex of *abdomen* feebly produced in middle. Length, 11½; width, 5 mm.

Hab.—Queensland: Coen District (Henry Hacker).

Much larger, and proportionately wider than any other Australian species of *Luciola*. The prothorax also is of different shape from that of the other species having entirely dark elytra.

Family CANTHARIDÆ.

Zonitis distortipes, n.sp.

♂. Head, undersurface, antennæ, palpi, tarsi, and tips of tibiæ black or blackish; elytra metallic purple, with greenish reflections in parts; prothorax, scutellum, and balance of legs reddish-flavous. Upper surface glabrous.

Head elongate, widest across eyes, a transverse impression between same, from impression to neck about half the length as from same to apex, with sharply defined, and moderately dense but not coarse punctures. Eyes widely separated. Antennæ extending almost to apex of elytra, third joint fully once and one-half the length of second. *Prothorax* about as long as wide, sides strongly diminishing in width from middle to apex, and feebly incurved between middle and base; median line almost continuous throughout, inflated on basal half, a vague transverse impression on each side at apical third; with comparatively small and rather sparse, but distinct punctures. *Elytra* densely, moderately strongly, and rugosely punctate, the interstices subvermiculate, and with very fine punctures. Front *femora* subdentate on upper surface near apex. Length, 9 mm.

Hab.—West Australia: King George's Sound (Macleay Museum).

Near the description of *Z. flavicrus*, but scutellum pale, hind tibiæ entirely and the major portion of the others pale, and elytra diminishing in width posteriorly. In colour, it is somewhat like the variety of *Z. rugosipennis* with red prothorax, but the elytra are much more wrinkled, although with smaller punctures, and femora entirely pale. The scutellum also is not black. From *Z. hakeæ*, it is distinguished by its paler legs, differently shaped prothorax, and much smaller cephalic punctures. Both *Z. murrayi* and *Z. brevicornis* have a shorter and paler head, differently formed prothorax, and more finely wrinkled elytra. *Z. cyanipennis* has more finely sculptured elytra, and stouter antennæ, with their second joint much shorter. From in front or behind, the upper surface of the front femora appears to have been pared down from the base to near the apex, leaving, near the apex, a subdentiform projection. But this is a sexual character.

Zonitis bimaculicollis, n.sp

Deep black, prothorax (except for a small, round, dark spot on each side of middle), and apical half of abdomen reddish-flavous. Pubescence of upper surface sparse and indistinct.

Head rather short, widest across eyes, vaguely impressed across middle, from clypeal suture to apex of labrum slightly shorter than from same to neck; with dense, and rather coarse and rugose punctures. Eyes widely separated and obliquely placed. Antennæ comparatively short and fairly stout, third joint almost twice the length of second. *Prothorax* about as long as wide, sides evenly rounded from middle to apex, and distinctly incurved between middle and base, the latter not twice the width of apex, median line feeble and irregular; with dense and coarse punctures. *Elytra* comparatively wide, parallel-sided to near apex: densely vermiculately rugose-punctate. Length, 7 mm

Hab.—West Australia: Swan River (A. M. Lea).

In Blackburn's table, would be associated with *Z. subrugata*, from which it differs in its somewhat thinner antennæ and legs,* with the second joint of the former distinctly shorter; flatter and spotted prothorax of very different shape, and with much coarser punctures. From *Z. brevicornis*, whose prothorax is normally bimaculate, it differs in many details of colour, and in being much more coarsely sculptured. It is, in fact, not very close to any other species known to me.

Zonitis pubipennis, n.sp.

Of a dingy flavous-red, elytra somewhat paler, antennæ (except the base, or the base and apex of each joint), palpi and legs (except the coxæ and trochanters) more or less black. Elytra with dense, short, whitish pubescence, rest of upper surface much more sparsely but moderately distinctly clothed.

Head rather short, widest across eyes, basal half with an impunctate median line; clypeal suture rather strongly curved, from same to apex of labrum distinctly shorter than from same to neck; with sharply defined and moderately dense, but not very large punctures. Eyes rather large, separated slightly more than length of basal joint of antennæ. Antennæ long and thin, third joint distinctly longer than second. *Prothorax* slightly longer than wide, sides regularly decreasing in width from middle to apex, and moderately incurved between middle and base, median line short, punctures somewhat sparser but otherwise as on head.

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* A cotype of *Z. subrugata* has decidedly stouter antennæ and legs than those of any other species before me.

Elytra rather narrow; with very dense, rather small, sharply defined, non-confluent punctures. Length, 8 mm.

Hab.—N.S.W.: Forest Reefs (A. M. Lea).

As the third joint of the antennæ is almost once and one-half the length of the second, the species should be referred to "AA," in Blackburn's table, and, in that group, it would be associated with *Z. murrayi* and *Z. subrugata*, with which it has little in common. The antennæ are thin and extend almost to the tip of the elytra, but I do not regard them as "extremely slender" for the genus. *Z. helmsi*,* which is so distinguished in the table, certainly has thin antennæ, but they are not particularly long, in fact they are distinctly shorter than in many species of the genus, and with the second joint quite unusually short. The eyes are almost as large as in *Z. picticornis*, but are not quite so close together, and the elytral punctures are different, being somewhat similar to those of *Z. melanoptera*; but the two species are otherwise very different. From *Z. pallicolor*, it differs in its entirely dark femora, antennæ with the joints pale at the base, prothorax more noticeably pubescent, and punctures on same slightly larger.

ZONITIS XANTHOSOMA, n.sp.

Flavous, antennæ (two or three basal joints excepted) black; palpi, tarsi, and sometimes tips of tibiæ more or less infuscated. Elytra with dense and very short pale pubescence, rest of upper surface almost glabrous.

Head rather short, widest close to base, almost evenly convex; from clypeal suture to apex of labrum about half as long as from same to neck; with clearly defined, and not very large punctures, somewhat irregularly distributed. Eyes widely separated and not very large. Antennæ rather thin, extending almost to apical segment of abdomen, third joint of antennæ not much longer than second. *Prothorax* not quite as long as the greatest width, which is distinctly nearer apex than base, sides moderately incurved between middle and base, apex comparatively wide and distinctly incurved to middle; with rather small punctures, fairly numerous

* The type of which is before me.

on sides but rather sparse elsewhere; median line rather feeble, a vague impression on each side of middle towards base. *Elytra* comparatively wide, slightly dilated posteriorly; with dense and minute, but clearly defined punctures, and with remnants of feeble ridges. Length, 10-12 mm.

Hab.—North-West Australia (Macleay Museum).

The second joint of antennæ is almost as long as the third, so that the species should be referred to "A" (in Blackburn's table), its position in which would be with *Z. tenuicornis*, which has differently coloured undersurface and legs, punctures of head and prothorax, and the shape of the latter different. In general appearance, it is close to *Z. pallicolor*, but the eyes are decidedly narrower, prothorax wider, with smaller punctures; elytra wider, with smaller punctures (but still sharply defined), and more of the legs pale, etc.

Family CURCULIONIDÆ.

PERPERUS ZICZAC, n.sp.

Of a dingy reddish-brown, in places almost black. Densely clothed with pale brownish-grey scales, becoming almost white, but with a metallic lustre on undersurface and legs; elytra with darker markings. In addition, with fairly numerous, depressed or subdepressed setæ.

Head with punctures normally concealed. Rostrum rather long, with two grooves along middle, sublateral sulci fairly deep but partially concealed. Antennæ thin, scarcely extending to base of elytra; second joint of funicle slightly longer than first. *Prothorax* rather lightly transverse, sides strongly rounded, with a moderately distinct but not continuous median groove; with dense granules, some rounded but many oblique or transverse. *Elytra* ovate-cordate, widest across middle, where the width is almost twice that of prothorax; with regular rows of large, partially concealed punctures; interstices regular and evenly convex. Basal segment of *abdomen* slightly longer than second and third combined, second almost as long as third and fourth combined. *Legs* rather long. Length, 11-13 mm.

Hab.—Queensland: Port Denison (Macleay Museum).

In general appearance close to *P. turgidus*, but second abdominal segment almost as long as third and fourth combined, and scutellum absent. On the elytra, the dark markings are rather sharply contrasted; they commence on each shoulder, about the middle are abruptly turned inwards, then outwards, and then terminate in a zigzag line at summit of posterior declivity. The prothoracic granules cause the surface to appear somewhat vermiculate; they are completely covered by scales, but easily traceable through them.

POLYPHRADES AMPLIATUS Pasc.

P. setosus Lea.

A cotype of *P. ampliatus*, sent for examination, proves to be the same as *P. setosus*, over which it has priority. Although its clothing was described as "albis vel subargenteis," the cotype is greyish without the least silvery gloss, and all the numerous specimens of the species, that I have seen, have opaque clothing.

POLYPHRADES PUSILLUS Pasc.

(?)*P. ortyx* Pasc.

A cotype of *P. ortyx*, sent for examination, agrees well with a species I have long had as *P. pusillus*,* and apparently correctly so. *P. ortyx* was described immediately after *P. pusillus* (a species sexually and individually variable—as are so many others of the genus); if really distinct, the differences need to be specified.

ZEPHRYNE LATICEPS, n.sp.

Black or blackish; appendages in parts more or less obscurely reddish. Densely clothed with greyish scales, somewhat variegated with brown. In addition, with fairly numerous, recurved setæ.

Head wide and depressed between eyes, and with a small but conspicuous lobe below each of these. The eyes themselves laterally prominent and distinct from above. Rostrum short, strongly increasing in width to base; with four rather feeble ridges, but each side at base with a very conspicuous tubercle.

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* From Champion Bay; the cotype is also labelled as from Champion Bay.

Antennæ rather short and thin. *Prothorax* almost as long as wide, sides feebly rounded; with a vague median depression, and with large punctures clearly indicated through clothing. *Elytra* suboblong, much wider than prothorax; with rows of large punctures, partially concealed by clothing; alternate interstices elevated, and the third and fifth with tubercles. *Undersurface* with large punctures indicated through clothing. *Legs* rather short. Length, 4-4¼ mm.

Hab.—West Australia: Beverley(A. M. Lea), Fremantle.

In general appearance, quite a typical species of the genus, but the head, although wide and depressed between the eyes, and with infra-ocular lobes, has no crest above each eye, and these are quite distinct from above. There is, however, a very strong tubercle on each side at the base of the rostrum, slightly in front of the eye. The third tarsal joint is no wider than the second, and is not deeply bilobed. On two specimens, the scales on the elytra and legs are almost uniform, the brown being but little in evidence. But on a third, the elytra are conspicuously variegated, the majority of the scales being brown verging to sooty, and there are two, conspicuous, irregular, pale fasciæ, one near the base, the other crowning the posterior declivity; its prothorax is rather conspicuously alternately striped with brown and grey scales. On the elytra, the third interstice has an obtuse but fairly distinct tubercle at the base, one before and one behind the middle, and a large conical one at summit of the posterior declivity; the fifth has one before, and one at middle, one crowning the posterior declivity, and one below same; there is also a small tubercle where the third and fifth are conjoined near apex. On the other specimens, the only fairly conspicuous tubercles are those on or about the summit of the declivity, the others, however, being indicated by slight swellings, with darker scales than on the adjacent surface.

Ethemaia ferruginea, n.sp.

Densely clothed with rusty-brown scales, everywhere concealing the derm, except for parts of the appendages. In addition, with a few suberect, stout setæ.

Head wide, with a slight median line; each side depressed close to the eye, but between depression and eye a strongly elevated subconical tubercle. Rostrum short and wide, with a rather strong, obtuse ridge, on each side towards the base. Antennæ rather short and stout, scape about the length of funicle. *Prothorax* moderately transverse, widest slightly in advance of the middle, somewhat constricted near apex; with coarse, normally concealed punctures. *Elytra* short and broad, considerably wider than prothorax, sides diminishing in width from near base; with rows of large, round, almost concealed punctures; alternate interstices lightly elevated, the fifth with a tubercle just below summit of posterior declivity. *Legs* rather short. Length, $3\frac{3}{4}$ mm.

Hab.—N.S.W.: Forest Reefs (A. M. Lea).

The position of this species is open to question. As its third tarsal joint is slightly wider than the second, and rather deeply bilobed, and as there are no infra-ocular lobes, it would appear to belong to *Ethemaia*, and to be distinguished from *Zephryne*, a position that would be suggested by its short elytra, and large supra-ocular crests concealing the eyes from above. The eyes themselves are subtriangular in shape. As it appears undesirable to propose a new genus for it, it has been provisionally referred to *Ethemaia*. On the type, the derm, except for parts of the appendages, is everywhere concealed, but it is probably entirely black, as are the claws. Its clothing is almost uniform in colour throughout, but may be slightly mixed with dirt, so that additional specimens may prove to have the clothing more variegated. As the species, however, is structurally very distinct, it has been described. Seen obliquely from behind, the base of the rostrum appears to be composed of four strong lobes.

OPHRYOTA SUBANGULATA, n.sp.

Very densely clothed with muddy-brown scales, with rather sparse, stout, suberect or depressed ones scattered about, and thinner and more conspicuous on the legs than elsewhere.

Head wide and depressed between eyes; above each eye a strong rounded crest, and below each a small but conspicuous lobe. Rostrum wide, with a wide median groove, with a semidouble ridge on each side, becoming single above front of scrobe (which is very conspicuous from above). Antennæ short. *Prothorax* about as long as wide, widest and subangularly dilated in advance of the middle, apex about as wide as base, and obtusely bilobed in middle, transversely impressed near apex, and rather widely grooved along middle; with coarse, concealed punctures. *Elytra* suboblong, much wider than prothorax; with rows of very large punctures, readily traceable through scales; alternate interstices irregularly elevated, third produced and subtuberculate at base, with a small tubercle before, and a large conical one at, summit of posterior declivity; fifth with a conspicuous oblique elevation near base, and a distinct tubercle at, and another below, summit of declivity; each shoulder with a conspicuous conical tubercle. *Legs* moderately long. Length, 9½-10 mm.

Hab.—South Australia: Macleay Museum, and A. Bovie.

Close to *O. nodosa*, but prothorax subangularly dilated in middle, and fifth interstice conspicuously elevated and somewhat oblique towards base. The derm is normally entirely concealed; but, where I have abraded the type, it is seen to be black. The clothing is entirely without pattern on the two specimens before me, but possibly on fresh ones some pattern would be in evidence.

MYOSITTA MELANOSOMA, n.sp.

♂. Black; rostrum, scape, and legs more or less reddish, apical half of abdomen diluted with red. Moderately clothed with white, depressed setæ or thin scales, denser on sides of undersurface than elsewhere.

Head with fairly dense punctures. Rostrum about the length of prothorax, almost straight; basal third with dense and rather small punctures, sparser and much smaller elsewhere. Scape thin, almost as long as funicle and club combined; funicle very little longer than club. *Prothorax* about as long as its greatest width, sides feebly increasing in width from apex to near base; with dense and rather small, but sharply defined punctures. *Elytra* moderately long, distinctly wider than prothorax, subparallel-sided to near apex; with rows of rather large punctures, becoming small posteriorly. *Metasternum* with a wide, vague, median depression. Two basal segments of *abdomen* with a wide depression, common to both. *Femora* stout, strongly dentate. Length, 5 mm.

Hab.—N.S.W.: Sydney, on flowers of *Banksia marginata* (H. W. Cox, his Nos.118 and 2688).

Very distinct from all previously described species; but in structure approaching *M. cirrifera*, *M. carpophaga*, and *M. sublineata*. Of the two males before me, one has the legs, except for the third tarsal joint, entirely reddish; while the other has them considerably darker, only the claw-joint being decidedly reddish. A specimen, evidently the female, differs in being larger (6 mm.), scutellum, elytra (except apex), and sterna black, and all the rest more or less reddish. Its metasternum, except for the medio-apical impression, is evenly convex, and the two basal segments of the abdomen are evenly convex.

MYOSITTA TESSELLATA, n.sp.

♂. Pale reddish-castaneous. Moderately clothed with depressed stramineous setæ or thin scales, giving the elytra a tessellated appearance, and denser on sides of undersurface than elsewhere.

Head with fairly dense punctures; a vague depression between eyes. Rostrum lightly curved, slightly longer than prothorax, with rather dense and small punctures becoming slightly larger about base. Scape thin, almost as long as funicle and club combined, club about as long as the five preceding joints combined. *Prothorax* moderately transverse, sides constricted near apex, then rather strongly dilated to near base, and then decreasing to base itself; with dense and moderately coarse punctures. *Elytra* much wider than prothorax, shoulders rounded, sides decreasing in width from near base; with rows of fairly large, subquadrate punctures, becoming smaller and more rounded posteriorly. Two basal segments of *abdomen* with a wide, shallow depression, common to both. *Femora* stout, strongly dentate. Length, $4\frac{1}{4}$-$4\frac{1}{2}$ mm.

♀. Differs in having medio-apical impression of metasternum somewhat narrower, two basal segments of abdomen evenly convex, and rostrum slightly thinner, with smaller punctures.

Hab.—S.A.: Myponga, on *Banksia marginata* (H. H. D. Griffith).

In general appearance, fairly close to *M. banksiæ*, but elytra with fairly dense, depressed clothing, instead of with series of semi-upright setæ. From *M. rufula*, it differs in being shorter, prothorax more transverse and differently shaped, and femoral teeth stronger; the elytral clothing is also less conspicuously spotted, although more so than on *M. carpophaga*. In build, it is very close to *M. melanocephala*, but the head and rostrum are not black. From the description of *M. tabida*, it differs in having the punctures on the rostrum moderately distinct, the prothorax distinctly transverse, and the elytral punctures different. On the elytra of that species, they are stated to "appear in certain lights to be surrounded by a paler ring." On the four typical specimens, I can see no such appearance, and the punctures are more or less quadrate or oblong.*

Myositta rufula, Pasc.

Three specimens before me appear to belong to this species. One is from South Australia (Myponga, in Coll. Griffith), the others are from Tasmania. In general appearance, they are close to *M. carpophaga*, but differ in being darker, and the elytral clothing forming moderately distinct spots.

Family CHRYSOMELIDÆ.

Calomela (Platymela) unilineata Baly.

Of this species, three specimens were known to Baly, one of them being described as a variety. A specimen (from the Richmond River) may represent another variety; it differs from the description in having the head black, with two green spots at the base; the prothorax has the pale median line of the type, but parts of the base are also pale. It was mounted on a card with two specimens of *P. sticticollis*, and I believe it to be a variety of that species, with the three black spots on each side of the prothorax extended to form an irregular blotch on each side.

* The punctures in other genera, when apparently so surrounded, are round.

CALOMELA SATELLES Blackb., var. VIRIVORA, n.var.

There are numerous specimens before me, from Beverley, that agree well with some cotypes and other specimens of *C. satelles*, except that the elytral punctures are rather more regular, and the markings more extended; on the cotypes and some South Australian specimens of *C. satelles*, the paler sutural portion of the combined elytra is much wider than the metallic portion of each; but, on the Beverley specimens, the metallic marking on each extends to within one interstice of the suture (except near the base) and one of the side, covering practically the same area as on *C. curtisi*, although differing in many respects from that species, and with the washed-out look of *C. satelles* On a specimen, placed with *C. satelles* in Coll. Blackburn, the elytra are almost uniformly coloured throughout, the metallic appearance having a still more washed-out look, and extending to practically the suture and sides. At Beverley, specimens were so numerous on a shrub of the dangerous "York Road" poison (*Gastrolobium* sp.) that it was almost defoliated.

CALOMELA SUBLINEATA, n.sp.

Black with a green, or brassy-green or brassy gloss, labrum, antennæ, and palpi of a dingy red, undersurface and legs darker, with a more or less metallic-green gloss.

Head with crowded punctures of moderate size, and, in places, obliquely confluent, with a narrow but shining and distinct median line; clypeal suture well defined but not deep. Antennæ rather thin, extending to about middle of metasternum. *Prothorax* more than twice as wide as long, sides gently rounded and widest at about basal fourth; with crowded and fairly large punctures on sides, much smaller and sparser elsewhere. *Elytra* moderately long, parallel-sided to near apex; with subgeminate rows of not very large punctures, larger behind shoulders than elsewhere, with minute scattered punctures on interstices. Intercoxal process of *prosternum* depressed along middle, and with some large punctures, base strongly notched. *Claws* rather strongly dentate. Length, 7$\frac{3}{4}$-8 mm.

Hab.—W.A.: Kalgoorlie (C. French), Kellerberrin (H. J. Carter).

From *C. prosternalis*, it differs in its less uniform colours, and absence of shagreening from the upper surface, the colours being very different from those of *C. imperialis*, and it is distinctly narrower than that species. In general appearance, it is close to *Chrysomela australica*, but all the claws are conspicuously armed. The punctures generally have a conspicuous greenish gloss, so that, in some lights, the elytra appear to be alternately irregularly striped with green (the series of punctures), and brassy or brassy-blue (the interstices).

Calomela subtuberculata, n.sp.

Dark metallic green, in places with a purplish or bronzy gloss, undersurface blackish, with a bluish gloss, antennæ (apical half infuscated), palpi, and labrum of a dingy red, legs darker, with a metallic gloss.

Head with crowded and fairly large punctures; clypeus depressed, with smaller and denser punctures than elsewhere. Antennæ comparatively long and thin. *Prothorax* almost thrice as wide as median length, sides rather strongly rounded, with large (larger on sides than elsewhere) and irregularly distributed punctures, and with minute scattered ones. *Elytra* elongate; with rather dense punctures, smaller about suture, and larger towards sides than elsewhere. *Prosternum* with coarse punctures in front, towards each side with conspicuous, transverse, and oblique impressions, and with a deep curved one; intercoxal process grooved and punctate along middle, base notched. *Claws* strongly and acutely dentate. Length, 9½ mm.

Hab.—Queensland: Dawson River (Macleay Museum).

At a glance like a rather dull specimen of *C. imperialis*, but with much coarser punctures, and the elytral ones not in almost perfectly regular series as on that species; on most species in which the elytral punctures are in series, these are usually eleven in number and well-defined, but, on the present species, the series (except near the suture) are but little in evidence, and certainly many more than eleven in number; the apical parts, in some lights, appear to be wrinkled. The prothoracic punctures are coarser even than on the roughly sculptured form of *C. ioptera* (and, owing to their irregular distribution, they cause the surface to appear subtuberculate in places), but those on the elytra are distinctly smaller. No other species approaching it has been recorded from Queensland, except *C. punctifrons* and *C. fugitiva*; and it differs from the descriptions of those species in being much larger, more soberly coloured, and markings and punctures different. On the elytra, the suture and a space towards each side are bronzy with a purplish gloss, but, from certain directions, those parts appear obscurely green, and the rest of the elytra of a dingy purple; from certain directions also, almost any part of the prothorax may appear purplish or greenish.

Calomela regalis, n.sp.

Brightly metallic, undersurface and legs black, with a bluish or greenish gloss, labrum, parts of base of antennæ, parts of palpi, knees and claws obscurely reddish.

Head with densely crowded punctures, and a distinct median line; clypeus slightly depressed, suture distinct. Antennæ moderately thin, just passing middle coxæ. *Prothorax* more than twice as wide as long, sides moderately rounded, and with crowded and rather large punctures, smaller, sparser, and somewhat irregularly distributed elsewhere. *Elytra* elongate; with numerous rows of not very large but well-defined punctures, larger towards sides and smaller about suture than elsewhere, on apical slope more or less wrinkled. Intercoxal process of *prosternum* grooved towards, and notched at, base. *Claws* strongly and acutely dentate. Length, $7\frac{1}{4}$-$7\frac{3}{4}$ mm.

Hab.—N.S.W.: Whitton (A. M. Lea).

I previously had identified this, from description, as *C. imperialis*,* and, in fact, the description of that species fits the specimens before me so well, except that they are slightly smaller, and that the prothoracic punctures are rather denser than is suggested by the description (both features commonly variable

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* The position assigned to *C. imperialis* in my table, agrees with both that species and the present one.

in the genus), that it is desirable to point out their distinguishing features. The type of *C. imperialis* is slightly larger, the prothoracic punctures are not quite so dense; but, in particular, the elytral punctures are in quite regular series, with wide interstices, of which there are, altogether, eleven rows (including the short scutellar row, and the marginal one) on each elytron; but, on the present species, the rows are much more numerous, and consequently closer together, the distance between the rows being much the same as that between puncture and puncture: on the disc, the distance between the rows is nowhere half the width of the scutellum: whereas, on *C. imperialis*, the distance between the rows is sometimes quite equal in width to the scutellum, and never less than half its width. The antennæ are almost entirely black; one specimen has the palpi entirely black. The metallic colours vary from coppery or golden, through green and blue, to violet or purple; on the head and prothorax, they are irregularly distributed, and alter from every point of view, the main colours, however, being brassy-purple; on the elytra, they appear to be in more or less regular stripes, varying with the point of view, and not alike on any two of the three specimens before me; on the type, starting from the suture, the colours are green, coppery-green, purple, bluish-green, coppery-green, bronzy, and blue, the colours more or less running into each other.

Calomela bimaculiceps, n.sp.

Pale castaneous, head with two round metallic-blue spots, knees metallic-blue, parts of tibiæ with a bluish gloss, six or seven apical joints of antennæ black or infuscated.

Head with minute and moderately large punctures, the latter more numerous between and behind eyes than elsewhere; clypeal suture not conspicuously impressèd, but with a few distinct punctures, the clypeus itself with denser punctures than elsewhere. *Prothorax* slightly more than twice as wide as long, sides moderately rounded; with numerous minute and moderately large punctures, each side with a shallow depression in which the punctures are denser than elsewhere. *Elytra* slightly wider than prothorax, parallel-sided to near apex, with regular rows of fairly large punctures becoming smaller posteriorly, interstices with minute but fairly numerous punctures. Intercoxal process of *prosternum* ridged along middle, a narrow groove on each side, base gently bilobed. *Claws* strongly and acutely dentate. Length, 6¼-7 mm.

Hab.—N.S.W.: Richmond River (W. W. Froggatt).

The general outlines are much the same as thoss of the species of *Platymela*, but the intercoxal process of the prosternum, whilst not conspicuously bilobed as on most species of *Calomela*, has not the gentle, even incurvature between the outer edges of its base as on the former. It is much the shade of colour of *C. monochromatea*, but the head is bimaculate and the knees metallic; the outlines, except that the sides of the prothorax are more rounded, are much as in *C. geniculata*, *C. flavescens*, and *C. cephalotes*. The metallic colour of the legs is more extended on one specimen than on another. At a glance, the elytral punctures, of the two specimens under examination, appear to be much larger than they really are, their apparent width being almost equal to the interstices between them, but this is due to "waterlogging"; their true size may be readily noted from an oblique direction.

CALOMELA VACILLANS, n.sp.

Castaneo-flavous, apical third of antennæ infuscated.

Head with dense and moderately large punctures; clypeal suture distinct. Antennæ rather short, sixth to tenth joints transverse. *Prothorax* more than twice as wide as long, basal two-thirds almost parallel-sided; sides with coarse and rather dense punctures, becoming much smaller and sparser in middle, with minute ones scattered about. *Elytra* slightly wider than prothorax, sides very gently rounded; with rather coarse punctures in places in very irregular series, on apical slope smaller, and behind shoulders larger than elsewhere. Intercoxal process of *prosternum* grooved towards, and deeply notched at, base. Length, 5¼ mm.

Hab.—Queensland: Cunnamulla (H. Hardcastle; unique).

In general appearance like *C. tarsalis*, or a very small *C. pallida*, but, on those species, the series of punctures on the elytra are quite easily counted; on all the other pallid species (including an immaculate variety of *C. crassicornis*), the elytral punctures are in more or less regular series. All the claws are thickened towards base, and, although not acutely dentate, from certain directions a subdentiform extension may be seen on each; the species has, therefore, been referred to *Calomela*, but might have been, with almost equal justice, referred to *Chrysomela*.

Phyllocharis jansoni Baly.

There are numerous specimens before me (from Mackay to the Coen River) belonging to this species, or to varieties of the same, but only one agrees entirely with the original description. All the others have the undersurface (except most of the abdomen) pale, and the femora (knees excepted) also pale; the scutellum is sometimes infuscated, but is usually pale. On the typical form, the postscutellar spot extends as a wedge to well beyond the middle; on one specimen, it is continued until it becomes conjoined with the subapical spots.

Var. A.—By the description, differing from the typical form only in the colour of the legs; I have not seen such a variety; the nearest to it being a specimen that has two small spots on the prothorax, forming, with the one on the head, the corners of an equilateral triangle; its postscutellar spot is short, wider than long, and with its apex trilobed.

Var. B.—A specimen (from Somerset, the locality of the variety) is evidently Jacoby's var. B; its prothoracic spots are large and of irregular size, the cephalic spot is also of large size.

Var. C, n.var. Head with a feeble, infuscate spot, prothorax immaculate, elytra dark metallic-blue, margins and base pale.

Var. D, n.var. Head with a feeble, infuscate spot, prothorax immaculate, postscutellar not extending to beyond the posthumeral ones, and rounded or truncate at its apex; one specimen differs in having the posthumeral spots connected with the subapical ones.

PHYLLOCHARIS SCULPTICEPS, n.sp. (Plate xlviii., fig.5).

Reddish-flavous; scutellum, shoulders, a subapical spot and two fasciæ on elytra, antennæ, knees, tibiæ and tarsi more or less purplish.

Head conspicuously sculptured, and with fairly large, scattered punctures. Antennæ stout, six basal joints shining, the others densely pubescent. *Prothorax* almost twice as wide as long, front angles somewhat rounded, hind ones rectangular; towards each side with numerous large punctures, a few smaller ones scattered about elsewhere. *Elytra* narrow, almost parallel-sided, distinctly wider than prothorax; with numerous rather small but distinct punctures, in almost regular series near base, but very irregular elsewhere, with a vague, transverse impression behind each shoulder. Intercoxal process of *prosternum* with apex not separately convex, base wide and almost truncate. Length, 6½-7 mm.

Hab.—Northern Territory: Darwin (N. Davies).

Allied to *P. hieroglyphica*, but prothorax and head almost immaculate, elytra without a large spot conjoined to suture on each side of base, markings otherwise different and femora mostly pale; the size and outlines are somewhat similar, but the punctures are not so coarse. There is a vaguely infuscate spot on the head, and a still more vague one on the prothorax; the elytral markings are of a beautiful purple, the humeral spots are slightly larger than the scutellum, and slightly smaller than the subapical one, the fasciæ, at a glance, appear to be continuous, but really do not quite touch the suture, the first at about the basal third, the second just beyond the middle; on the left elytron of one specimen, a vitta narrowly conjoins the two. The impressions on the head consist of a short groove close to each eye, inwards of each of these an oblique groove, the two meeting in the middle of the base, inwards of these are two oblique elevations conjoined posteriorly so as to become V-shaped, and close to the base of each antenna is a rounded elevation. One specimen has the elytra more bluish than purple, and with the pale markings reduced to an irregular oblique patch on each side of the scutellum, and a small space at the apex; the suture, however, is narrowly obscurely reddish throughout, its prothorax is immaculate, but the spot on the head is fairly well defined.

PHYLLOCHARIS VITTICOLLIS, n.sp.

Flavous, a wide median vitta on prothorax, scutellum, eight large spots on elytra, parts of the pro- and meso-, and flanks of metasternum, antennæ and legs, brassy-brown or black.

Head almost impunctate; clypeal suture semicircular, but an oblique impression connected with each side of same to near hind margin of eye. Antennæ rather stout, six basal joints shining, the others densely pubescent. *Prothorax* about thrice as wide as long, sides parallel except in front, front margin distinctly incurved to middle; with a patch of rather large punctures on each side of base, and a few small ones scattered elsewhere. *Elytra* conspicuously wider than prothorax, shoulders regularly, the sides gently, rounded, a distinct impression on each side at base, and a shallow one behind each shoulder; with rows of distinct but not very large punctures, becoming smaller and irregular towards sides and apex. Intercoxal process of *prosternum* with apex scarcely separately convex, base obtusely bilobed. Length, $6\frac{1}{4}$ mm.

Hab.—Queensland (H. J. Carter; unique).

In general appearance, strikingly close to the typical form of *P. cyanicornis*, but prothorax much shorter in proportion, with a wide median vitta continuous from base to apex, not quite parallel-sided, and covering rather more than one-third of the surface, and without lateral spots; the elytra also are somewhat wider, are widest near the base instead of beyond the middle, and the spots, although the same in number and position, are not quite the same, the medio-sutural one being notably wider, the depression between each shoulder and the suture is also deeper. On the elytra, there are two, large, round spots close to the scutellum, a somewhat oblique one on each side behind the shoulder, a large one (wider than the head) on the suture between these, two transverse ones at about the apical third, and a sutural one at apex.

RHÆBOMELA, n.g.

Antennæ long and filiform. Apical joint of maxillary palpi short and conical. Epipleuræ of *elytra* moderately wide at base, gradually narrowed to apex, flat or gently convex throughout. Intercoxal process of *prosternum* not conspicuously elevated above the adjacent parts, very wide, base and apex very gently incurved to middle; front coxal cavities widely open behind. Middle *tibiæ* strongly curved at base; claws each with a large, suboblong, basal appendix.

Allied to *Phyllocharis* and *Chalcolampra*, but front coxal cavities conspicuously open behind; on those genera, they are closed, although with an oblique suture behind each; the intercoxal process of the prosternum is wider than in any other Australian genus of the subfamily. The sexual differences of the males are suggestive of many of the *Eumolpides.* The typical species is *R. maculata*; a second species is somewhat narrower, and its intercoxal process, although much wider than in any other genus of the subfamily, is slightly longer than wide; its middle tibiæ are also not so curiously formed.

RHÆBOMELA MACULATA, n.sp. (Plate xlviii., fig.6).

♂. Flavous, prothorax with a median vitta dilated to base, and elytra with ten spots black with a brassy-green gloss, antennæ black, tip of apical joint and four basal joints, or parts of same, flavous.

Head impunctate; clypeal sutures well defined but not deep. Antennæ with five basal joints shining and sparsely clothed, the others densely pubescent and somewhat stouter, third and fifth joints slightly longer than the adjacent ones. *Prothorax* more than twice as wide as long, sides gently rounded, subparallel towards base, hind angles somewhat acute; with rather sparse and small or minute punctures, a few well-defined but not large ones at extreme base. *Scutellum* subtriangular and impunctate. *Elytra* distinctly wider than prothorax, shoulders evenly, the sides very gently, rounded; without striation, but with regular rows of not very large but conspicuous punctures, interstices with minute, scattered punctures. *Legs* moderately long; femora unarmed; front tibiæ somewhat dilated about apex, with the dilated portion gently incurved on one side; middle tibiæ strongly curved on basal half, inner side with a narrow ridge, about apex much as front pair; third tarsal joint widely dilated. Length, 5 mm.

Hab.—Queensland: Mulgrave River (H. Hacker).

On the elytra, there is a small spot on each side at the base, and one common to both on the apical slope; the others are in two transverse series, the first of these consisting of three spots, of which the largest is sutural; the second is just beyond the middle, and consists of four irregularly rounded spots.

RHÆBOMELA FASCIATA, n.sp. (Plate xlviii., fig.7).

♂. Flavous, two small spots (sometimes conjoined) at base of prothorax, and two elytral fasciæ black, appendages partly or entirely pale.

Head impunctate, or almost so; clypeal sutures shallowly impressed. Antennæ elongate, joints more or less cylindrical. *Prothorax* about twice as wide as long, sides gently sinuous, hind angles acute, front margin regularly incurved to middle; with minute scattered punctures, and some of larger size (but not very large) on each side of base. *Scutellum* subtriangular, impunctate. *Elytra* distinctly wider than prothorax, shoulders regularly, the sides feebly, rounded; with regular rows of conspicuous but not very large punctures; the interstices with minute scattered punctures. *Legs* moderately long; femora unarmed; front tibiæ with apical third inflated, and lower margin of inflated part gently incurved. Length, 5-5¾ mm.

♀. Differs in having somewhat shorter antennæ, front tibiæ simple, and basal joint of each tarsus distinctly smaller.

Hab.—Queensland: Cairns (E. Allen).

Rather narrower than the preceding species, and with the middle tibiæ scarcely different from the hind ones; the sexes are readily distinguished by the front tibiæ. The scutellum is sometimes as dark as the basal fascia, the dark parts in some lights having a purplish or greenish gloss. There are seven specimens before me; of these, five have the elytra bifasciate, the first fascia being basal, about two-thirds the length of prothorax, and sinuous on its hind edge; the second is subapical, sinuous both in front and behind, and semicircularly produced on the suture posteriorly; two of these specimens have the prothorax bimaculate at base, the third has the spots conjoined, the fourth has an infuscate cloud at the base, and the fifth has it immaculate; the third specimen (the type-male) has the antennæ black, except for parts of the two basal joints, and the tip of the eleventh; its tibiæ and tarsi are also partly blackish; two of the others have parts of the five apical joints of antennæ dark, but the legs entirely pale; the others have entirely pale appendages. The sixth specimen has a fairly large basal spot on the prothorax, and the subapical fascia represented by a large spot on each side; its appendages (except for a slight infuscation of the eleventh joint of antennæ) are entirely pale. The seventh specimen (from the Coen River) is entirely pale, except that most of the antennal joints and the tarsi are blackish.

STETHOMELA FULVICOLLIS Jac.

Two specimens from the Coen River (H. Hacker) differ from the typical form of this species in being somewhat larger, and in having brassy elytra without (except in the lateral gutters, and in a few punctures) the least trace of green, the prothorax with a conspicuous brassy-green gloss, and a remnant of same on the head. In structure, they are close to var. *femoralis* of *S. submetallica*, but (apart from colour) may be readily distinguished therefrom by numerous small punctures on the interstices between the rows of punctures on the elytra.

STETHOMELA LATERALIS Lea, var.

A specimen, evidently belonging to this species, has a vague, reddish spot on the disc of each elytron.

STETHOMELA FULVITARSIS Jac.

A specimen from Kuranda differs from the description of this species in having the head (lip excepted) and prothorax deep black, without trace of metallic gloss, but, in other respects, it agrees well with the description.

STETHOMELA RUFIMANA, n.sp.

Reddish-castaneous, basal joints of antennæ paler, the others infuscated, elytra dark metallic coppery-green; legs black, except tarsi and coxæ.

Head with fairly dense but rather small punctures, much the same on clypeus as elsewhere, clypeal suture well-defined but not deep. Antennæ moderately long and thin, none of the joints transverse. *Prothorax* more than thrice as wide as long, sides gently rounded, front angles rather strongly produced, a shallow depression on each side; with dense and rather small but well-defined punctures, and with a few larger ones on base near sides. *Elytra* at base slightly wider than prothorax, but otherwise with outlines subcontinuous with same; with regular rows of rather small punctures, interstices with numerous minute but well-defined ones, a shallow depression behind each shoulder, in which the seriate punctures are larger than elsewhere. Intercoxal process of *prosternum* flat, its front obtuse and conspicuously elevated above the adjacent parts. *Claws* bifid. Length, 7 mm.

Hab.—Queensland: Mount Tambourine (H. J. Carter).

Readily distinguished from *S. limbata*, *S. caudata*, and *S. purpureipennis* by the dense prothoracic punctures, not larger (except for a few at the base) on the sides than elsewhere; the elytra also have numerous small ones on the interstices. The prothorax is less convex in the middle than in any other species known to me.

STETHOMELA GRANDIS, n.sp.

Bright metallic coppery-green, appendages and labrum reddish.

Head with numerous small punctures, but becoming coarse and irregular between eyes, median line sharply impressed in front, but feeble towards base; clypeus with dense punctures, suture well defined, each end blocked by a subtuberculate elevation. Antennæ rather long, none of the joints transverse, second about half the length of third. *Prothorax* feebly shagreened, about thrice as wide as long, sides gently increasing in width from base to apical third and then evenly rounded, but lightly constricted at apex; with coarse and deep irregularly distributed punctures, smaller and sparser in middle than elsewhere. *Elytra* distinctly wider than prothorax, shoulders rounded, sides subparallel to near apex; with rows of large, round, deep, and rather distant punctures, becoming smaller (but still fairly large) towards suture, interstices with a few minute punctures. Intercoxal process of *prosternum* feebly depressed along middle, apex obtuse and conspicuously elevated, base dilated and strongly notched. *Claws* strongly and acutely dentate. Length, 11½-13 mm.

Hab.—Queensland: Cairns (E. Allen).

The largest Australian species of the genus, and with unusually coarse punctures; on the elytra, they are comparatively small and regular close to the suture, but they rapidly increase in size until, on the sides, they might be regarded as round, deep foveæ; the only species, at all approaching it in this respect, is *S. poroptera*,* but that species is much smaller, very differently coloured, elytral punctures much less regular (much smaller towards the suture, but quite as large, although more irregular towards sides).

STETHOMELA ATRA, n.sp.

Black; legs and clypeus reddish, labrum, palpi, and basal joints of antennæ (the others blackish) somewhat paler.

Head with sparse and minute punctures, median line sharply impressed in front but scarcely traceable to base; clypeus short, suture deep and straight. Antennæ long and thin, none of the joints transverse. *Prothorax* more than thrice as wide as long, sides feebly dilated from base to apical third, and then rather strongly rounded; with very minute punctures and a few of larger size (but not very large) scattered about. *Elytra* suboblong, distinctly wider than prothorax; with regular rows of sharply defined but not very large punctures, interstices almost impunctate, sides somewhat inflated near shoulders and behind same transversely impressed, with the punctures in the impres-

* Presuming *S. foveipennis* to be a variety of that species; in any case, the present species differs from its description in being larger, cephalic and prothoracic punctures much more numerous, elytral punctures in more regular series, and antennæ and legs entirely pale.

sion much larger than elsewhere. Intercoxal process of *prosternum* grooved throughout, but the groove narrowed at base, this being subtriangularly notched, the apex, from certain directions, appearing to project as two small tubercles above the adjacent parts. Four front *tibiæ* rather strongly curved on apical half, the hind ones less noticeably so; claws strongly and acutely dentate (almost bifid). Length, 6 mm.

Hab.—Queensland (H. J. Carter; unique).

Not very close to any previously described species. Parts of the prosternum and of the undersurface of the head are obscurely reddish, in some lights parts of the upper surface have a vague metallic gloss. The curvature of the tibiæ is probably sexually variable, and the type is probably a male.

AUGOMELA ORNATA Baly, var.(?).

A specimen from Darwin may represent a variety of this species, with the beautiful purple cross on each elytron of the typical form replaced by a brassy-green one, but which, in some lights, has a vague purplish gloss in parts of the posthumeral depression; the intercoxal process of the prosternum is somewhat narrower and less conspicuously notched at the base, and the elytral punctures are smaller. Possibly it belongs to a distinct species, but, at present, it appears inadvisable to describe it as such.

AUGOMELA NITIDICEPS, n.sp.

Black with a vague brassy-green gloss in places; labrum, parts of basal joints of antennæ, palpi, and parts of femora more or less reddish.

Head almost impunctate, median line very feeble; clypeal suture distinct but not deep. *Prothorax* not thrice as wide as median length, basal three-fourths almost parallel-sided; with sparsely scattered and not very large punctures, more distinct at extreme base than elsewhere, and with very minute punctures. *Elytra* slightly wider than prothorax, sides feebly dilated behind shoulders; with regular rows of not very large punctures, becoming much smaller posteriorly, interstices scarcely visibly punctured. Intercoxal process of *prosternum* obtusely elevated in front, middle depressed towards base, which is triangularly notched. *Claws* strongly and acutely dentate. Length, 8mm.

Hab.—Queensland: Cairns (E. Allen).

With the wide intercoxal process of *A. iridea*, but the same not so densely hairy, clypeal suture much less pronounced, head generally smooth, and colour very different. In general appearance, it is like some of the smaller forms of *A. hypochalcea*, but the claws are more strongly armed, the posthumeral depression is much less conspicuous and is without a fovea. Only four joints (which are rather thin) of one antenna are left on the type, and but one of the other, and, of these, the third and fourth are almost entirely dark.

ÆSERNIA TRIPARTITA, n.sp. (Plate xlviii., fig.8).

Head, prothorax, basal joint of antennæ (the others purplish), palpi, part of femora, and apex of abdomen fulvous-red, scutellum and basal three-fifths of elytra brassy-green, apical two-fifths flavous, undersurface mostly brassy-green, becoming purplish on legs.

Head with a few scattered punctures, with a large subtriangular depression; clypeal suture semicircular and well-defined. *Prothorax* about twice as wide as long, towards each side with two, irregular, coarsely punctured foveæ; a few distinct punctures on each side at base, elsewhere almost or quite impunctate. *Elytra* at base not much wider than prothorax, sides dilated to beyond the middle; with irregular rows of punctures, distinct and well-defined on brassy-green portion, very irregular and much smaller elsewhere, with three transverse series of impressions containing coarse punctures on each side behind the shoulder, a large semicircular depression on each side of base. Length, 13½-18 mm.

Hab.—Queensland: Coen River (H. Hacker).

Differs from *Æ. australica* in its uniformly coloured head, and the flavous portion of the elytra occupying much more of the apex. It is apparently closer to the typical form of *Æ. latefasciata*, but differs from the description of same by having the elytra (of three specimens) not metallic-blue, each at base with a deep impression, and the fourth and the apex of the third segment of abdomen pale, as well as the fifth.

Lamprolina hackeri, n.sp.

Dark metallic-blue, sometimes purplish, sometimes with a greenish gloss; head, prothorax, femora, tibiæ, palpi, and from two to four basal joints of antennæ (wholly or in part, the others usually purplish) flavous, scutellum blackish, sometimes diluted with red, tarsi usually with a metallic gloss, but occasionally infuscated only.

Head with a few punctures between eyes, elsewhere impunctate. Clypeus depressed, suture semicircular and well-defined. Antennæ stout and moderately long. *Prothorax* scarcely twice as wide as long; with two coarsely punctured foveæ on each side, a few distinct but not very large punctures scattered about. *Elytra* elongate-subelliptic; with rows of distinct but not very large punctures, becoming irregular about middle (but not near suture) and very small posteriorly, with a rather shallow posthumeral depression, in which the punctures are larger than elsewhere, largest in fifth row from suture. Length, $10\frac{1}{2}$-$12\frac{1}{2}$ mm.

Hab.—Queensland: Coen River (H. Hacker).

Of the size and somewhat the appearance of *L. grandis*, but prothorax smooth, with smaller and sparser punctures, foveæ smaller and sides more parallel; elytra somewhat wider, with stronger punctures and several small foveæ in the posthumeral depressions. Two specimens from Cairns (E. Allen) have the prothoracic foveæ more approaching those of *L. grandis*, but, in other respects, they conform to the types.

EXPLANATION OF PLATE XLVIII.

Fig. 1.—*Bolboceras inconsuetum* Lea; front view of clypeus.
Fig. 2.—*Bolboceras varioliicolle* Lea; front view of clypeus.
Fig. 3.—*Bolboceras interruptum* Lea; front view of clypeus; 3A, back view.
Fig. 4.—*Polystigma vitticolle* Macl.
Fig. 5.—*Phyllocharis sculpticeps* Lea.
Fig. 6.—*Rhæbomela maculata* Lea.
Fig. 7.—*Rhæbomela fasciata* Lea.
Fig. 8.—*Æsernia tripartita* Lea.

THE AUSTRALIAN *STRONGYLIINÆ* AND OTHER *TENEBRIONIDÆ*, WITH DESCRIPTIONS OF NEW GENERA AND SPECIES.

(Family TENEBRIONIDÆ.)

BY H. J. CARTER, B.A., F.E.S.

(With nine text-figures.)

The species of the Australian *Strongyliinæ* are rare in collections, and are often confused with the *Cistelidæ*, from which they can be readily distinguished by their non-lamellate tarsi and non-pectinate claws. There are only three existing genera, to which I propose to add two more. These five genera may be tabulated as follows.

Genera of the Australian *Strongyliinæ*.

1. Procoxæ not contiguous.
2. Prothorax with explanate margins.......................... *Tyndarisus* Pasc.
3. Prothorax without explanate margins.
4. Prothorax twice as wide as long, with slight transverse convexity.
5. Sides of prothorax dentate in middle............ *Notostrongylium*, n.gen.
6. Sides of prothorax not dentate................. *Pseudostrongylium* Kraatz.
7. Prothorax not twice as wide as long, with strong transverse convexity.. *Strongylium* Kirby.
8. Procoxæ contiguous.. *Notolea*, n.gen.

Tyndarisus longitarsis Pasc., is described as copper-brown in colour; and I have a specimen that is so from Dorrigo, N.S.W. More often, however, it is mottled with a grey pubescence, giving it a close likeness to *Lepispilus sulcicollis* Boisd. It may be readily separated, however, from this species by its greater length, narrower form, and the extremely long anterior tarsi. It is common in the mountain-districts of New South Wales and Victoria, and I have a specimen from Tasmania.

Pseudostrongylium viridipenne Kraatz.—I think I have correctly identified this species in a rather common insect from Cooktown, Cairns, and other North Queensland districts. Mr.

H. Hacker took a large number, and it is found in most collections. It is very variable in the colouration of the elytra, this being sometimes entirely peacock-blue, or green, sometimes with the suture, sides, and base red or yellow; or the red colour may largely pervade the elytra.

Strongylium.—After an examination of Macleay's types of *S. ruficolle* and *S. Mastersi*, there only remained three species to identify, viz., *S. australe* Mäkl., *S. reticulatum* Mäkl., and *S. Macleayi* Pasc. I think I have a species of *S. australe* from Kuranda. *S. Macleayi* (from Cairns, and other Queensland districts) is readily determined from specimens in the Melbourne and Adelaide Museums. *S. reticulatum* Mäkl., determined from description, evidently belongs to a different genus, described below as *Notostrongylium.* I have taken this at Blackheath, Blue Mountains, under bark, and in the Victorian Alps, under a stone. The following new species are now described and tabulated.

NOTOSTRONGYLIUM, n.gen.

Form shorter and more convex—especially longitudinally—than in *Strongylium.* Prothorax rugose, the sides toothed in the middle or angulately widened. Elytra coarsely foveate-punctate, or reticulate, antennal joints stout and subtriangular.

I propose this genus for the reception of three species whose form and sculpture separate them from the typical *Strongylium.* The three species may be tabulated as follows.

Notostrongylium.

1. Body closely covered with short brown hair........... *fuscovestitum* Cart.
2(4) Body smooth.
3. Prothorax toothed in middle, elytra without reticulation.................. .. .. *rugosicolle*, n.sp.
4. Prothorax angularly widened in middle, elytra reticulate.......... .... *reticulatum* Mäkl.

NOTOSTRONGYLIUM RUGOSICOLLE, n.sp.

♂. Elongate, convex, robust; glabrous, dark brown, head and prothorax opaque, elytra and underside subnitid, oral organs, basal joints of antennæ, tibiæ and tarsi red, femora reddish-brown, apical joints of antennæ infuscate.

Head: epistoma densely punctate, rounded in front, limited behind by wide shallow depression, canthi elevated into a nitid knob impinging on the eyes; the latter large, subapproximate, separated by a space less than half the diameter of one, forehead between eyes rugose. Antennæ: joint 1 robust, 2 bead-like, 3 slightly longer than 1 and 2 combined, 3-7 gradually shorter and stouter, a little enlarged at apex, 8-10 equal, 11 as long as 10, but narrower and bluntly rounded. *Prothorax* 3 x 4 mm., very convex, widest at middle, this width emphasised by a short lateral tooth, apex truncate, base bisinuate, wider at base than at apex, sides well rounded, obtuse anterior angles depressed, posterior angles (seen from above) acute and slightly produced backwards, base with folded margin sulcate within, lateral and apical margin narrow; disc coarsely rugose, the medial line only indicated by finer rugosity, a shallow foveate depression near base on each side. *Scutellum* large, curvilinear-triangular, coarsely punctate, with a smooth middle line. *Elytra* convex, considerably wider than prothorax at base and three times as long, shoulders prominent, squarely rounded, sides a little constricted in middle, sharply tapering and rather strongly declivous at apex; coarsely punctate-striate, with nine rows of large, deep, square punctures set closely, besides a short scutellary row and a lateral row of smaller punctures, the seriate punctures continuous but becoming smaller to the apex, intervals subcostate, especially the 2nd and 3rd, and slightly crenulate on the outside; the 1st and 3rd joining to form a rounded ridge on each side of the scutellum. Pro- and mesosternum with rather large punctures, metasternum and abdomen more finely punctate; the latter with short, sparse pubescence. Posterior intercoxal process widely triangular; femora coarsely punctate, tibiæ and tarsi

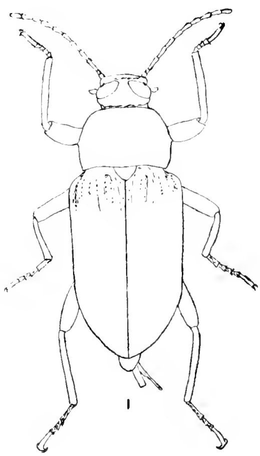

Fig. 1.
Notostrongylium rugosicolle.

with pale red pubescence, posterior tarsi with 1st and claw-joint subequal. *Dimensions*, 13 × 5 mm.

♀. Wanting.

Hab.—Claudie River, North-East Queensland.

A single specimen, from the Melbourne Museum, is an ally of *N. fuscovestitum* mihi, but is wider and more convex, especially in the prothorax, while without the strong hairy clothing of that species. The lateral tooth of the prothorax is more pronounced than in *N. fuscovestitum.* Type in the National Museum, Melbourne.

The following is a table of the Australian species of *Strongylium.*

Strongylium Kirby.

1(5) Colour more or less metallic.
2. Head, prothorax, and elytra green-bronze.................... *australe* Mäkl.
3(5) Head and prothorax black, elytra blue.
4. Size larger (12-14 × 5 mm.), intervals of elytra nearly flat...*Macleayi* Pasc.
5. Size smaller (9·5 × 3 mm.), elytra faintly cyaneous, intervals sharply convex......... .. .. *corrugatum*, n.sp.
6(12) Colour non-metallic, elytra black.
7. Prothorax red....... .... *ruficolle* Macl.
8-12. Prothorax black.
9. Elytral intervals flat.......... .... *Mastersi* Macl.
10(13) Elytral intervals more or less convex.
11. Pronotum minutely punctate, legs very long............... *longipes*, n.sp.
12. Pronotum distinctly, not closely nor deeply punctate........................ .... *cylindripenne*, n.sp.
13. Pronotum densely and deeply punctate................ *punctithorax*, n.sp.

STRONGYLIUM LONGIPES, n.sp.

Elongate, subcylindric, nitid-black, tarsi, apical joint of antennæ and edge of maxillary palpi red.

Head very finely punctate, more closely on the epistoma than on forehead, the former rounded in front, the canthi strongly raised and impinging on the eyes; these large and approximate, in the ♂ only separated in front by a thin carina triangularly widened behind, in the ♀ the space between eyes about 0·7 mm. Antennæ: joint 1 stout, 2 half as long as 1, 3 and 4 subequal, 4-8 gradually shorter and wider (at apex), 9-10 of same length but not as wide as 8, 11 narrower than 10, widened at apex. *Prothorax* 3 × 3 mm., subtruncate at apex and base, sides faintly rounded, and arcuately converging in front without angles, posterior angles subrectangular, basal margin with a strong fold sulcate within, apical margin raised, lateral margin scarcely evident from above, disc almost microscopically punctate, medial furrow clearly impressed. *Scutellum* rather widely triangular, raised in middle, smooth. *Elytra* parallel, moderately convex, considerably wider than the prothorax at base and nearly four times as long, shoulders prominent and rounded; subsulcate-punctate, with nine rows, besides a short scutellary row of rather large, round punctures, somewhat closely placed in sulci, the intervals smooth and strongly raised, those near the suture costate, becoming less convex laterally, the punctures becoming subobsolete and the intervals flatter towards apex. Underside apparently quite lævigate; legs very long, posterior tarsi with basal joint not as long as the rest combined. *Dimensions*, 14 × 4·5 mm.

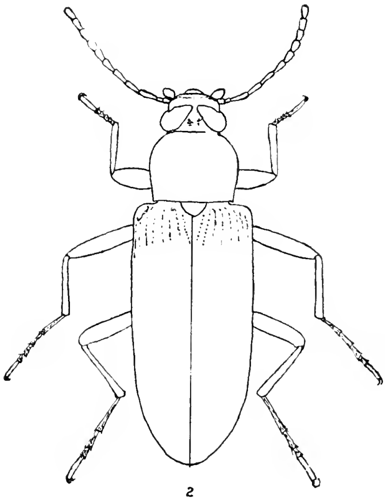

Fig. 2. —*Strongylium longipes.*

Hab.—Mackay and Cairns (North Queensland), (?)Sydney (New South Wales).

Five specimens examined, 3 ♂, 2 ♀. It is widely separated from the only nitid-black species so far described from Australia (*S. Mastersi* Macl.) in its larger and more elongate form, and having strongly raised intervals on the elytra. Superficially, it is very like *Homotrysis* (*Allecula*) *subsulcata* Macl. One of the specimens in Mr. Lea's collection is labelled Sydney, and differs from the Queensland examples in having less raised elytral intervals, with smaller seriate punctures; but, at present, I can only consider it as a variety. Type in the National Museum, Melbourne.

STRONGYLIUM CYLINDRIPENNE, n.sp.

Elongate, cylindric, nitid-black, tarsi, a few basal and the apical joint of antennæ red, rest of antennæ obfuscate, legs reddish-brown.

Head vertical, wide as prothorax across the eyes, epistoma convex, arcuate in front with deep suture behind, rather strongly and closely punctate, eyes in ♂ almost contiguous, in ♀ more widely separated, eyes large, occupying the greater part of front, scarcely impinged upon by the small nodular canthus. Antennæ long, gradually but not greatly enlarged towards apex, basal half sublinear, 3 longer than 4, 8-10 longer than wide, moderately enlarged at apex, 11 ovate. *Prothorax* very convex, widest at base, subparallel on basal half, slightly arcuately narrowed at apex, subtruncate at apex and base, anterior sides depressed and rounded, posterior angles subrectangular and deflexed, basal margin folded, apical margin narrow, lateral margins not visible from above, disc distinctly and rather closely punctate, with two small discal and three small basal foveæ. *Elytra* convex, wider than prothorax at base and three times as long, shoulders rounded, sides parallel; striate-punctate, the striæ well-defined, and becoming sulcate laterally, the first two striæ wider than the rest and continuous to apex, the punctures in striæ large and close, intervals convex (3rd, 4th, 5th, and 6th subcarinate) and quite smooth. Epipleuræ narrow and concave, prosternum coarsely punctate, metasternum and abdomen smooth nitid-black. Legs of moderate length, posterior tarsi with first joint longest, but not as long as the rest combined. *Dimensions*, 9·5 x 2·5 mm.

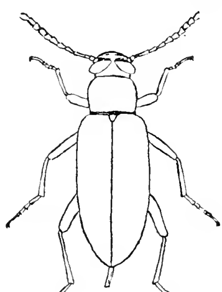

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Fig. 3.
S. cylindripenne.

Hab.—Tambourine Mt., Queensland, and Sydney, N.S.W.

Var. A. Larger (10·5 × 3 mm.), with the elytral intervals less convex, and the seriate punctures rather smaller. (Labelled Sydney in Coll. Lea).

The ♂ and ♀ types are in my own Coll., the ♂, given me by Mr. H. W. Brown, without a locality-label (probably Queensland), the ♀ taken by myself at Tambourine Mountain. It is easily distinguished from *S. Mastersi* Macl., by its raised elytral intervals and more cylindric form. In this, it superficially resembles some species of *Anaxo*. Types in the author's Coll.

Strongylium corrugatum, n.sp.

Elongate, cylindric, nitid-black, elytra with faint cyaneous reflections, apical joints of antennæ opaque black.

Head finely and densely punctate on epistoma, canthus much larger than in the preceding species (*S. cylindripenne*), eyes large and subcontiguous, the separating lamina very narrow in front, triangularly widening behind, with a small fovea and sparse punctures thereon; antennæ with basal joints much stouter than in the preceding, joint 3 slightly longer than 4, and tumid at apex, first five joints nitid, 6th joint widest, succeeding joints elongate, 11th elongate-ovate. *Prothorax* very convex anteriorly, wider than long, and somewhat rectangular in outline, of same width (2 mm.) as head between the eyes, subtruncate at base and apex, sides parallel, anteriorly rounded and depressed, posterior angles rectangular, basal margin thickly folded and sulcate within, the sulcus terminating each way in a fovea, apical margin raised, lateral margins not evident from above; disc apparently lævigate (really microscopically punctate), without medial line *Scutellum* equilatero-triangular, punctate. *Elytra* wider than prothorax at base and about three times as long, sides subparallel anteriorly, slightly widened behind middle,

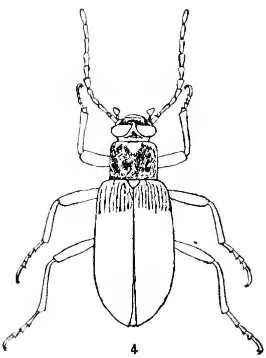

Fig. 4.
Strongylium corrugatum.

shoulders rounded, the surface more depressed than in *S. cylindripenne*; punctate-sulcate, all intervals subcarinately raised, the sulci deep throughout, the punctures therein small and half-hidden, intervals lævigate; prosternum sparsely, abdomen very finely punctate, meso- and metasterna lævigate except on their episterna, posterior tarsi with basal joint shorter than usual (as long as the 2nd and 3rd combined). *Dimensions*, 9·5 x 3 mm.

Hab.—Port Darwin, North Australia.

Two specimens, both I think ♂, in Mr. Lea's collection. Compared with *S. cylindripenne*, the antennæ and legs are darker, the former much stouter, with joints of different proportions, prothorax almost lævigate, the elytra more evenly and deeply sulcate, the punctures therein smaller and half-hidden, and the form is more depressed. Type in Coll. Lea.

STRONGYLIUM PUNCTITHORAX, n.sp.

Elongate, cylindric, nitid-black, elytra with a reddish tinge, oral organs, antennæ, legs, and underside red.

Head very densely and strongly punctate, shape as in *S. cylindripenne*, eyes of ♂ close in front, space rapidly widening behind, of ♀ separated by a space greater than half the diameter of an eye; antennæ very slender and short, the joints sublinear, 3 longer than 4, 5-7 successively shorter, 8-11 subequal. *Prothorax* less convex than in the two preceding species, the outline as in *S. corrugatum* except that the base is slightly sinuate, and the sides with a slight incurving tendency posteriorly, with the posterior angles acute and a little produced, disc densely punctate, the punctures round, deep, and crowded; the basal and apical margins of nearly equal width, the former with a wide transverse sulcus within, terminated by rather large basal foveæ; also a shallow longitudinal sulcus near the extreme sides. *Scutellum* large, curvilinear-triangular, coarsely punctate. *Elytra* wider than prothorax at base and three times as long, sub-

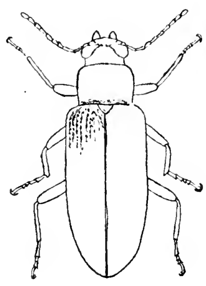

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Fig. 5.
S. punctithorax.

cylindric, shoulders rather squarely rounded, striate-punctate, the punctures in series, large and somewhat square, becoming larger towards sides, smaller towards apex, and separated by irregular, subcancellate, transverse strigæ, the sutural stria wider than the rest and almost devoid of punctures except near base, intervals convex and finely punctate. Prosternum rather thickly covered with large, round punctures, meso- and metasternum with smaller punctures more sparsely scattered, abdomen finely but distinctly punctate; legs shorter and more slender than usual; posterior tarsi with basal joint as long as the rest combined. *Dimensions*, 10 × 3·5 mm.

Hab.—Jenolan Caves district, New South Wales; and Brisbane, Queensland.

Two specimens—the sexes—in Coll. Lea, are easily separated from the two preceding species by the densely and coarsely punctured head and prothorax. The elytra are not so deeply or so regularly striate as in *S. corrugatum*, but more so than in *S. cylindripenne*, while the seriate punctures are of about the same size as in the latter species, but squarer and even more closely placed. From *S. Mastersi* Macl., easily differentiated by the punctured thorax and convex elytral intervals, the same being quite flat in *S. Mastersi*. Type in Coll. Lea.

Notolea, n.gen.

Elongate, parallel, depressed. *Head* vertical, triangular; *mandibles* bifid at apex; *mentum* cordate, notched above; *maxillary palpi* long, joint 1 linear, 2 obconic, 3 triangular, last joint securiform; *labial palpi* with last joint subtriangular with rounded angles, notched and spinose on inside; *antennæ* very long, joints linear; eyes widely separated. *Prothorax* transverse, subcordate, with narrow carinate margin throughout, laterally separating propleuræ from pronotum. *Elytra* depressed, subcostate with transverse reticulation, closely irregularly punctate. *Epipleuræ* narrow. *Prosternum* very short, procoxæ large, globular, and contiguous, occupying nearly the whole space between base and apex near the middle, without any separating lamina, or produced prosternum; midcoxæ very close, the post-intercoxal process small and sharply triangular. Metasternum briefly longitudinally sulcate at apex. *Legs* long and slender, tibiæ slightly enlarged, with a small spine at apex, tarsi with penultimate joint very short, posterior with 1st joint not as long as the rest combined.

A genus separated from any of the described genera in Mäklin's monograph by the different prosternum with its contiguous coxæ, and widely distinct in form and sculpture from the other described Australian Strongylia. At first, it seemed a possible member of the Œdemeridæ, but the anterior coxal cavities closed behind preclude this.

NOTOLEA LIMBATA, n.sp.

Elongate, parallel, depressed, reddish-brown, glabrous, subnitid; elytra with a wide pale red or flavous margin, oral organs, antennæ, and legs red.

Head coarsely and rather closely punctate, labrum strongly produced, epistoma rounded and raised in front, concave behind, limiting suture scarcely defined, canthus small and nodular, eyes moderately large, separated by a distance greater than the diameter of one eye; antennæ slender, joint 1 very stout, 2 half as long as 1, 3 not as long as 4 and 5 combined, 4-8 subequal, 9-10 slightly wider than preceding, 11 elongate-ovate.

Fig. 6*a*.*

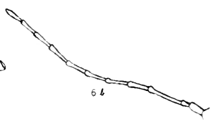

Fig. 6*b*.†

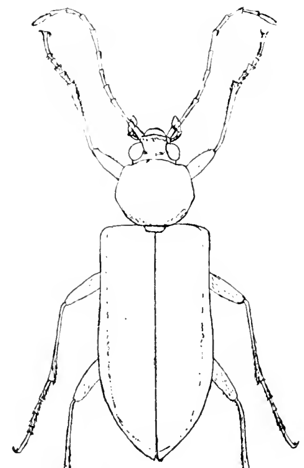

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Fig. 6.—*Notolea limbata.*

* Mentum, palpi, labium, and mandibles of *Notolea limbata.*
† Antenna of same, ♂.

Prothorax subcordate and rather flat, widest at middle, bisinuate at apex, the rounded anterior angles a little produced, sides arcuately widening from apex to the middle, then subangularly narrowed, in a wide curve, posterior angles obsolete, base narrow and subtruncate; disc everywhere densely punctate, the punctures round and deep. *Scutellum* transverse, oval, punctate. *Elytra* much wider than prothorax at base and nearly three and a half times as long, shoulders prominent and rather square, sides a little compressed before and widened behind the middle, a narrow lateral raised border not evident from above; each elytron with about four subobsolete costæ, the 2nd and 3rd most apparent, posterior half of elytra with irregular lightly raised reticulation (somewhat as in *Lepispilus*), the whole surface (including costæ, transverse strigæ, and interspaces) crowded with round punctures without any seriate arrangement, the irregular raised surface at the sides on the pale-coloured margins showing large smooth spaces; whole underside densely punctate and glabrous, legs with sparse clothing of short yellow hairs on underside, tarsi pilose. *Dimensions*: ♂, 12 × 4 mm.; ♀, 15 × 5 mm.

Hab.—Mount Horror, Tasmania (O. L. Adams, per A. M. Lea), also Tasmania (Coll. Blackburn).

Three specimens examined, one ♂, two ♀, of this interesting species, the ♀ specimens being larger, with thicker antennal joints and a prominent ovipositor. The characters diagnosed above show an insect widely separated from any hitherto described member of the subfamily. Type ♂ in Coll. Lea; ♀ in Coll Carter.

GONOCEPHALUM ALTERNATUM, n.sp.

Shortly ovate, opaque-brown with asperate derm.

Head with epistoma rounded in front, excised in the middle, the canthus impinging on the eyes beyond halfway, the width of the exterior piece about equal to the diameter of an eye, surface finely shagreened. Antennæ rather short, joint 3 twice as long as 4, 4-8 successively shorter and wider, 9-10 very transverse, 11 widely ovate. *Prothorax* very transverse and widely horizontally explanate, anterior foliation produced (in normal position of head) to meet the canthus, anterior angles subrectangular, sides widely rounded, then strongly sinuate before the acute, slightly deflexed posterior angles; widest at middle, base strongly bisinuate, disc and foliation closely granulose, without raised border, a transverse depression just behind the apex. *Scutellum* small, curvilinear-triangular. *Elytra* ovate, wider than prothorax at base, shoulders pronounced and obtuse, each elytron with 9 rows (including the sutural row) of small raised shining nodules, the sutural, 3rd, 5th, 7th, and 9th consisting of double rows, the alternate costæ consisting of single lines of similar nodules; interspaces uneven (under a Zeiss binocular seen to be obscure rows of shallow foveate depressions). Underside finely rugose, fore-femora tumid, fore-tibiæ enlarged at apex and clothed with short bristles, middle and hind tibiæ not enlarged at apex. *Dimensions*, 8·5 × 4·5 mm.

Hab. —Raine Island, North-East Queensland.

A single ♂, in the Melbourne Museum, is a close ally of *G. costipenne* mihi in its elytral sculpture, but differs from it in (1) larger size, (2) absence of vitreous spots, and hairy clothing, (3) foliation of prothorax, horizontal throughout, with anterior angles rather sharply rectangular. Type in National Museum, Melbourne.

Gonocephalum costatum Cart.—In describing this species (Trans. Roy. Soc. S. Austr., 1914, p.222), I overlooked the pre-occupation of this name for a European species (*G. costatum* Brll.). I therefore propose the name *costipenne* for my species.

G. Meyricki Blackb., = *G. victoriæ* Blackb.—I have examined cotypes of these in the South Australian Museum, and can find no valid distinction.

Titæna pulchra Bates.—In my tabulation of the genus (Proc. Linn. Soc. N. S. Wales, 1915, p.102) I omitted this species. It would come in this table after *T tyrrhena* mihi, from which it can readily be distinguished by size alone, 7 mm. long.

PTEROHELÆUS SERICEUS, n.sp.

Ovate, black, glabrous and subopaque, antennæ and tarsi reddish.

Head and pronotum very densely and finely punctate, epistoma straight in front, sides obliquely raised to the canthus, limiting suture faintly impressed, eyes rather widely separated, antennæ short, joints submoniliform, apical four transverse, the last nearly spherical. *Prothorax* 2 × 4 mm., anterior angles widely obtuse but advanced, sides arcuately diverging to base, posterior angles acute and strongly produced backwards, base bisinuate, explanate margins horizontal but punctured like disc, extreme border not raised, central line depressed and sublævigate. *Scutellum* transversely triangular, punctate. *Elytra* convex, of same width as prothorax at base and nearly three times as long, ovately widened to beyond halfway, and widely rounded behind, lateral margins horizontal, moderately wide, but contracting towards apex, extreme border raised; a well marked line of lateral punctures, and some very indistinct lines of punctures on disc becoming obsolete towards suture; surface generally uneven, with some almost obsolete wavy costæ, the whole surface densely covered with minute punctures presenting a subopaque and silky appearance, underside minutely and closely punctate, with some larger punctures sparsely scattered on sternum, tibiæ serrated on outside, especially the protibiæ. *Dimensions*, 9 × 5 mm.

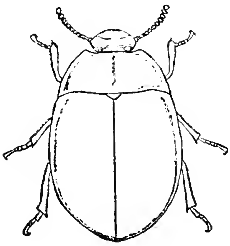

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Fig. 7.
Pterohelæus sericeus.

Hab.—Banana, Queensland (E. Barnard, per Mrs. Hobler).

Two specimens, sex doubtful, differ from all described species in sculpture, and in the finely serrated tibiæ. Indeed, this latter character suggests generic distinction. In shape, like *P. ovulus* Haag Rut.; in sculpture, nearest to *P. nitiduloides* mihi, near which it should be placed. Type in the author's Coll.

OMOLIPUS Pasc.

Synonymy.—*O. corvus* Pasc., = *O. grandis* Macl. *O. cyaneus* Pasc., = *O. chalybeus* Geb. *O. oblongus* Bates, = *O. affinis* Geb.

Macleay's species, *O. grandis*, is only a large-sized case of *O. corvus* Pasc., a common species round Brisbane, and in Southern

Queensland. Pascoe gives Melbourne as the locality, but I have not seen any specimens taken south of Sydney. It may be noted that all the species of *Omolipus* are subject to great variation in size.

There seems to me little doubt as to the above names being synonymous. I have seen a large number of examples from various parts of West Australia which present the slight colour-variation on which Gebien founded his *O. chalybeus*. Pascoe says of *O. cyaneus* "legs . . . . reddish," while in *O. chalybeus* they are black In most of the blue species, there is a tendency to redness on the underside and appendages, especially in slightly immature examples. Gebien seems not to know *O. oblongus* Bates, and states, in his tabulation of the species, that the colour is dark green. Bates says in the description "dark green with a chalybeate tinge." I have cotypes of this, which are quite blue. My specimens of *O. cyaneus* Pasc., were compared with type. The differences noted by Gebien between *O. chalybeus* and *O. affinis* are exactly the differences which exist between *O. cyaneus* Pasc., and *O. oblongus* Bates, the apex of prosternum bent upwards in *O. cyaneus*, downwards in *O. oblongus*. As Gebien's table is incomplete, I append a tabulation of the genus.

Group i. Species with short mesosternum, form ovate.

1(7) Colour black.
2(4) Surface nitid.
3. Elytra striate-punctate, seriate punctures large.............. *socius* Pasc.
4. Elytra seriate-punctate, seriate punctures very small........ *lævis* Pasc.
5(7) Surface (especially pronotum) subopaque.
6. Size large, seriate punctures irregular in size and distance...*corvus* Pasc.; .... *grandis* Macl.
7. Size small, seriate punctures round and regular......... *gnesioides* Pasc.
8. Pronotum violet, elytra blue. .... *bimetallicus*, n.sp.

Group ii. Species with long mesosternum, form elongate.

9. Whole surface black.................. .... *parvus* Bates.
10(13) Upper surface blue.
11. Elytra clearly striate-punctate, seriate punctures small.. *angustus*, n.sp.
12. Elytra substriate-punctate, intervals convex, seriate punctures large and round........ .... *cyaneus* Pasc.; *chalybeus* Geb.

13. Elytra seriate-punctate, intervals flat, seriate punctures elongate and smaller than in 12................ .. *oblongus* Bates; *affinis* Geb.
14. Prothorax black, elytra blue.......................... *cyaneipennis* Champ.
15. Prothorax black, elytra dark bronze..... .... **submetallicus* Geb.

OMOLIPUS BIMETALLICUS, n.sp.

Oval, convex (longitudinally and transversely), head and pronotum brilliant metallic-violet, the base and apex of the former suffused with blue; elytra, legs, and underside a rich deep blue, very nitid; antennæ and tarsi reddish-brown, apical 4 joints of the former opaque.

Head densely and finely punctate, epistoma rounded in front, depressed below the level of the convex forehead, and clearly separated from it by an arcuate suture; antennæ not extending to base of prothorax, joints 3 and 4 slightly elongated (3 longer than 4), the remaining joints bead-like and successively wider, 8-10 transverse, 11 longer and wider than 10. *Prothorax* (of ♂) 3 × 4 mm., very convex, apex slightly advanced in the middle, base truncate, anterior sides depressed, angle obsolete, posterior angles widely obtuse, sides very widely rounded without any sinuation, basal margin raised, lateral margin not evident from above, disc very closely and finely punctate without depression or medial line. *Scutellum* very small and transverse. *Elytra* ovate, convex, of same width as prothorax at base, and about twice as long, gradually enlarging behind base to beyond halfway, with a steep apical declivity; seriate-punctate, the suture showing an obscure striation, punctures in series round, regular, smaller than in *O. oblongus* Bates, larger than in *O. angustus* (*infra*), not very closely placed, intervals flat and apparently quite impunctate (under a Zeiss binocular, minute sparse punctures can be seen); underside closely, minutely punctate, submentum transversely rugose, prosternal intercoxal process produced downwards. *Dimensions*: ♂, 9 × 4½ mm.; ♀, 6 × 3 mm.

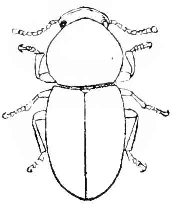
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Fig. 8.—*Omolipus bimetallicus*.

Hab.—Oempelli, East Alligator River, North Australia.

* Species unknown to me.

Two specimens, from the Melbourne Museum, show the most beautiful species of the genus in its brilliant metallic contrast of two colours. The colouration is much as in *Cha iothes Besti* Blackb., except that the colours of the pronotum and elytra are reversed. It is the only metallic (non-black) species belonging to Gebien's 2nd section "with short mesosternum." The larger specimen is, I think, ♂ from its enlarged penultimate tarsi. I find no other sexual character. Type in the National Museum, Melbourne.

OMOLIPUS ANGUSTUS, n.sp.

Whole upper surface bright blue, nitid, underside darker blue; antennæ, legs, and underside of head reddish, upper surface of femora blue.

Head closely punctate on epistoma, more sparsely and closely on forehead, rounded in front, epistomal suture rather indistinct; antennæ with apical 4 joints wider than the rest, 8-10 subspherical, 11 widely oval, twice as long as 10. *Prothorax* 2·5 x 3 mm., very convex laterally, widest at middle, considerably narrowed anteriorly, slightly so posteriorly, strongly produced forward in the middle at apex, base truncate, anterior sides depressed and without angles, posterior angles widely obtuse without previous sinuation, sides moderately rounded, disc closely but not deeply punctate. *Scutellum* transverse, oval, reddish. *Elytra* subcylindric, of same width as prothorax at base and less than twice as long, sides slightly widening behind prothorax, apical declivity moderate, lateral margins not evident from above; striate-punctate, the striæ clearly cut throughout, the punctures therein small and close, intervals slightly convex and nearly smooth, with a few sparsely scattered microscopic punctures; abdomen minutely punctate, with a row of larger punctures at the apex of each segment; underside of head and prosternum slightly rugose, prosternal intercoxal process very small and not produced. *Dimensions*, 8 x 3 mm.


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Fig. 9. *O. angustus.*

Hab.—Cue, West Australia (Mr. H. W. Brown).

A specimen (sex ?), given me by its captor, differs from the other blue species in its narrower and more depressed form, more clearly defined striæ, finer seriate punctures (finer than in any species except *O. lævis* Pasc.), the prolonged and narrowed antero-prothorax and brighter colour. Type in author's Coll.

In the publication of my paper on "Revision of the *Cyphaleinæ*" (These Proceedings, 1913), the description of one new species, *Platyphanes cyaneipennis*, was inadvertently omitted, though mentioned in the table of the genus. I, therefore, include its description below.

PLATYPHANES CYANEIPENNIS, n.sp.

Elongate-parallel, moderately convex; head and prothorax black, elytra dark blue, nitid; underside and legs black, antennæ and tarsi brown, the last three joints of the former castaneous.

Head evenly and clearly punctate, epistoma straight in front, obliquely rounded at sides, forehead convex, eyes separated by a space less than the transverse diameter of one eye. Antennæ with joints 3-7 gradually shorter and stouter, 3 little longer than 4, subcylindric, apical four joints rounded and transverse. *Prothorax* rather flat, slightly wider at base than at apex, glabrous, rather closely and finely punctate, with small, smooth spaces near middle; disc without medial line or impression, arcuate-emarginate at apex, bisinuate at base, anterior angles advanced, less than 90°, but slightly blunted at apex, sides feebly rounded, a little incurved near base, posterior angles obtuse (about 100°), lateral border raised, subsulcate within. *Scutellum* triangular with rounded sides, punctate. *Elytra* wider than prothorax at base and three and three-quarter times as long, with narrow, horizontal, lateral border becoming obsolete at apex, humeral callus well marked; striate-punctate, each elytron with ten rows, besides a short scutellary row of punctures somewhat irregular in size and spacing, the sixth row consisting of smaller punctures confusedly jumbled; intervals and striæ wide, the former smooth, convex at middle and sides, becoming flatter towards apex. *Prosternum* subpustulose, meso- and metasternum nearly smooth, their episterna with a few large punctures; abdomen finely punctate, becoming finer towards apex; posterior tarsi with claw-joint as long as the rest combined. *Dimensions*, 21 × 9 mm.

Hab.—Tambourine Mountain, South Queensland.

Two specimens under examination are both, I think, ♀. The species is nearest to *P. oblongus* Waterh., and *P. chalcopteroides* mihi, from both of which it may be distinguished by colour, the much more elevated elytral intervals, and the larger seriate punctures. Type in Coll. Carter.

THE GEOLOGY AND PETROLOGY OF THE GREAT SERPENTINE BELT OF NEW SOUTH WALES.

Part v. The Geology of the Tamworth District.

By W. N. Benson, B.Sc., B.A., F.G.S., Linnean Macleay Fellow of the Society in Geology.

(Plates xlix.-liii.; and fifteen Text-figures.)

CONTENTS.

Introduction and previous Literature.

Tamworth, now a prosperous town of more than nine thousand inhabitants, is one of the old country-towns of the State. It lies on the Peel River at the foot of the Moonbi Ranges, almost due north of Sydney, and at a distance therefrom by rail of two hundred and eighty-two miles. Though small amounts of gold and copper have been discovered in the neighbourhood, it has never been in any way a mining centre, and its prosperity has been due to its pastoral and agricultural industries. In this respect, the district falls into three divisions: the hilly north-eastern part, composed of granite and slaty rocks; the gently undulating south-western part, chiefly made up of clayslates; and the wide flood-plains of the Peel and Cockburn Rivers that intersect the district. The first two of these divisions were devoted to sheep- and cattle-raising, and to a small amount of dairying, but now, much of the second division, and the flatter portions of the first, are devoted to the cultivation of wheat. The deep alluvium on the flood-plain produces abundant crops of lucerne.

The district first attracted the attention of geologists when the Rev. W. B. Clarke passed through it in 1852, on his way to investigate the gold-fields of Barraba and Bingara. He noted the large masses of limestone on Moore Creek, to the north of the district, and compared them with the Devonian limestones in the Murrumbidgee valley(**1**). His collections of fossils were described by Professor De Koninck of Liège(**2**), whose results, first published in 1876-7(**2**), were translated into English, and appeared as a Memoir of the Geological Survey of New South Wales(**3**). He described five species of corals as coming from Moara or Mowara Creek, north of Tamworth. A little doubt has arisen as to the spot indicated by this name(**11**), but there seems no reason to think it other than what is now termed Moore Creek. In his reports, Clarke rendered the original name of the stream by the spelling "Moura" or "Mouara," and an old map shows the name "Mooar."

Very little geological work was done in the district for the next forty years, though collections were made by Mr. D. A. Porter, of Tamworth, of the minerals and fossils of the district, among which he found hyalite occurring with chromite at Moonbi(**4**), and a new species of coral, described by Mr. R. Etheridge, Jun., as *Diphyphyllum porteri*, in the limestone in the Tamworth Common(**5**).

In 1893, in an address to this Society, Prof. David suggested that the jasperoid slates of the Bingara, Barraba, and Nundle District, which pass through the eastern portion of the area now under discussion, may be altered abyssal deposits(6). Three years later, he discovered that, not only do the jasperoid rocks contain numerous spherical casts, probably replacing radiolaria, but there is a large development at Tamworth of claystones and cherts, and siliceous limestones, containing abundant radiolarian remains, which he briefly described(7). He stated that there appeared to be two beds of coral limestone, one of which was greatly altered by the metamorphosing effect of the New England granite. The thickness of the limestone he placed between 100 and 1000 feet, and added four more forms to the list of fossils. He further remarked: "The claystones and cherty rocks, both above and below the limestone, have also been much altered by innumerable granite sills for a zone over five miles in width measured at right angles to the junction line between the sedimentary rocks and the granite. . . . The sills vary from a fraction of an inch up to several feet in thickness, and at first sight have every appearance of being regularly interstratified with the sediments. A careful examination, however, at once revealed their intrusive character, as they trespass slightly across the planes of bedding, and have slightly altered . . . the sedimentary rocks both above and below them." In another paper he said: "The whole zone for several thousands of feet is half sill, half sediment."(8) So far, however, these apparently intrusive rocks do not appear to have been subjected to microscopical examination.

In 1899 appeared the classical paper on this district, namely, the account given by Professor David and Mr. Pittman conjointly(9). With this there is a geological map of the area. The authors showed that there is an anticline in the valley of Seven Mile Creek, east of the town, and adjacent to the boundary of the granite. Metamorphosed limestone occurs on either side of the axis. Above this, there continues a series of radiolarian cherts, claystones, and lenticular patches of limestone, interspersed with igneous rock. This dips steadily to the west, and a thickness of 9,260 feet is stated to occur between the anticlinal axis and Spring Creek in the Tamworth Common. Here is a great fault, east of which the limestones appeared again, followed by more radiolarian sediments and interstratified igneous rocks. This limestone is shown to be on the same horizon as that at Moore Creek, and is believed to be also the equivalent of the limestone in Seven Mile Creek. The microscopical examination of the igneous rocks made by Mr. Card having revealed their clastic nature, they are now stated to be felsitic tuffs, but it is still held that they are often intrusive or crushed into the sediments, and pictorial evidence of this is given. The new view, however, removed them from any direct relation with the Moonbi granites. While formerly *Lepidodendron* was found only above the radiolarian rocks, it was now shown to occur within them. On the grounds of the association of the radiolarian chert with coral limestones, the absence of coarse terriginous sediments, the abundance of plant-remains, and the presence of ripple-marking, it was concluded that the radiolarian rocks "were deposited in clear sea-water, which, though sufficiently far from land to be beyond the reach of any but the finest sediment, was nevertheless probably of not very considerable depth." Finally, they discovered certain coarse agglomerates on the hills to the north of Tamworth, which they considered to be unconformable on the clayslates, and probably the basal beds of the Carboniferous System.

The radiolaria in these rocks were investigated by Dr. Hinde, who described fifty-three species, all new to science(**10**). This does not exhaust the radiolarian fauna of the district, however, for additional forms, not yet described, have been noted by Professor David and Dr. Jensen.*

The fossils in the limestones at Moore Creek, Tamworth, and Moonbi, collected by Messrs. David, Pittman, Porter, Beedle, and Etheridge, were described by the last-named, who found nineteen species of corals to be present, most of which were new to science. He considered that the limestone of Moore Creek

* Verbal communication.

and Tamworth lay on the same horizon, and that at Moonbi was rather older, though all might be classed as of Middle Devonian age(**11**).

On account of the lithological nature of the granite at Moonbi, and the characteristic topography of the areas occupied by that rock, Mr. E. C. Andrews concluded that it was the equivalent of the sphene-granite-porphyry of northern New England, which invades Permo-Carboniferous sediments, and is presumably of early Mesozoic age(**12**).

A beautiful illustration of the red "marble" of Nemingha has been published by the Technological Museum, and notes made thereon by Mr. Laseron(**13**).

In the first part of the present series of papers, the writer stated that the Moonbi limestone was on the same horizon as that at Seven Mile Creek, and accepted the view of Messrs. David and Pittman, that the latter was the faulted equivalent of the Tamworth and Moore Creek limestones. He doubted the unconformity between the agglomerates of Cleary's Hill, north of Tamworth, and the underlying claystones, and considered that the former was the equivalent of the Baldwin Agglomerates, and formed the lower part of the Upper Devonian system, which lay conformably on the Middle Devonian rocks. In addition, it was suggested that there was a strong fault running approximately in the valley of the Peel and Cockburn Rivers(**14**).

This divergence in the conclusions drawn from palæontological and stratigraphical evidence as to the correlation of the limestones, and the different interpretation placed on the agglomerates, were clearly matters calling for investigation. Moreover, it seemed possible that, by detailed mapping, horizons of reference might be discovered, by which the tectonics of the district might be worked out, and a closer approximation made to the true thickness of the formations present, than was formerly possible. There were also the problems of the conditions for the deposition of radiolarian sediments, and the mode of origin of the "intrusive tuffs."

The area studied stretches along the northern side of the Peel River from Moore Creek to Nemingha Creek, a distance of seventeen miles, and, with a small area south of the river, it comprises eighty square miles, including the Parishes of Woolomol, Tamworth, and Nemingha, and portions of the Parishes of Moonbi and Calala. A topographical and geological map of this was prepared by a survey with a plane-table, and contour-lines were drawn thereon at intervals of two hundred feet, determined by aneroid-readings. The datum-points were the railway stations of Tamworth, Nemingha, Tintinhull, and Moonbi (now renamed Kootingal), which are respectively 1279, 1351, 1330, and 1381 feet above sea-level. The results of the geological and petrological work, and of the determinations by Mr. Dun of fossils collected, are here presented; the physiography will be discussed in another communication.

The result of the work, as will appear, has been to confirm the main points of the views held by Messrs. David and Pittman, though some modification of the details has been found necessary. It seems fitting to acknowledge here the generous help of the officers of the State Geological Survey, and the writer's constant indebtedness to Professor David for advice and encouragement, both in the laboratory and in the field.

General Geology and Tectonics.

The result of the present examination shows that the fourfold subdivision of the Devonian system, formerly proposed by the writer, holds good for the Tamworth district, though the definitions of the several sections need some modification, and it has seemed best to unite the two upper divisions, and to subdivide the large Middle Devonian series below these. On the other hand, it has been found that the subdivision of the Middle Devonian series, deduced from the study of the Nundle district(**15**), does not hold good here, for the reason previously suggested, namely, that the structure of the Nundle district is so complicated by strike-faulting that the apparent succession is probably not the true one. This appears very clearly from the structure of the Parish of Nemingha, which is in a position tectonically similar to that of the Nundle district. The succession in the less disturbed areas of the Parish of Tamworth is probably much nearer to the true stratigraphical succession, though even here are faults, the extent of which cannot yet be determined, which render all estimates of relative thickness of strata very unreliable. The absence of many good horizons, and the lateral variation of some of the formations are additional causes for uncertainty. On this account, we can no longer accept, as final criteria, the distinctions previously made between the cherts of the Tamworth Series and the mudstones of the Barraba Series, or between the pyroclastic rocks of the Barraba and Tamworth Series and the Baldwin Agglomerates. In spite of this, however, the general facies of a series of associated rocks is usually conclusive. It has been found necessary to separate the limestones of Moore Creek and Tamworth from those in the Moonbi (Nemingha) district, the stratigraphical evidence confirming Mr. Etheridge's conclusion, drawn from palæontological evidence, that the latter were on a lower horizon. There is reason to believe in the occurrence of a third limestone-horizon, the relation of which to the limestone of Moore Creek is not yet obvious. The three limestone-horizons have been termed the Nemingha, Moore Creek, and Loomberah horizons respectively. The last-named is as yet but little known, and its description is reserved until the study of the Parish of Loomberah is made. The several divisions of the formations developed will now be discussed in chronological order.

1. *The Eastern Series, partly of Lower Devonian age.*

It has been assumed in previous papers, that the rocks east of the serpentine, comprising jaspers, and phyllites, are largely of Lower Devonian age, and, to the Lower Devonian rocks proper, the name Woolomin Series has been applied. Unfortunately, they are so intensely folded and faulted, and have thrust in among them so much that seems to be derived from the Middle or even Upper Devonian Series, that it has not seemed worth while, at present, to attempt to disentangle the Woolomin Series from the others, if such a series should really exist. The whole complex, therefore, will be considered together under the term Eastern Series. The following discussion refers only to the nature and distribution of the several types of rocks developed.

One of the most striking features is the presence of a large amount of basic rock. This forms long intercalations scattered throughout the Eastern Series as shown (diagrammatically) on the Map (Plate I.). These consist of tuffs, breccias, and spilitic rocks, many of which, though more or less altered, are very similar to rocks occurring in the Middle Devonian Series. In the neighbourhood of the granite, they have been changed, into amphibolites, the zone of metamorphism extending from half a mile to a mile from the granite. This amphibolite occurs, for instance, in the north-eastern corner of the Parish of Nemingha, intercalated with mica-schist, and other masses run southwards through portion 155. Where the basic rocks cross the creek in portions 147 and 190, they form several narrow bands of spilite interstratified with jasper and chert. There is no clear evidence of pillow-structure, but some suggestion of it. South of this, spilite crosses Spring Creek as a thick band, partly schistose, partly massive, with some trace of pillow-structure. It is intersected by bands of jasper, and interstratified with highly crushed banded cherts, and with tuff-breccias like those of the Middle Devonian Series.

South of the watershed of Spring Creek, is a sharp hill, marked by a thicket of pine-trees. Here the rock is quite different, partly a tuff-breccia, partly a rather devitrified flow-breccia, of which the brown glass contains crystals of quartz and altered felspar, and pseudomorphs after felspar-augite. This zone of tuff-breccia is of great width, and is interstratified with cherts. It extends southwards across Oakey and Nemingha Creeks, in the beds of which it is well exposed. Many masses of spilite occur with some approach toward a pillowy structure, and intersected by abundant veins of secondary chert. The basic breccia is cemented into a uniformly resistant rock, which makes bold rounded outcrops.

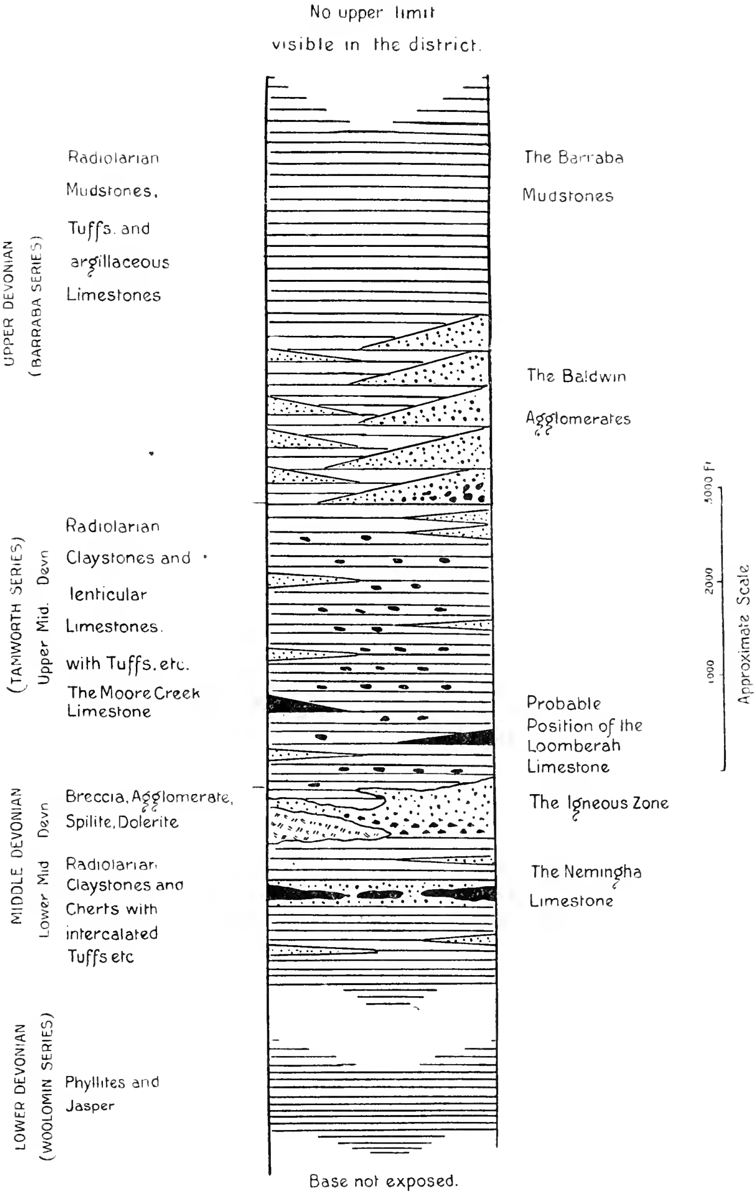
A very perplexing hill is that east of the northern end of the serpentine-belt. At its western base is a large mass of altered basic rock, probably of Middle Devonian age. Above these are fine grey rocks of quartzitic appearance, and greener masses, like altered tuffs and greywackes. Higher up, the quartzitic rock becomes more coarsely granular, and contains scattered crystals of felspar, and it is intersected by an occasional vein of jasper. The microscope reveals that the greenish rocks are highly altered silicified and strained tuffs, while the rocks of a quartzitic appearance are chiefly much crushed and metamorphosed keratophyres of a type that finds no analogy among the rocks of the Middle Devonian Series. All the rocks of this hill seemed to have been recrystallised under the metamorphosing influence of the adjacent granite. The details of the petrography are given below.

About a quarter of a mile south of this, is a large mass of tuff-breccia, lying east of the serpentine, but very closely resembling some of that to the west in the Middle Devonian Series.

The purely sedimentary rocks, in addition to the banded cherts, are jaspers, phyllites, rarely so fissile as slates, and generally pale brown or green in colour. These pass into jaspers, or are veined or interstratified with jasper. There is no exact analogy for these rocks among those of the higher series, unless they are derived from the Upper Devonian mudstones, which seems unlikely. It is these rocks, if any, that are to be considered of Lower Devonian age. It is quite impossible to estimate their thickness.

2. *The Tamworth Series of Middle Devonian age.*

The main interest in the stratigraphical portion of this paper, lies in this division of the geological record. We cannot yet, however, be certain as to the relative thicknesses of the subdivisions that have been adopted. The zones proposed depend partly on their lithological character, partly on the fauna of their associated limestones. In place of the single horizon of limestone formerly recognised, three are now believed to be developed, though the position of one of them is scarcely known at present. The three, in probable chronological order, are as follows: the Nemingha Limestone, the Loomberah Limestone, and the Moore Creek Limestone.



Text-fig. 1.—Columnar Section of the Devonian Series in the Tamworth District.

To see the succession most clearly, we must commence at the anticline in the valley of the Seven Mile Creek, and follow west along the line of section described by Messrs. David and Pittman. The lowest beds are radiolarian claystones, in places more or less cherty, and associated with several bands of tuff. Above them comes a narrow band of limestone, bent sharply by the anticline. It is not more than fifty or a hundred feet thick, and is so altered by the contact-effect of the adjacent granite, that its fossil-content is scarcely recognisable. The presence of *Favosites*, *Alveolites*, *Diphyphyllum*, and a pentameroid shell, was noted by the previous observers. For reasons which will appear subsequently, this limestone is considered to be on the same horizon as that which we have termed the Nemingha limestone. It is associated with more or less tuffaceous material. Above this commence the great thicknesses of radiolarian cherty claystones with lenticular, interbedded, radiolarian limestones, and vast quantities of pyroclastic material, that form the bulk of the Middle Devonian Series. Not far above the limestone, however, is frequently found a finegrained, grey, quartzitic rock, and, above this, is the greatest and most persistent of the zones of igneous rock. In this portion of the district, the Igneous Zone is composed chiefly of pyroclastic rock, though, elsewhere on this horizon, large masses of spilite and spilite-porphyry are developed. For convenience of reference, all the Tamworth Series up to and including the Igneous Zone are here classed as the Lower Middle Devonian Series.

The Upper Middle Devonian Series, above the Igneous Zone, consists of a great thickness of cherty radiolarian claystone, and banded cherts, with lenticular masses of radiolarian limestone, interstratified with pyroclastic rocks. This extends uninterruptedly up to the base of the Baldwin Agglomerates in the Upper Devonian Series. If we anticipate the discussion of the distribution of this series, however, it will be seen that, on two horizons in this sequence, limestone might occur. Northwards of Messrs. David and Pittman's line of section, the large mass of limestone on Moore Creek will be found to lie among radiolarian cherts above the Igneous Zone, but far below the Baldwin

Agglomerates. The horizon so determined is taken as the Moore Creek limestone horizon. South of the limits of the present map, in the Parish of Loomberah, is a richly fossiliferous limestone also occurring a short distance above the Igneous Zone, but differing in character from the Moore Creek limestone. This is accepted as marking another horizon, that of the Loomberah limestone. Very little is known of it as yet, and its relation to the Moore Creek limestone is undetermined. The presence of this limestone in the area covered by the present map is not fully proved, though two unfossiliferous masses in the south-eastern corner probably belong to it.

Fossils of the Tamworth Series.—The fauna of the Nemingha and Moore Creek limestones is tabulated below :—

NEMINGHA LIMESTONE.	MOORE CREEK LIMESTONE.
Lower Middle Devonian.	Upper Middle Devonian.
	*Lithistid Sponges (several undetermined species).
Favosites gothlandica var. *moonbiensis*.	*Favosites gothlandica*.
	F. basaltica var. *salebrosa*.
F. multitabulata.	*F. squamulifera*.
F. pittmani.	**F.* sp., cf. *pittmani*.
F. sp., cf. *forbesi*.	
**F.* sp.nov. *α*.	*F. crummeri*.
**F.* sp.nov. *β*.	**F. reticulata*.
	**F.* sp.nov. *γ*.
	**F.* sp.nov. *δ*.
**Stromatopora* sp.	*Stromatopora* sp.
**Stromatoporella*(?) sp.	*Stromatoporella*(?) sp.
**Diphyphyllum porteri*.	*Diphyphyllum porteri*.
	**D. giganteum*.
	D. robustum.
	**D.* sp.nov.
	Spongophyllum giganteum.

* *Tryplasma*, sp.†	
* *Sanidophyllum davidis.*	*Sanidophyllum davidis.*
* *Alveolites* sp.	*Alveolites subæqualis.*
	Litophyllum konincki.
	* *L.* sp.nov.
	Actinocystis cornu-bovis.
* *Cyathophyllum*, sp.nov.	*Cyathophyllum obtortum.*
	Microplasma parallelum.
* *Heliolites porosa*	*Heliolites porosa.*
* *H.* sp., cf. *interstincta.*	
* *Syringopora* sp.	*Syringopora auloporoides.*
	S. porteri.
*Monticuliporoid.	
Crinoid-stem ossicles.	Crinoid-stem ossicles.
Pentameroid brachiopod.	* *Pentamerus* sp., cf. *knightii*
* *Athyris* sp.	
* *Zygospira* sp.	
* *Cœlospira*(?) sp.	
	* *Atrypa* sp.
	* *Aviculopecten*(?) sp.
* *Cyclonema* sp.	
Indeterminate gasteropod, four inches long.	* *Vetotuba* sp.

In drawing up this table, the writer has had the privilege of using the collections of Mr. T. England, B.A., of Tamworth, and Mr. S. M. Tout, to whom he is greatly indebted, and, in these as well as in his own, occur several forms, kindly determined by Mr. W. S. Dun, which do not appear in the earlier lists. These have been marked with an asterisk.

It may be advisable to call attention to the points of difference in the two faunas. The Nemingha limestone is characterised by the abundance of *Favosites multitabulata* and of *F. pittmani.*

† Mr. Etheridge states that this species is very like *T. lonsdalia* var. *scalariformis*, which he has already recorded from the Nemingha Limestone (Memoirs Geol. Survey of N.S.W. Palæontological Series, No.13, p.81). He is preparing a description of this form, with others collected from the Devonian rocks of the Great Serpentine-Belt.

Stromatopora is fairly common, and a form of *Heliolites*, that is apparently not *porosa*, is occasionally present, while a certain species of *Tryplasma* is rather common The other forms are of less stratigraphical importance, and *Sanidophyllum*, though occasionally present, is very rare. The Moore Creek limestone is characterised by the abundance of *Sanidophyllum davidis*, *Spongophyllum giganteum*, *Actinocystis cornu-bovis*, *Syringopora auloporoides*, *Litophyllum konincki*, and *Heliolites porosa*, the last often forming very large masses. All these forms are rare or not developed in the lower limestone.

The study, by Dr. Hinde, of the radiolaria of the Middle Devonian Series included the description of fifty-three new forms(**10**); others still await description.

The Upper Middle Devonian claystones, but not, so far as is at present known, the Lower Middle Devonian, contain numerous casts of *Lepidodendron australe*, both in its normal form, and in the *Knorria*-condition. It may be found especially in Long Gully, and also in Loder's Gully, but is not so abundant here as it is in the Upper Devonian rocks.

Distribution of the Lower Middle Devonian Rocks.—Taking the limestone (associated with tuff), the cherty and quartzitic rocks, and the Igneous Zone as the characteristic rock-types of the Lower Middle Devonian Series, let us trace them northwards and southwards from the above-mentioned line of section, to ascertain the structure of our area. The northward-pointing arch of the limestone in the anticline in Seven Mile Creek, is met by another pointing southwards, and very sharply bent. Its two branches are close together, and, traced northwards, appear at intervals all the way to Moore Creek. They form narrow, lenticular patches generally closely associated with pyroclastic rocks, and frequently completely surrounded by them, or appearing merely as large or small inclusions of limestone in a mass of pyroclastic rock. This passage of a band of limestone into an igneous breccia containing fragments of limestone is a constant feature of this horizon throughout the whole of the Serpentine-Belt, as was pointed out in earlier papers, and is particularly well exhibited in the Nundle District(**15**). It is also seen in the Middle Devonian Series of the Dillenburg district, in Germany(**18**), in the Carboniferous formation of the Isle of Man(**19**, Vol. ii., p.25), and elsewhere. As will appear later (p.574), the same structure is developed in the Ordovician Series of the West of Ireland, in association with a varied group of rocks, some of which are remarkably like those of the Middle Devonian formation of New South Wales(**20**).

The various outcrops of limestone do not join up regularly into two lines continuing the branches of the Seven Mile Creek anticline. Sometimes three lines are present, sometimes only one. The grey quartzite appears here and there in small amount. The occurrences of pyroclastic rocks, which are indicated on the map in a generalised manner only, are equally irregular in their development, though all are approximately parallel. The dip of the rocks is very steep (60°-85° to the N.E. or E.N.E.), and the exposures in the steep easterly-flowing gullies show much shearing and shattering. All these features indicate that the Lower Middle Devonian Series in the narrow zone along the margin of the granite-massif, is affected by much strike-faulting and repetition, as well as simple folding. Intrusive into those rocks are some small basic sills of porphyrite; that occurring in the south-western side of portion 158, Woolomol, has phenocrysts of basic labradorite, and has suffered very little from the metamorphosing effect of the granite when compared with the pyroclastic rocks.

We return to Seven Mile Creek, and now trace the Lower Middle Devonian Series to the south-east. The continuous band of limestone ceases by the Loder's Gully track to Tamworth, but is represented beyond this by small isolated lenticular masses which run round the wide open valley of Seven Mile Creek, and, swinging round in a rough semicircle, are found again in the small ridge west of Tintinhull railway-platform.

Here the limestone is again associated with a small amount of pyroclastic matter. Below the limestone, the regular sequence of outcrops of claystones and tuffs curves in a similar manner, dipping to the south-west, south, and finally to the south-east. To the east of the anticlinal axis, they follow parallel to the boundary of the granite, and dip steeply to the north-east and north. They have here undergone considerable metamorphism, which has increased their resistance to erosion, so that they form a ridge between the granite and the valley of Seven Mile Creek. Thus this arching of the strata is not a simple anticline, but an ovoid pericline. The discontinuity of some of the beds suggests that some faulting is also present, but this cannot be proved. An apparent thickness of about a thousand feet of strata is exposed below the limestone.

Above the limestone are, here and there, masses of the fine-grained quartzitic rock, and a thickness (at Tintinhull) of approximately four hundred feet of claystones with some radiolarian limestones, and a small amount of pyroclastic material. Elsewhere this zone is of greater thickness. The angle of dip at times is quite small; one has been measured as low as 5° to the S.S.W. Above these comes the great mass of pyroclastic rock, which makes up the Igneous Zone. It is not more than one hundred feet thick at the head of Loder's Gully, but increases in width to the south, the outcrop being more than a quarter of a mile across. The very indented outline of this mass is partly the result of an interdigitation of claystones and tuffs, but may also indicate some repetition of beds by strike-faulting. The wide zone of pyroclastic rock forms the crest of the ridge between Loder's Gully and Seven Mile Creek, and, swinging round in conformity with the limestone, and becoming more coarse in grainsize as it turns, it is partly replaced by massive igneous rock (porphyritic spilite) about half a mile south-west of Tintinhull railway-platform. The line of junction of the massive and pyroclastic rock is not anywhere visible; indeed, there seems to be a passage between the two. On either side of the massive rocks is a varying amount of pyroclastic material, usually fine-grained. It varies somewhat in character; sometimes it has a granular base with a grainsize of about 0·5mm., but more usually the base is aphanitic and more or less vesicular. Except for the presence of vesicles, the rocks are very similar to those which occur in the Eastern Series, in the Nundle district(**17**, p.146). With these is a finegrained, apparently massive rock, which microscopical study shows to be pyroclastic. The matrix of the rock is the same as that of the more finely granular spilite-porphyrites, and contains some well shaped phenocrysts, but the majority of the larger grains, which are only 0·2 mm. in diameter, are fragments of albite-crystals. There are also fragments of a pilotaxitic, felspathic rock rather poor in ferromagnesian minerals (keratophyre), as well as others richer in these minerals (spilite). This rock is one of the most finely granular of the rocks which seem to have a character intermediate between that of massive and pyroclastic types.

The petrological character of this complex must be our guide to further unravelling the stratigraphy of the Lower Middle Devonian Series. The wide alluviated valley of the Cockburn River obscures any direct linking of the formations across the stream, but the exact equivalent of the Tintinhull spilite is found to form the small hill in portion 48, Parish of Nemingha, by Pullman's farm. The hill, which is probably divided by a fault, consists of two masses of porphyritic spilite, separated by a band of pyroclastic material. The upper mass shows some indefinite signs of ellipsoidal partings. The dip of the associated beds (W. 10° N. at 40°) shows that a syncline exists below the river, and that this spilite-mass may well be the same band as that occurring at Tintinhull. As this rock was fairly free from epidote, it was chosen for analysis, and proves to be thoroughly albitic (see No.1130, p.602).

Eastward of this hill, are phyllitic claystones and quartzitic rocks, resembling those that lie between the Igneous Zone and the limestone. But, in place of the limestone, the igneous band appears again, southwards from portions 66/148; its reappearance is probably due to a fault, rather than to anticlinal folding, as the dip is to the west also. The igneous series here consists chiefly of pyroclastic material, but on its eastern side is a mass of porphyritic spilite like that at Tintinhull. The thick pyroclastic series extends southwards for over two miles, and forms the greater part of the hill, which we will term West Gap Hill (see Topographical Map, Pl. xlix.). The indented outline of the igneous rock, and its repetition, probably indicate the presence of a group of strike-faults here. The nature of the rock varies to a certain extent; parts of it are richer than the remainder in fragments of keratophyre, and very coarse-grained agglomeratic rock, part of which is very ferruginous, occurs immediately west of the Gap. Associated with these is a red finely granular to aphanitic tuff, that appears quite massive in hand-specimens, save for the presence of a few larger fragments. The associated cherts are interbedded with tuffaceous material, and the beautiful instance of an intrusive tuff, which is discussed below, came from this spot. See Text-fig.5 and Plate liii., fig.10.

The mass of tuffs and breccias is invaded by a small intrusion of dolerite in the southern end of the hill. On the northern end of the hill, a spur runs towards the forking of the roads. This consists very largely of banded claystones and grey quartzite like that at Tintinhull. At the base of the hill, and following up the Gap Road, is a series of limestone-outcrops. One of these, the large mass exposed in portion 163, was the source of the fossils described by Mr. Etheridge from "Beedle's Freehold"(11). The limestones north of the Gap are usually grey or white, and are more or less associated with tuffaceous material (see p.575). South of the Gap, the limestone has a reddish colour, doubtless connected with the presence of ferriferous keratophyres. (See chemical analyses, p.611). A small quarry was opened in these to exploit the Nemingha crinoidal marble; several varieties of ornamental stone were obtained, of which beautiful examples may be seen in the museums of Sydney, particularly the Technological Museum. [See the coloured illustration in(13)]. The stone has not yet been put to much use commercially. This is the typical occurrence of the Nemingha horizon, and the stratigraphical details mentioned above are the grounds upon which it is correlated with the limestone of Seven Mile Creek. For some distance south of here, as will appear more particularly in a later communication, the limestone is directly associated with massive, brecciated, ferruginous rocks, keratophyres and the like, and is separated from the Igneous Zone by a considerable thickness of claystones and cherts. The close approximation of the limestone and the Igneous Zone in the Gap must be due to faulting. A small fault is visible by the limestone-quarry, marked by a breccia of red and white limestone. The fauna of this limestone has been tabulated above.

Directly east of the Nemingha limestone zone is the largest mass of porphyritic spilite that occurs in the district; it forms the ridge termed East Gap Hill. This, also, must be correlated with the Tintinhull spilite. The southern end of the hill consists of pyroclastic rocks, with the seemingly massive, ferruginous keratophyre-breccia like that on West Gap Hill. This passes without any junction-line into a very vesicular porphyrite, and, on the top of the ridge, into a slightly vesicular porphyrite, with phenocrysts of albite, and a subvariolitic groundmass of felspar, uralite, and chlorite (see Text-fig.4, p.565). Except for the greater abundance of the felspar, the mineral-composition is exactly that of the spilites of Tintinhull, and there is little reason to doubt that this is but a thicker, and more coarsely crystalline portion of the same mass as the other rocks, brought by faulting or folding into its present position. The northern end of East Gap Hill is occupied by a mass of rather decomposed dolerite, which invades the spilite-porphyrite, and extends nearly to the Cockburn River. This intrusion is partly albitic, but the greater portion contains andesine, or labradorite. We will return subsequently to discuss the manner of origin of the igneous rocks of East Gap Hill (p.564).

Eastwards of this occurrence of the Igneous Zone, we can not determine the tectonic structure with any degree of probability. No further zones of igneous rock occur, which resemble either the spilite-porphyrite, or the ferruginous keratophyre-breccias described above. Moreover, the angles of dip of the strata, when observable (and this is but seldom), afford no help, being usually almost vertical. However, the large mass of limestone in portion 91 and the eastern end of 88, though too altered for the preservation of fossils, resembles that of the horizon last described, and may be supposed to be the limestone that should occur below the spilite-porphyrite of the Igneous Zone on East Gap Hill. Isolated lenticles of limestone occur on the same horizon in portion 168, and are included in a mass of tuff-breccia in portion 207, while a possible continuation of this zone is shown by the small patch of limestone in the keratophyres of portion 175 (see p.572). The lenticles of limestone that lie about a quarter of a mile east of this line, in portions 180 and 216, are probably on the horizon of the Loomberah limestone. They are white, crystalline rocks, free from pyroclastic impurities, and all trace of fossils has been lost. East again of these, there is another line of doleritic intrusions, lying along the western side of Spring Creek. These may perhaps be correlated with the Igneous Zone. If so, we may class with the Nemingha horizon the series of limestones that occur in the creek-valley, and commence to the north with the large mass of metamorphosed limestone, in portions 88, 91, and 118, which is exactly like that described above. This is followed to the south by a series of small lenses of limestone, generally intimately associated with pyroclastic rocks, occurring in portions 126, 216, and 153. At the southern edge of the map in portion 121, is a large lenticular mass of white crystalline limestone, quite free from traces of fossils, about 400 yards long and 60 yards wide. This is probably on the same horizon as the limestone that occurred on the boundary of portions 180 and 216, and may tentatively be classed with the Loomberah limestone. The stratigraphy of the southern end of the area mapped is quite indefinite. To complete the tracing of the structure-lines, as far as is possible, one may note that, east of Spring Creek, in portions 113, 119, and 123, is a mass of highly altered dolerite, and other basic rocks, which may represent still another repetition of the Igneous Zone. Further repetitions of the rocks of the Lower Middle Devonian Series occur, as has been noted above, among the rocks of the Woolomin Series, and, together with them, make up the Eastern Series, which lies east of the Serpentine-Belt.

Distribution of the Upper Middle Devonian Rocks.—This series has been defined as that extending from the Igneous Zone, which closes the Lower Middle Devonian, upwards to the Baldwin Agglomerates. It includes the Loomberah and Moore Creek limestones, but, as these occur at opposite ends of the area mapped, their relation to one another is not known. Apart from these limestones, the Upper Middle Devonian Series is a monotonous succession of radiolarian claystones and cherts, with lenticular intercalations of radiolarian limestone, frequent casts of *Lepidodendron australe*, preserved in the radiolarian rock, with abundant masses of interstratified and intrusive pyroclastic rock, which show spheroidal weathering particularly well in the railway-cuttings. The interstratified tuffs may also show casts of *Lepidodendron* or contain radiolaria.

The limestones which occur at the extreme south-eastern end of the map, which, also, have been correlated with the Loomberah limestone, and the cherts associated with them, probably belong to this series; but the southernmost definite instance of its occurrence is afforded by the rocks that form the western slopes of West Gap Hill. The zone occupied by the series then follows the flexions of the Lower Middle Devonian rocks, bending with syncline and anticline, passes up Loder's Gully, and forms the hills by the Tamworth trigonometrical station, and the western slopes of the ridge extending to Moore Creek. Here the limestone occurs in abundance, and is the type-occurrence of the Moore Creek limestone. Only one band is present, but, as shown on the map and sections, (Plates l.-li.) it is much folded, faulted, and repeated. The previous writers have stated that the limestone reaches a thickness of 1000 feet, but the writer has not seen any section showing a thickness of limestone which one can with safety assume to be more than 450 feet. The evidence available is too poor to admit of a more definite statement than this. The masses of limestone are lenticular in shape, and thin out, and disappear about a mile south of the creek. They are directly underlain and overlain by radiolarian cherts.

The greater part of the Upper Middle Devonian Series is repeated by the fault that runs along Spring Creek through the Tamworth Common, which fault was discovered by Messrs. David and Pittman(**9**). This is not a simple fault, however, but a fault-zone or plexus. In several places, the faults are made very obvious by the fact that the adjacent rocks have been strongly silicified or even metasomatically replaced by quartz, owing to the action of siliceous solutions rising in the fault-fissures. The lowest beds made visible by the fault are the clayshales and cherts, immediately underlying the limestone, which is obviously of the same character as the Moore Creek limestone, is silicified in the same way, contains precisely similar fossils, and is associated with similar rocks. The silicification of the limestone is very irregularly distributed; portions of some fossils may be replaced by silica, a sort of beekite, while the remainder may be pure calcite. Again, long or short, irregular, siliceous bands occur quite apart from the fossils, or, again, the fossils may be found to have merely an outer skin of silicification. The limestones on Spring Creek are divided up into small masses, partly, no doubt, by the plexus of faults (sometimes marked by fault-breccias), but also owing to the fact that they were originally formed as small lenticles, or masses which interdigitated with the claystones. This is clearly seen in a small cutting below the Corporation's stone-crushing mill (see Text-fig.2). These claystones

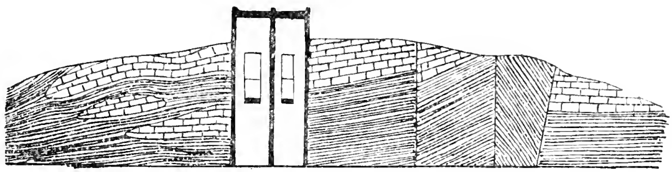


Fig 2.—Lenticular coral-limestone and radiolarian claystone of the Moore Creek horizon, exposed in road-cutting by the rock crushing plant on Spring Creek, Tamworth Common.

are of the normal siliceous type; they are not calcareous mudstones, such as one might expect if the coral-reef, that is now limestone, had risen to the surface of the sea, and had come under the shattering influence of the waves. In this way, the Tamworth and Moore Creek limestones differ from the Devonian limestones of Ohio, that were described by Grabau, and from other limestones of a like character(**21**).

Neither the Moore Creek nor the Tamworth limestone-occurrences are closely associated with any igneous rock, though a short distance above the limestone at Tamworth are a few thin bands of pyroclastic rock, and some very narrow layers of felspathic tuff, which show the clearest evidence of their intrusive character. Little veins, that break across the stratification of the claystones, project outwards from the otherwise apparently interbedded tuff. It was first pointed out to the writer by Mr. Aurousseau, B.Sc., that one of the bands of igneous rock about a yard in width, though no different to the naked eye from the normal fine-grained tuff, was really a massive and thoroughly albitised spilitic dolerite. Though a number of other fine-grained igneous rocks in the Upper Middle Devonian series have since been subjected to microscopic examination, this is the only massive rock yet found in that series. It occurs in the road-metal-quarry, at the southern end of the ridge beside the creek. In this quarry, and in that adjacent to it, are the most accessible examples of the interbedded lenticular radiolarian limestones. They occur up to six feet in length, and nearly two feet in width, but the majority are smaller than this. Some sign may at times be seen of a structure that has been most clearly observed in a limestone-lens at Nundle, namely, that the same lines of stratification as are in the adjacent mudstone continue right through the limestone, but are much further apart here than in the claystones. The bedding-planes of the claystones, therefore, appear to bend inwards at either end of the limestone-lens, and thus to follow its outline (see Text-fig.3). Presumably the lens was

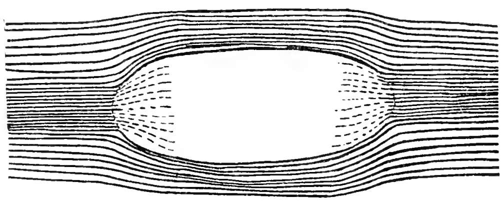


Fig.3.—Lenticle of Radiolarian Limestone.

formed by segregation of lime in the soft unconsolidated muds, which have subsequently been much more closely compacted by pressure of overlying sediment, etc., than the solid lens which had formed in them.

Below the limestone at the southern end of its outcrop, is a small anticline noted by the previous authors. It seems, however, to be most probably only the dragged-down edge of the strata adjacent to the fault.

West of this limestone-horizon, is the monotonous series of claystones and lenticular radiolarian limestones extending to the foot of the ridge between the Moore Creek and Manilla roads, which ridge is composed of the Baldwin agglomerates. For this reason, the claystones must be correlated with the cherty rocks that lie below the agglomerates, at the mouth of Long Gully, and would, therefore, indicate that a variation of the degree of silicification may occur when a series is traced along the direction of the strike. Such variation is, indeed, very common in the rocks of the Upper Middle Devonian Series, and often causes uncertainty as to the proper correlation of isolated occurrences.

The repetition of the Upper Middle Devonian Series is found again on Moore Creek, where the limestone itself is repeated in the small hill in portions 41, 42, 43 of the Parish of Woolomol, which is the top of an anticline. This limestone is exactly similar in all its features to the other large mass of limestone on the southern side of Moore Creek, and must clearly be correlated with it. Unfortunately, the whole of the central part of the Parish of Woolomol is covered with drift, so that the details of the stratigraphy are hidden. It may be safely assumed, however, that a fault separates the limestones in portions 41-43 from the pyroclastic rocks immediately to the west of them, as the intervening distance is far too small to permit of the unhindered development of that part of the Upper Middle Devonian Series which lies between the horizon of the Moore Creek limestone and that of the Baldwin Agglomerates.

The geological sequence is very indefinite south of the Peel River owing to the want of clear exposures. The Baldwin Agglomerates may be recognised on the hill east of Goonoo Goonoo Creek, and all the country east of these is made up of slightly silicified and soft radiolarian claystone, with lenticular limestones and pyroclastic intercalations. These most probably belong to the Upper Middle Devonian Series, but it has not been possible yet to link up definite bands of pyroclastic rock with similar bands north of the river. The alluvium of the Peel

River seems to hide some line of faulting or discontinuity, in the lithological character of the country.

Igneous Rocks of the Middle Devonian Series.

In the foregoing, the more important occurrences of igneous rock have been briefly mentioned, but no attempt has been made to discuss the conditions attending their development. This we will now endeavour to do. The most varied and instructive area is that of East Gap Hill, of which a sketch map is given (Text-fig.4). Passing from north to south, one has :—

1. Massive dolerite.
2. Porphyritic spilite.
3. Spilite only slightly porphyritic.
4. Vesicular spilite.
5. Passage-rocks between vesicular spilite and breccia.
6. Breccia or agglomerate.

There exists a very clearly marked boundary between the first two, but a gradual passage between all the other members. There can be no doubt that the dolerite is intrusive into the cherts, and also into the spilites. The relations of the spilites are not so clear. Along the eastern, and presumably lower side of the igneous mass, the boundary of the spilite seems to transgress the bedding of the cherts, and is rather irregular, though it is not clear whether it should be considered transgressively intrusive into consolidated cherts, or merely into the semi-liquid unconsolidated sediments on the sea-floor. This point was discussed in another connection in the previous paper(**17**). The igneous rock along this eastern (lower) side is locally brecciated, and such breccias, often with the relations of intrusion-breccias, may contain very vesicular patches. These vesicular patches of breccia may grade into massive vesicular rock and thence into the dense solid rock of the main mass of spilite. This seems to indicate that the igneous mass was intruded into sediments that were at least partially consolidated. From this edge of the mass, there projects a narrow tongue of solid spilite a short distance to the east, but it is not clear that this is a feeding dyke; it may be merely a portion of the mass displaced between two faults. The main mass of the intrusion, occurring on the top of the ridge, contains large and abundant phenocrysts of albite. These decrease in size as the rock is traced to the south, and the rock at the same time becomes more

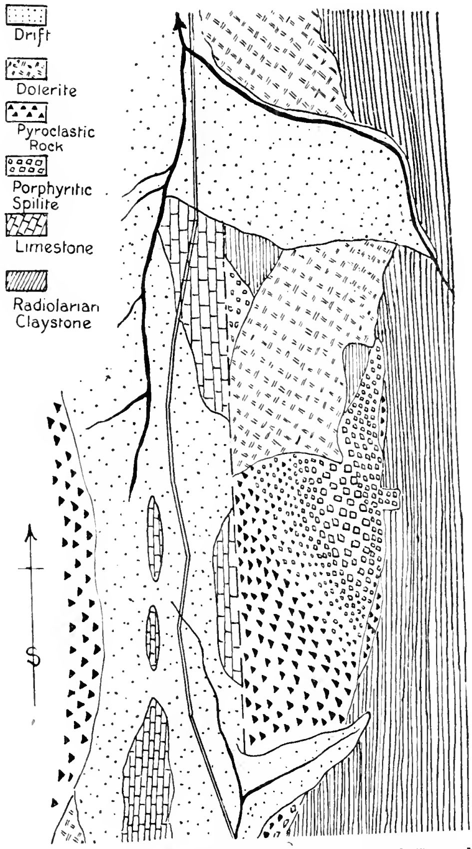


Fig. 4.—Sketch Map of the East Gap Hill Complex.

and more vesicular; it begins to take on a reddish tint: fragments make their appearance, and imperceptibly one passes into breccias and agglomerates, composed of more or less ferruginous keratophyres or spilites, in which the ferromagnesian minerals have been destroyed, leaving only a red staining of hæmatite. These are described in detail in a later portion of this paper. The relation of these breccias to the overlying sediments is obscured by drift. The Nemingha limestones follow immediately west of the hill, but are believed to be separated from the igneous rocks of East Gap Hill by faulting. They show no sign of contact-alteration, and there is other evidence of the presence of one or more strike-faults running through the Gap itself, *e.g.*, in the presence of a fault and a band of fault-breccia traversing the limestone in the "red marble" quarry in Portion 134. The problem is rendered more complex by the presence of tuffs in intimate association with the limestone, which often cannot be distinguished from those that occur in the Igneous Zone and lie stratigraphically several hundred feet above the limestone.

The igneous rocks of West Gap Hill are almost entirely fragmental. They are quite similar to those of East Gap Hill, of which they are, it is believed, the faulted equivalent They are sometimes very coarsely granular, the fragments being several inches in length, and include cherts and limestones, as well as igneous rocks. The cherts form particularly large angular pieces. This mass of fragmental rock is invaded by massive albite-dolerite, which occurs on the southern end of the hill. Various exposures show the relation of the pyroclastic and sedimentary rocks to one another, and the frequently intrusive nature of the former can be thoroughly substantiated. No single specimen, however, is more instructive than that shown in Text-fig.5, and Plate liii., fig.10. This consists of green banded chert, with intercalated bands of purplish pyroclastic material, which have a sharply marked boundary on the one side against the chert, and a gradual passage between the two rocks on the other. This is clearly due to successive small eruptions of tuff, which filled the sea with fine ash, that deposited in layers at first sharply distinct from the clay on to which it fell, but faded away gradually upwards, as the slowly settling remnants of the ashy material became more and more mixed with the normal sediment (radiolarian clay). Intrusive into this banded rock, and cutting across its bedding-plane, is a tongue of breccia, of the same composition as the interbedded tuff, though of larger grain-size.

The writer has not been able to find an account of associations of pyroclastic rock and sediment exactly similar to those of the

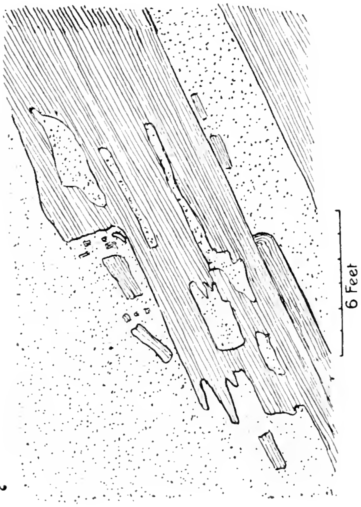


Fig.6.

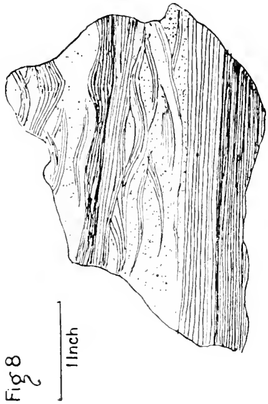


Fig 8

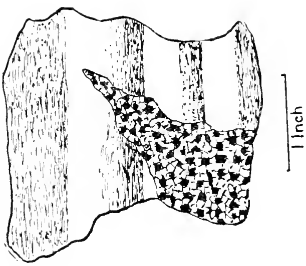


Fig 5.

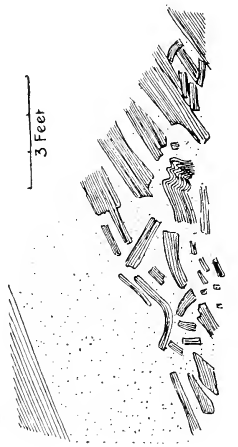


Fig 7.

Fig.5.—Interbedded and intrusive pyroclastic rock, West Gap Hill.
Figs 6-7.—Intrusive pyroclastic rocks, Railway-cutting, Nemingha.
Fig.8.—"Eddy-bedding" in claystone and tuff, Railway-cutting, Nemingha.

Tamworth District,* and has been led to adopt tentatively a rather speculative explanation of the features present. A fact

* See Postscript to this paper.

that is difficult to understand, is the almost complete absence of glassy matter among the pyroclastic rocks. As will be seen, they consist (*a*) of fragments of rocks passed through by the ascending igneous material, chert, limestone, etc., and (*b*) fragments, isolated crystals, and portions of crystals from medium- and fine-grained rocks of the dolerite-spilite-keratophyre series. In the case of the "intrusive tuffs," the rock consists largely of grains of minutely crystalline trachytic keratophyre, which recall the constituent granules in the brecciated keratophyre of Hyde's Creek(**17**). Though the ascending magma must have been rapidly chilled by the wet sediments, it must also have been charged with a considerable amount of water, from which it could not free itself. There would thus be a mineraliser constantly present during the period of consolidation, which might partly account for the advanced crystallisation, frequently very minute, of the rock. Also, any glass that formed in these conditions would probably be rapidly devitrified, and, indeed, much of the crypto-crystalline grains may be devitrified glass. The movement of the molten material below would break up the crust as it consolidated, and it would also be shattered by the strains produced in the necessarily rapid variations in temperature, so that, above the level where the crystallisation took place, the comminuted igneous material would move forward in the form of a watery slurry or mud. This mud would escape from the vent in which it rose, by the path of least resistance, which, under a considerable overburden of silt and sea-water, might sometimes be by intrusive injection into the surrounding partially consolidated sediments, at other times, by breaking through and discharging into the sea. This would doubtless be accompanied by more or less energetic convulsions. In the latter case, the igneous material would settle down on the sea-floor, as a band of tuff, either pure or mixed with normal marine sediment. Hence might arise the well ascertained fact, that it is often quite impossible, by purely petrographic means, to distinguish between a sedimentary and an intrusive pyroclastic rock in this district.

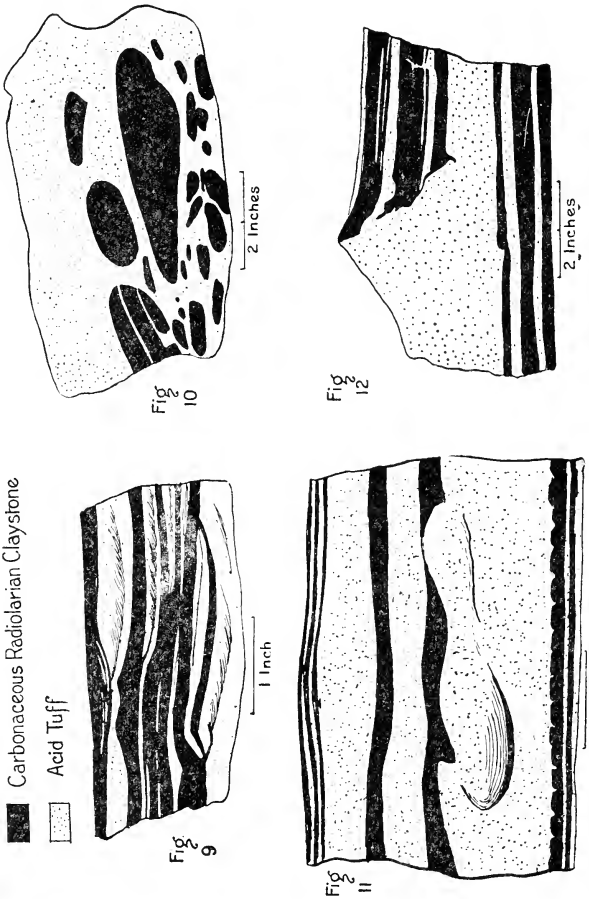
An objection to this explanation, which cannot yet be satisfactorily answered, is the uncertainty that the greatest depth which we can assume for the sea in which the sediments were deposited, would give an overburden of water and silt sufficient to act in the manner indicated. There would also need to be a rather nice adjustment of the rate of protrusion of the magma. If it were greater than that necessary for the development of intrusive tuffs, masses of lava would invade the sediments, and different features would result.

It seems possible to explain thus the passage between the massive and brecciated igneous rocks seen on East Gap Hill, and also, though not so clearly, on the ridge north-west of Tintinhull Railway-platform. The upper portion of a mass of lava intrusive into, or flowing through wet, semi-consolidated sediment, would naturally be especially liable to brecciation. Again, the abundant opportunity offered by such brecciation for the passage of solutions would be exceptionally favourable for the destruction of the ferromagnesian minerals, and the oxidation of their iron-content to magnetite and hæmatite. To some such processes, the peculiar features of the red breccias and agglomerates of East and West Gap Hills may owe their origin.

The sections exposed in the railway-cuttings between Tamworth and Tintinhull, particularly those immediately east of Nemingha, afford further examples of this phenomenon, as will be seen from the features illustrated in the figures herewith. (Text-figs.6,7,10,12).* An intrusion of pyroclastic material into partially consolidated sediment might be expected frequently to transgress the bedding-planes of the sediments, to crumple them, and to include numerous crumpled or uncrumpled fragments of them. The exposures illustrated clearly exhibit these features, and further indubitable evidence of intrusion is afforded by the microscopical preparation illustrated in Plate liii., fig.6. The original of this is in the collection of the Geological Survey of New South Wales (No.1190), and was one of the slides used by Messrs. Pittman and David in the preparation of their work. The writer is indebted to these gentlemen for permission to

* Compare with these illustrations the figure given by Sir A. Geikie of a breccia invading a slate (19, Vol. ii., p.50, fig.198). The explanation of this feature is not, however, applicable to the Tamworth rocks.

illustrate it here. Again, lateral injections and explosions within unconsolidated sediments of the character we are considering, would be accompanied by more or less sliding of the lamellæ over one another, which would result in the tearing up



Figs. 9 and 11.—Effect of lateral thrust on unconsolidated, interlaminated acid tuff and carbonaceous claystone, Railway-cutting, Nemingha.
Fig. 10.—Intrusive tuff with rounded inclusions of carbonaceous claystone.
Fig. 12.—Tuff intrusive into carbonaceous claystone, Railway-cutting, Nemingha.

of the lamellæ, and their injection into one another. This is particularly well shown when black carbonaceous layers alternate with white tuff. A specimen of this is illustrated by Text-figure 11. Again, the small convulsions caused by the ejection of material, would occasion some oscillatory movement in the water on the sea-floor, which might result in a sedimentary structure resembling current-bedding in the mass of the silt lifted and redeposited at each convulsion. The specimens illustrated by Text-figs. 8 and 9 may perhaps be an example of this. We may compare with figure 8, the illustration of false bedding in chert seen by Clements in the Pre-Cambrian rocks of Michigan, which are also associated with tuffs (**22**, Plate xxvii.). It must be noted, however, that ripple-markings were seen among these rocks by the previous authors(**9**). According to Hunt(**23**), these do not necessarily indicate a very shallow sea. They may form at considerable depths, as much as 188 metres in one instance cited. It is not clear to the writer whether the features seen in Text-fig.8 are the result of a general rippling oscillation or eddying produced as suggested above. The extremely local character of the phenomena may indicate that the latter alternative is the more probable.

Intrusions of pyroclastic rock into more consolidated chert would require more energetic explosions than those described above, and would result in much shattering. Rocks which illustrate this are very frequent along the west side of the serpentine in Spring Gully, and have been found in the Nundle District(**17**, pp.166-7.* See also p.575).

The conception here advanced, of the semi-liquid nature of unconsolidated fine-grained sediments, is in accord with the results of Dr. Sorby's studies(**34**). Injection of pyroclastic material into sediments with varying degrees of consolidation down to that of a "creamy" (*op. cit.*, p.197) consistency, would naturally result in an appropriate variety of intrusion-phenomena. Ejection into the open water, and normal sedimentation would be the limiting case.

Another igneous complex of great interest occurs in Mr. MacIlveen's property (Portions 180, 175, and 162, Parish of Nemingha), about two miles south of East Gap Hill. A sketch-

* In the first part of this series of papers(14), a different explanation of the intrusive tuffs was suggested, but experience has shown it to be untenable, and it has been withdrawn(17, *loc. cit.*).

map of this is given in Text-fig.13. It recalls some of the features of the Hyde's Creek complex(**17**). The western side of the area sketched consists of normal, steeply dipping, banded chert,

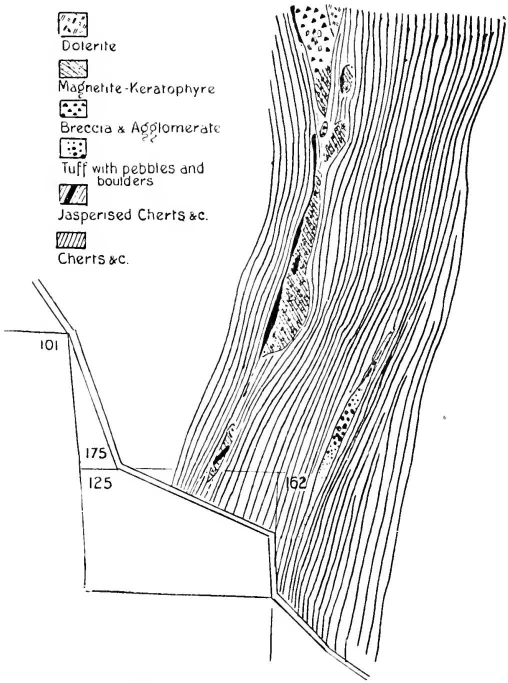


Fig.**13**.—Sketch Map, MacIlveen's Igneous Complex (Nemingha Parish).

which, at its contact with the keratophyre, is impregnated with hæmatite, or is changed into red jasper. The line of contact runs in a N.N.E. direction for half a mile, and then is deflected into a direction a little west of north. The keratophyre, east of this line, varies from a rock with very little iron-ore, to one rather rich in magnetite, which has been more or less replaced by hæmatite. There are also vesicular and slaggy varieties, as at Hyde's Creek. The keratophyre includes large fragments of limestone, and an intimate, breccia-like mixture of limestone, chert, and magnetite-keratophyre; it is also traversed by small veins of red jasper, and hæmatitic chalcedony. In microscopic structure, the rocks have many of the features of the keratophyres in the breccias of the Gap Hills. When traced northwards, the keratophyre becomes mixed with breccia, and coarse agglomerates, containing large boulders of a magnetite-keratophyre-porphyrite, while the northern extremity of the complex is a mass of coarse agglomerate, 100 yards wide, mixed with intrusions(?) of vesicular hæmatitic keratophyre, and large intrusions of massive keratophyre-dolerite, beside which is a large mass of the porphyrite. Brecciated jasperised chert occurs on either side of this. It would seem that, in this area, the intrusion of keratophyric dolerite and porphyrite was followed by a disruptive invasion of keratophyre, which broke up or brecciated the massive rocks, and emitted siliceous and ferruginous solutions, which jasperised the surrounding cherts.

Less than 200 yards south of this complex, is yet another feature of the igneous activity of no less interest, though differing greatly from the above. A band of apparently normal tuffaceous rock, at least 500 yards long, runs through Portion 162, Nemingha. It contains numerous small pebbly inclusions at the northern end, which are either angular or rounded and smooth as if waterworn. As we follow the band southwards, the pebbles increase in size until the tuff is full of large boulders, often beautifully smooth and rounded, sometimes as much as a foot in diameter. These pebbles often fall easily out of their matrix, and one would scarcely doubt, from the inspection of a pebble so isolated, that its shape was due to water-erosion. South of the point where the pebbles reach their maximum size, they diminish rapidly, and in 50 yards they decrease to their original diameter of less than an inch, and the tuff-band continues thus across the road to the south without any interruption. The distance from the northern to the southern point where the pebbles are not more than half an inch in diameter, is scarcely 200 yards. On either side of this band, which reaches a thickness of 30 yards, is normal, undisturbed, fine-grained, banded chert. There is a clear affinity, in lithological character, between the tuff-matrix and the inclusions. With a few exceptions, the boulders, though they may differ in macroscopic appearance, (they are purple, speckled grey, or green) prove to be porphyrites, composed of phenocrysts of augite and plagioclase, in a very fine-grained base. The exceptional rocks are certain rhyolitic keratophyres. The matrix is a brecciated crystal-tuff, of the same composition as the inclusions, and consists of minute fragments of these rocks, or of their phenocrysts. These are sometimes so closely and regularly packed together that it is difficult, at the first glance through the microscope, to distinguish between the matrix and the inclusion. These features must owe their origin to one or both of two causes: either the mass is a deposit of volcanic ejectamenta, which were rounded by attrition in the vent; or it is detritus from a volcanic cone, which reached above the surface of the water, and gave an opportunity for the shaping of the blocks by wave-erosion. It is difficult to decide which was the paramount factor. In either case, the rapid variation in the size of the boulders, shows that the rocks exposed were deposited near the source from which they were distributed, whether this be the centre of eruption, or the outlet of a valley which cut into the volcanic mass. The very small thickness of the mass, and the very regularly banded and minutely granular character of the sediments above and below the igneous material render the wave-erosion hypothesis difficult of application unless it be considered that this exposure is on the outer fringe of a large mass of ejectamenta, of which there is no other sign in the vicinity.

Another feature, which we may associate with the explosive action of the igneous eruptions, is to be found in the nature of the limestones. These show many features identical with those described by Messrs. Gardiner and Reynolds from the Ordovician rocks of the Tourmakeady District, County Mayo, Ireland. Besides the normal, massive, coral-bearing limestones, there are to be found, in the Parish of Nemingha, "limestones brecciated *in situ*, pink or white rocks, which, after being cracked into numberless pieces, have been recemented by the deposition of material into the cracks," and, even more frequently, "limestone-breccias, a coarse type of which contains angular blocks of limestone, red, pink, or grey in colour, and horny or crystalline in texture, intermingled with angular blocks of red or green felsite," which, on microscopical examination, proves to be keratophyre or spilite, as the writer understands, is also the case with so-called felsite at Tourmakeady (see **20**). "The matrix, in which these blocks are embedded, is . . . . . . a calcareous ashy grit." The writer has "found no fossils in the matrix, although some of the included limestone blocks have yielded a rich harvest of fossils." The mass of limestone in Beedle's Freehold, Portion 163, Nemingha, is of this character. As in the case of the rocks described by Messrs. Gardiner and Reynolds, so here, "it seems impossible to avoid the conclusion that, after the deposition of the fossiliferous limestone, it was in some cases broken up by volcanic eruptions, and the fragments, accompanied by fragments of felsite, were embedded in a tuff which thus must be of later date than the limestones. It does not, however, follow that there was any very great interval of time between the deposition of the limestone, and its disruption, succeeded by the embedding of its fragments in a coarse tuff. . . . The view of the explosive origin of the limestone-breccia affords an adequate explanation of its patchy mode of occurrence." The writer cannot find words more appropriately descriptive of the brecciated limestone of the Nemingha horizon than those used by the authors cited.

One would naturally expect that brecciated cherts and claystones should occur in an analogous manner, either with or without intermingled tuff. Such rocks are well developed in the Middle Devonian Series west of the serpentines in Spring Creek, and are particularly abundant in the Eastern Series on the opposite side of the valley, which rocks are considered to be an infolded repetition of portion of the Middle Devonian Series. It is not necessary to describe these in detail; they are naturally connected by intermediate types with those described above (p.571).

There remain to be considered the more massive intrusive rocks. One of these is a porphyrite, the phenocrysts of which are greatly shattered, though the rock appears to be massive This forms a small mass in Portions 213, 214, or 216, Parish of

Nemingha. It was, unfortunately, not exactly localised, and the writer could not find it on a second visit to the place of its discovery. It is described below (see p.598).

The intrusions of dolerite at the extreme south and north of the long complex, of which East Gap Hill is the central part, are normal dolerites, the felspar of which is labradorite; but several specimens from the central portion of this mass are albitic. So far as can be seen, there is no evidence of the formation of adinole in the cherts, associated either with the albitic or the non-albitic dolerites, nor is there any difference recognisable in hand-specimen between the two types of intrusive rock. The microscope shows that the albitic rocks are thoroughly uralitised, but some of the calcic dolerites are also considerably altered. The dolerite in Portion 166, Nemingha, contains veins of epidote, with which is associated a large amount of axinite. The discovery of this is due to Mr. D. A. Porter. Axinite also occurs in the vesicles of the spilite-porphyrite on East Gap Hill. Nothing more can be said as to the source of the axinite than was said concerning that of the Nundle district, namely, that it probably is derived from the basic rocks themselves, and is not necessarily a product of the intrusion of the not very distant granite (see **17**, p.126).

There are, finally, a few small intrusions of quartz-keratophyre, of which the largest occurs on the extreme south of the area studied, Portion 171, Nemingha, while a series of smaller intrusions are to be found along the eastern side of the East Gap Hill zone of igneous rocks, and an isolated occurrence a quarter of a mile north of Housefield's Hill in the Parish of Woolomol. The characteristic feature of these rocks is the very great amount of strain-effect which they exhibit: the rock breaks with a peculiar jagged fracture, the felspars are often bent and broken, and the grains of quartz are shattered and ragged, with very undulose extinction. The reason of this great exhibition of pressure-effects is not at all clear. One may recall the fact that the keratophyres of the Nundle district showed strongly brecciated structures, and the suggestion made previously (**17**, p.164), that possibly these rocks owed their character to movements acting on a very viscous magma, during and after its consolidation. At the same time one must note as a fact at present without explanation, the very considerable resemblance between these acid quartz-keratophyres, and the veins of quartz and albite, that occur in the serpentine in other parts of the Serpentine-Belt (see **16**, p.691).

Barraba Series (of Upper Devonian age).

Two divisions of the Upper Devonian Series are recognised; the lower is the Baldwin Agglomerates, and the upper the Barraba Mudstones. This is in conformity with the classification adopted in the first part of this series(**14**). However, since the lower agglomerates are frequently not developed, it seems best to extend the term Barraba Series to comprise the whole of the Upper Devonian formation, and to recognise the Baldwin Agglomerates merely as a basal zone, which may or may not be present. Both divisions occur in the Tamworth District. We commence with the discussion of the agglomerates.

It was stated in a previous paper(**14**, pp.500-1) that the coarse agglomerates did not, as was previously supposed, rest unconformably on the banded claystones of what is now termed the Upper Middle Devonian Series, where they are exposed on the hills about Cleary's Selection, to the north-east of the Tamworth Common. The inference was drawn chiefly from a consideration of the lithological similarity between the matrix of the agglomerates, and the tuffs and breccias in the underlying Middle Devonian, as well as the overlying Upper Devonian rocks, and the criteria for the lithological proof of a conformity through continuous oscillatory change of condition, were discussed from a hypothetical point of view. This conclusion can now be thoroughly substantiated on stratigraphical grounds. The coarse agglomerates may be traced round the face of the hills from the Two-Mile Bridge, on the Peel River, south-east of Tamworth, until they meet the fault in Spring Creek, on the northern boundary of the Common. The boundary of the agglomerates is at every point, in complete conformity with the strike of the Middle Devonian rocks, on which they rest. Particularly clear proof of this, is afforded by the sections exposed in Long Gully, Cleary's Gully, the small gorge in portion 246, and again in Spring Creek in portions 148 and 237, and is sufficiently indicated in the map herewith (Plate l.). The agglomerates are interstratified with mudstones, and these also show dips conformable with those of the underlying rocks. The small gorge cited above shows a very instructive exposure of these rocks. Again, as mentioned by the previous authors, there are frequently short irregular beds of pebbles in the agglomerates(**9**, p.23), and if these represent the bedding-plane of the agglomerates, as observations at Borah Creek Gap, in the Baldwin Mountains, near Manilla, convinced the present writer that they do, there is additional proof of the conformity here claimed.

The mode of origin of the agglomerates is not directly obvious. They consist of fragments of chert, andesite, porphyrite, keratophyre, and rhyolite, with some limestone, set in a matrix exactly similar to that of the normal pyroclastic rocks, which is made up of close packed fragments of crystals and rocks, evidently derived from rocks of the same nature as those which occur as included pebbles. These pebbles are frequently very smooth and rounded, particularly in the lower portion of the series, though some angular blocks occur. Professor David was of the opinion that they were waterworn in many cases, but was doubtful whether magmatic corrosion had not played some part in the rounding of some of the larger blocks(**9**). The boulders and fragments reach a diameter of nearly a foot in the neighbourhood of Cleary's Hill, but diminish in size as they are traced to the north-west or south-east, and are rarely more than half-an-inch in diameter, where the rock appears on the railway-cutting by the Two-Mile Bridge, or in the valley of Spring Creek. The source of these boulders was, therefore, in the neighbourhood of Cleary's Hill.

In many features these agglomerates are analogous to those previously described (p. 574), but differ from them in their immense thickness, which reaches a maximum in the Tamworth Common of nearly 2000 feet, but dies out by interdigitation with Barraba mudstones. These interstratified mudstones are richer in *Lepidodendron* than any other rocks in the district, and casts of this plant sometimes occur in the igneous materail itself. There is thus less reason in this case to doubt the possibility of a volcanic cone rising above the surface of the sea. It must be noted, however, that there is not any great thickness of agglomerate, uninterrupted by intercalations of radiolarian mudstone, so that the sea-floor must have been sinking rapidly, and the islands, if formed, would not be of long duration. The largest rounded boulders are in the base of the series, lying on undisturbed claystones. The intercalated mudstones were not deposited on steep slopes, but are quite conformable with the claystones below the agglomerates, so far as can be determined; and the upper members of the agglomerate series show little or no sign of water-erosion.

The mudstones, and pyroclastic rocks have a varying degree of resistance to erosion. Strongly resistant bands, forming well marked outcrops, may often be traced for some distance, others die out rather irregularly. The map, in this region, does not pretend to have more than a general accuracy.

The mass on Cleary's Hill, which is taken to represent the base of the series, owes its great width of outcrop, not to its thickness, but to the fact that it slopes down the face of the hill. A certain amount of faulting occurs where Cleary's Gully debouches on to the Common, which makes estimates of thickness in this region very unreliable.

A second occurrence of the Baldwin Agglomerates is indicated by the rocks west of the limestones in Spring Creek, forming the ridge between the Manilla and Moore Creek roads. Here the coarse conglomeratic character has quite disappeared; the rock is merely a breccia, of medium grain-size, and the interbedded mudstones greatly predominate over the pyroclastic rock. The several bands of the agglomerate occupy the whole of the western part of the Tamworth Common, and, on the extreme west, are bent into an anticline. This anticline may be traced northwards to Moore Creek, but becomes rather flattened out. While much of the material in the agglomerate in this region, may have been derived from the centre of eruption near Cleary's Hill, there was evidently another point of eruption towards which these rocks may be traced, which is indicated by the prominent hill in Housefield's Selection, Portion 120, Parish of Woolomol. This consists of coarse bouldery agglomerate, the inclusions of which are similar to those on Cleary's Hill, and are so rounded as to resemble even more closely, normally waterworn pebbles, and these are abundant in the upper portion of the mass which is at least 200 feet thick, and is free from interstratified mudstones. North of the hill is a small dyke of keratophyric quartz-felpar-porphyry, fragments of which also occur in the agglomerate.

The horizon of the Baldwin Agglomerates seems to be represented south of the Peel River by the mass of agglomerate, that runs through the eastern corner of the town of West Tamworth, and through portion 27, Parish of Calala, as well as by a band of tuff in the valley of Goonoo Goonoo Creek, portions 15 and xx. Evidently the agglomerate has greatly thinned out in this direction. No continuation of the great mass of agglomerate that comes down to the north side of the river, at the Two-Mile Bridge, can be traced on the southern side; which is a further piece of evidence in favour of the view, that the Peel River alluvium conceals an important fault.

The line of junction between the Middle and Upper Devonian claystones and mudstones is quite an indefinite one, when there is no intervening development of agglomerate, as is the case with the majority of the boundary line drawn through the Parish of Woolomol. This line is, therefore, almost entirely arbitrary, and was drawn merely by reference to the occurrence of the limestone on the east and agglomerate on the west. The claystones of the Middle Devonian Series, when they have not been silicified into cherts, can rarely be distinguished from those of the Upper Devonian Series. There is probably a fault between the limestones and agglomerates in sections 41 and 44 respectively of the Parish of Woolomol, as they are much closer to one another than would be otherwise possible.

Above the agglomerates, extend the monotonous series of thick claystones, and mudstones, occasionally radiolarian, interstratified with some tuffs, just as has been described for the Barraba Series in previous papers. These occur typically in the south-western corner of the area shown in the map herewith. The fossils of this zone, apart from the radiolaria, which may occur in the tuffs as well as the claystones (see **10**) are confined to *Lepidodendron australe*, and fluted stems like Calamites, just as occur in the rocks of the Upper Middle Devonian Series.*

These fossils are particularly abundant in the gully traversing portion 59, Tamworth, "Porter's Gully" of the previous authors, where they occur in the mudstones that are interbedded with the Baldwin Agglomerates. They are fairly common elsewhere in this association. It remains to add that intrusions of felspathic tuff into the Upper Devonian mudstones, show just the same features as are exhibited in Figs. 9-12. Not infrequently the material of the tuff has been more or less impregnated with prehnite.

Tectonics of the Devonian Series.

It is now possible to summarise the main tectonic features, discovered by tracing such stratigraphical horizons as the district affords. For the central feature, there is the well-marked elongated pericline, the axis of which runs in a north-westerly direction up the valley of Seven-Mile Creek. Northwards, this is followed by close-packed anticlines, and "schuppen"-strips, extending to Moore Creek. Southwards, there is an interruption in the strike marked by the Cockburn River syncline, which has a north-easterly strike; and a parallel anticline to the west of it, the axis of which crosses the railway-line near the Nemingha platform. The Seven-Mile Creek pericline is thus the result of intersecting folds. South and east of this are the close-packed folds and "schuppen" fault-strips, that form the greater part of the Parish of Nemingha, and occur with even greater intensity of disturbance east of the serpentine.

* With regard to the remarks of the previous authors(**9**), concerning the downward range of *Lepidodendron*, nothing has yet been found to invalidate their conclusions. No *Lepidodendron* has been found at a horizon that can be proved to be lower than that of the Tamworth-Moore Creek Limestones, but some Lepidodendra, that occur in Loder's Gully, and in the railway-cuttings east of the Nemingha Siding, must be very close to the horizon on which the Moore Creek limestone would occur, if it were developed in this region.

Westwards from the pericline, the series continues with a south-westerly dip and decreasing inclination. There are probably one or more faults running to the west of the Igneous Zone, causing repetition of it. Again, there are the faults in the Tamworth Common, at Cleary's Hill, and at Spring Gully, which seem to extend to Moore Creek. These have a roughly meridional direction. The strata, however, do not follow this direction, but swing round to the north of the Tamworth Common, till they are dipping due south. This bend possibly represents the edge of another syncline with a N.E.-S.W. axis, of which the south-western limb has been cut off by the fault in Spring Creek valley. The strata to the west of this fault are flattened out, and are bent into a syncline, which can be traced northwards to Moore Creek, and southwards across the Peel River. Its axis runs in a direction trending N.N.W. to S.S.E.

Recognisable zones, wherever they have been found, are seen to have been repeated by faulting, and it is safe to assume that more strike-faulting must be present undiscovered in the monotonous series of mudstones and tuffs in the Upper Middle Devonian, and the Upper Devonian Series. The rarity of faults in the sections exposed in the railway-cuttings should, however, warn one against over-estimating this feature.

In addition to these roughly meridional faults, there are others which are more nearly parallel to the axis of the Cockburn River (and Tamworth Common ?) syncline. Thus there are two directions of folding and faulting in the district, with some lines following an intermediate direction. The question as to the relative age of the two at once arises. There is not yet, however, sufficient evidence to show the nature of the thrusts and movements that have brought about this reticulation of tectonic lines. In adjacent districts now under investigation, a different intersection of tectonic lines is observable, and, until more is known of these areas, a discussion of the tectonics of the region would be premature.

Thickness of the Devonian Series.

The facts recorded in the foregoing paragraphs show that the attempt to find definite continuous horizons, from which the tectonic structures and the thickness of the formations involved might be exactly determined, has been in a large degree unsuccessful. It has, however, been proved that some faulting is present, producing a greater degree of repetition of strata than was assumed in the previous estimate of the total thickness of the series, though the thickness of the individual beds of limestone, claystone, and tuff, and the total apparent thickness, were measured with great care. As yet, however, it is quite impossible to determine the exact amount which must be deducted from that total (9,260 feet). Plotting the old line of section on the new map, we find that the lower portion of the Baldwin Agglomerates on Spring Creek was included in the earlier total. The agglomerates here are as finely granular as much of the pyroclastic matter in the Middle Devonian Series, and they would naturally be classed with the latter, before detailed mapping had shown their connection with the deposit of large boulders on Cleary's Hill. To obtain the total apparent thickness of the Devonian rocks in this district, we must, therefore, add the remainder of the Baldwin Agglomerates, about 1000 feet and the thickness of the Barraba mudstone, *apparently* about 2400 feet. The columnar section given in Fig. 1 shows the relative thickness of the various subdivisions of the Devonian Series as far as can be ascertained at present.

Conditions attending the formation of the Radiolarian Rocks.

As this district is frequently cited as a classical example of the development of a series of radiolarian rocks in comparatively shallow water, the subject should not be passed over in the present communication; but, as further studies are in progress in adjacent areas, where similar rocks are developed, and much remains to be investigated, we will merely note the bearing of the new observations on the views of the authors who studied the question here previously. According to them, the radiolarian rocks "were deposited in clear seawater, which, though sufficiently far from land to be beyond the reach of any but the finest sediment, was, nevertheless, probably, not of very considerable depth"(**9**). This conclusion was based on the following considerations:—(1) The presence of ripple-marking, (2) the abundance of plant-remains indicating the proximity of land, (3) the absence of any coarse terriginous sediment, and (4) the intercalation of coral-limestones. The present writer concurs entirely with these conclusions. The only consideration which gave rise to some doubt was the possibility that the Baldwin Agglomerates, now proved to be interstratified in the radiolarian series, might owe the rounded character of their inclusions to water-erosion. The present study, however, tends to the conclusion, that, even if this were so, as seems possible in some cases, this would not indicate the presence of a persistent coastline, but only the development and rapid destruction of islands, which were the summits of masses of agglomerate erupted from vents in the flat floor of the sea. The development of the Baldwin Agglomerates marks an epoch when such great eruptions were in progress. It is not yet clear that the building of volcanic islands characterised the eruptions, that produced the Igneous Zone in the Middle Devonian Series. The eruptions may have occurred at a considerable distance from a persistent coastline. Except for the products of these great eruptions and the many minor convulsions, the sediments are of the finest grainsize, and largely composed of the remains of radiolaria. The depth of the sea in which they were laid down, must have been sufficiently great to give the overburden requisite for the production of intrusive tuffs, and sufficiently shallow to permit of the formation of ripple-markings, and coral-reefs. The exact depth at which this balance was obtained cannot be estimated with any precision. Doubtless it varied somewhat, as the presence of definite zones of limestone would lead one to infer; but as the radiolarian rocks, with interbedded and intrusive tuffs, adjacent to the limestones, are quite similar to those elsewhere in the series, there is no reason to assume that these variations were large. We may, perhaps, conclude that there is no evidence that the radiolarian rocks were formed at a depth less than the maximum at which it was possible for the limestone to have been formed. The work of Darwin, Dana and many others has shown that the reef-building corals in the modern seas, do not live at greater depths than about fifteen or twenty fathoms, though certain isolated forms extend much further down. The corals of the past seem to have had the same general range. [The evidence for this statement has been recently summarised by Grabau(**21**)].

Serpentines, etc.

As in the areas described in former papers, the serpentine follows the line of fault, which separates the highly disturbed rocks of the Eastern Series, from the less crumpled rocks, which lie to the west. The band of serpentine varies greatly in width. At the southern end of the map, on Nemingha Creek, it is not more than 50 yards across, and is even narrower a short distance to the north. It is much broader at the head of Spring Creek, being nearly 300 yards wide there, and then tapers gradually northwards, dying out completely in Portion 144 of Nemingha Parish. The fault-line may, however, be traced into Portion 169, where there is a small lenticular area, about ten yards long, composed of ferruginous carbonate rock, such as represents the serpentine in other portions of the Serpentine Belt, as in the Nundle and Crow Mountain districts.

The serpentine is mostly of the sheared, chrysotilic variety; some massive bastite-serpentine is present, and a little antigoritic rock. Other alteration-products are rare. A chalcedonic replacement of bastite-serpentine occurs in Portion 176, and opal, with dendritic markings, in Portion 129. Near this was found a small patch of olivine-gabbro, only a few yards in extent. The felspar of this rock was converted partly to saussurite, and partly to clinozoisite. Small segregations of chromite occur in the serpentine. With this, hyalite has been found by Mr. D. A. Porter(**4**).

In several places there are abundant intrusions of a porphyritic or massive dolerite in the serpentine. This rock has exactly the same characters as that occurring in a similar situation in the neighbourhood of Bowling Alley Point(**17**, p. 156). The individual masses are quite small, ten or twenty yards long, and about half as wide. Some are rather sheared. None appear to cut the serpentine transversely, but the individual masses may be fragments of larger instrusions torn apart by movements in the body of the serpentine. No dolerites of this character have been found outside of the serpentine.

The tectonic features of the serpentine-intrusion differ from those normal elsewhere in the Serpentine Belt, in the sudden bending of the serpentine into a north-north-easterly direction, where it approaches the granite. That this is not due to the wedging outwards of the strata by the invasion of the granite, is shown by the fact that the strike of the Devonian rocks continues almost unchanged, and is cut obliquely by the serpentine. We may, perhaps, see in this some evidence that the stresses, which determined the Cockburn River axis of folding, had begun to make their influence felt when the intrusion of the ultrabasic rock occurred.

Moonbi Granite.

About fourteen square miles of the area covered by the present map are occupied by granite. This is the southern extremity of a batholith which extends from Bendemeer to the north, in the direction of Attunga, to the north-west. According to Mr. E. C. Andrews(**12**), it is invaded by the more acid granite of Bendemeer, which forms resistant masses that stand out in relief above the more basic Moonbi granite. On the east, the granite is bounded by the jasperoid rocks of the Eastern Series, which, also have a high relief, and form the prominent peak of Bullimballa (Black Jack), about six miles to the N.N.E. of Moonbi. Both these prominences are, however, outside the limits of the area under discussion.

The granite is of coarse or medium grainsize, even-grained, or slightly porphyritic. It is fairly potassic, containing a considerable amount of orthoclase and biotite. Hornblende is the dominant coloured constituent, and sphene is generally present in notable amount. Mr. Andrews has compared this granite with the sphene-granite-porphyries of northern New England, to which he attributes an early Mesozoic age(**12**).

The granite is invaded by a variety of vein-rocks; aplites, with druses containing crystals of quartz with a mica like zinnwaldite, occur associated with veins of quartz bearing small amounts of molybdenite, in the high ridge between the Cockburn River and Moore Creek. Various types of pegmatite, either graphic quartzose pegmatite, or more richly felspathic rocks, often containing a little tourmaline, are to be found near the Kootingal railway-station, and a beautiful garnetiferous, and graphic tourmaline-aplite, is developed on the travelling stock-route, in the north-eastern corner of the Parish of Tamworth. Dykes of finely granular rocks of intermediate composition are found, and are best described as microdiorite and micromonzonites, or diorite and monzonite aplites; and a peculiar lamprophyre, which has the mineralogical composition of an augite-minette, and contains spherulites of quartz and felspar. A few dykes of pegmatite and quartz-porphry extend from the granite into the surrounding Devonian rocks, but only for a short distance. This absence of an extensive series of dyke-rocks is a characteristic feature of the Moonbi granite.

The metamorphosing effect produced by the granite on the surrounding rocks has been considerable, and is especially noteworthy in the limestones, and the pyroclastic rocks. In the latter, it generally has the effect of causing the augite to change into the stable actinolite, rather than into chlorite, the ilmenite is replaced by sphene, and the felspar is recrystallised, sometimes as a mosaic of minute, indeterminable, untwinned grains, and sometimes in clear crystals of andesine. In the more altered types, abundant tiny plates of biotite are formed, the calcite in the vesicles, or irregularly distributed throughout the rock, passes into garnet, and, still more rarely, some secondary pyroxene is developed at the expense of the amphibole. These rocks are best developed in a railway cutting east of Tintinhull, while the most altered garnetiferous types occur in Portions 113, 123, and 169, Parish of Nemingha. Rocks with secondary pyroxene also occur in the north-eastern corner of the Parish of Tamworth. Associated with the garnetiferous rocks in Nemingha, are massive hornblende-schists, representing former dolerites, and garnetiferous hornblende-schists, that were, in all probability, amygdaloidal spilites. The hornblende-schists, which extend southwards from Portion 157, and those occurring in Portions 42, 63, and 64, Nemingha, are probably also altered spilites. The zone of alteration of the igneous rocks varies somewhat in width; generally, it is about a quarter of a mile across.

The zone in which alterations of the limestone are recognisable is less extensive. The limestone in Seven-Mile Creek is greatly altered within a furlong of the granite, but, beyond that, it is unchanged or merely recrystallised, with the partial obliteration of the fossils. In the more altered parts, the limestone is changed to silicates such as garnet, wollastonite, diopside, and vesuvianite; but sometimes traces of the fossils are preserved among them, as noted by previous authors.

In the Parish of Nemingha, the limestones are much less altered. All the fossils have been obliterated near the granite, but comparatively little silicate-mineral has been formed. Where, however, the limestone was originally mixed with tuffaceous material, there are druses filled with calcite, epidote, and vesuvianite; and in the adjacent, often quartzose, tuffs there are regenerated felspars, with diopside and garnet. These druses, doubtless, represent original inclusions of limestone in pyroclastic rock.

The clayslates and cherts show least sign of alteration. The metamorphic zone extends barely 100 yards from the boundary of the intrusion. The most altered rocks are those which form the small patch of sedimentary rock that is completely surrounded by granite; this occurs in Portion 76, Tamworth. These consist of a highly crystalline, biotite-schist, containing veins and knots of granite and pegmatite. Less altered schists occur at the foot of the hill in Portions 42 and 64, Nemingha, and in Portions 178 and 183, Tamworth. Generally, however, the contact of the sedimentary rock and the granite is hidden by drift. The greater part of the boundary, as plotted on the map, was obtained by linking up isolated exposures of the contact-line, seen here and there in creek-beds.

The form of the granite-mass calls for comment. The previous authors showed that the margin of the granite in Seven-Mile Creek is concordant with the strike of the sedimentary rocks, and stated that the latter dip *beneath* the granite, which, they accordingly suggest, is of the nature of a laccolite(9). While unable to confirm this observation, the writer finds that the constant dip of the sediments *towards* the granite is a marked feature of its western margin, and certainly suggests that the limits of the granite-intrusion may have been determined by the tectonic structure of the invaded rocks. It seems quite clear, however, that the granite, if laccolitic, did not extend far over the Seven-Mile Creek anticline. The rocks that form this structure are very little altered, while the rocks, which, in Erdmannsdörfer's view(**24**), are to be regarded as the Devonian and Carboniferous rocks altered by the overlying laccolite of the Brocken granite, are the highly altered series, that form the Eckergneiss.*

The southern margin of the granite is quite transgressive. It seems to be no more than a coincidence that part of it is approximately parallel to the axis of the Cockburn River syncline, for elsewhere it cuts right across the axis, and also across the several repetitions of the Lower Middle Devonian Series, the Serpentine Belt, and invades the Eastern Series. Hence we may conclude that the folding of the Devonian rocks, both along the main structural N.N.W.-S.S.E. axis, and the subsidiary N.E.-S.W. axis was accomplished before the intrusion of the granite occurred. The absence of any noteworthy gneissic structure along the margin of the granite is also evidence towards the same conclusion.

Tertiary Basalt.

A small plug of basalt occurs on the western edge of Portion 83, Parish of Woolomol. It is roughly oval in shape, and about sixty yards long. It does not give any noticeable relief. The rock is granular or aphanitic, with small crystals of olivine, and is massive or slightly vesicular. The microscope reveals the presence of cognate xenoliths of olivine, pyroxene, and picotite, and very interesting vesicles filled with natrolite and opal, which seem to be of primary origin. In general character, the rock is quite analogous to the majority of the Tertiary basalts in other parts of the State.

Terrace-Gravels.

On either side of the Cockburn and Peel Rivers, may be seen terraces of gravels lying thirty or forty feet above the present

* Goldschmidt, however, doubts the possibility of such gneisses being produced under so small a pressure as Erdmannsdörfer assumes(26).

flood-plain. The best examples of these are the gravels south of the Cockburn River, near Kootingal railway-station, which are exposed in the road-cutting by the Public School. A large terrace covered by gravel, also occurs on the point between the Peel River and Goonoo Goonoo Creek, in Portions 15 and 21 of Calala Parish, and smaller masses at other points, *e.g.*, by the railway-viaduct at West Tamworth, in Portions 1 and 30 of Calala Parish, and north of the Peel River by Nemingha railway-platform. These consist, for the most part, of pebbles of jasper and quartz, with a binding of clay and red loam. Scattered pebbles of rocks of the Eastern Series can be found in several other spots, and doubtless represent other terraces, now more or less destroyed. Practically all the pebbles in the terrace-gravels have been derived from the Eastern Series.

Drift.

The masses of drift have not been separated from the terrace-gravels in the map, though they are a noteworthy feature in the agricultural geology of the district. We may distinguish stream-drift, the material brought down and deposited in an irregular manner, by the tributaries of the main rivers, and superficial drift, flanking the bases of the hills and accumulating through general soil-creep, etc., and, generally, any widespread deposit not flood-plain alluvium, which completely hides the underlying rocks.

The stream-drift deposits are well seen in the valleys of Nemingha and Gap Creeks, in the south of the Nemingha Parish. The latter has entirely filled its valley, and does not debouch as a single stream; the former had also a wide distributary area, but has recently been confined to a single channel. Spring Creek, by the serpentine, has also a great accumulation of detritus: and isolated patches of gravel, high above the present creek, as on Portions 70 and 85, indicate where the older stream-drifts of this creek joined with the terrace-gravels. These drifts cover the western margin of the serpentine to a great extent. To a combination of stream-drift and soil-creep is due the great thickness of gravel and soil along the foothills of the range behind Tamworth, and, in particular, that between Long Gully and Cleary's

Gully. Again, the drifts covering the margin of the granite in the Parish of Woolomol have this conjoint origin. The very large amount of drift at the present head of Seven-Mile Creek has been preserved in its present position by the capture of the headwaters of this stream, which now flows northward as Daruka Creek, to join Moore Creek. It is probable that the broad areas of drift that form the central part of the Parish of Woolomol similarly owe their preservation to the capture of their parent-stream, of which the headwaters are known as Levy's Springs, by Spring Creek, which runs through the Tamworth Common.

Where the drift is entirely derived from mudstones, it decomposes into a clay suitable for the manufacture of bricks. The clay-deposits of this character at West Tamworth are more than twelve feet thick.

A considerable thickness of stream-drift lies below the alluvium of the flood-plain of the Peel River. From records in the Department of Public Works, kindly placed at the writer's disposal by the Chief Engineer for Railway Construction, it is to be seen that the bed-rock of the Peel River valley at the railway-viaduct lies at a depth of forty to fifty feet below the present land-surface. The basal portion of the drift consists of from two to four feet thick of clay, which is covered by clay, gravels, and drift up to a thickness of twenty-four

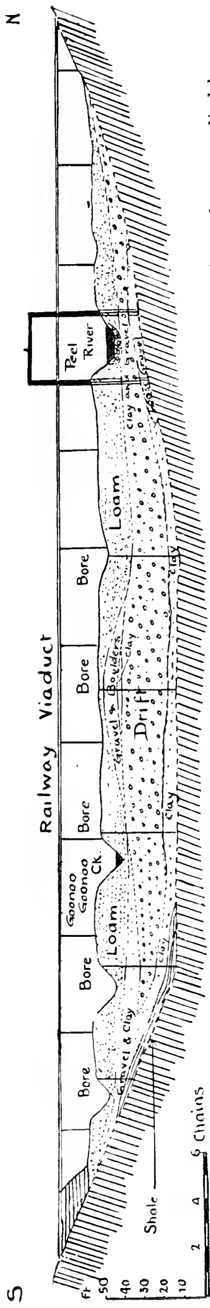


Fig. 14.—Section showing the alluvial deposits in the valley of the Peel River at Tamworth, from data supplied by the State Department of Public Works.

feet, with a bank of gravel and boulders in the centre of the valley ten feet high above this. (See Text-fig.14).

Alluvium of the Flood-plain.

The broad flood-plain of the two rivers is covered with a soft, black loam, of great agricultural value. In places, it is more than a mile wide, and is of varying depth, generally ten to fifteen feet. This is the depth of the soil by the railway-viaduct.

Petrology.

The following notes are based upon a study of about two hundred thin slices of rocks from the Tamworth district, of which seventy came from the collections of the New South Wales Geological Survey, and of the University, and were those used by Messrs. David, Pittman, and Card, in the preparation of the previous paper on this area. Attention has been devoted chiefly to the igneous rocks; the sedimentary and metamorphic rocks show a much smaller range of interesting features. The chronological order has been followed as far as possible in the sequel.

Eastern Series.

The basic rocks of the Eastern Series are spilites, vitrophyres, and hornblende-schists, the product of the contact-metamorphism of the spilites. The spilite, which crosses the head of Spring Gully, south of Portion 189, Nemingha, has a poorly developed ellipsoidal habit, is massive or slightly sheared, and of fine grain-size. It has a well marked subvariolitic structure (1354). The felspar has been largely changed to epidote, the remainder is glassy, and frequently untwinned; it is probably albite. The pyroxene is changed to chlorite, or remains quite fresh. It is a colourless diopside. Magnetite-crystals occur in abundance. There are small veins of epidote, quartz and chlorite. A completely epidotised rock was found by Mr. Aurousseau, as a pebble in Spring Creek, doubtless derived from the Eastern Series. It is very like the Pre-Cambrian spilitic dolerite, from Tayvallich, in Argyllshire, which was described by Dr. Flett(41), a specimen of which was kindly given to the writer by Dr. H. H. Thomas (a slice from specimen 13218 of the collection of the Geological Survey of Great Britain.) The preservation of the subvariolitic structure in the epidote is very distinct.

The amphibole-schist, derived from the metamorphism of the spilite, which occurs in Portion 155, Nemingha, is considerably decomposed (1338). The original structure has been entirely lost, and the large grains of plagioclase have been replaced by finely granulated albite, while the remainder of the rock consists of matted chlorite and actinolite, dotted with minute grains of titanomorphite. Another form of altered spilite occurs in the north-eastern corner of the area mapped in Portion 64, Nemingha(1323). It has completely lost its original texture, and has now the habit of a fine-grained amphibolite. It consists of a mosaic of interlocking grains of untwinned albite, actinolite scattered irregularly in isolated prisms or sheaf-like aggregates, and a little irregularly granular sphene, sometimes in small clusters. A few prisms of apatite are also present. Slide 1305, from the same locality, is probably an altered vesicular magnetite-quartz-keratophyre-tuff. It is a strongly schistose rock (see Plate lii., fig. 1). The grey, dusty, felspathic groundmass is too minutely granular for determination. It is sprinkled with small isolated prisms of hornblende, and well formed crystals of magnetite, evenly though not densely distributed throughout the rock. Interlaminated with the grey felspathic portions, or forming fragments in it, or apparently filling vesicles, is a mosaic of quartz-grains, with abundant prisms of actinolite. The rock has been so cut by "schuppen" shearing, that the form of these has been largely lost. They perhaps result from the recrystallisation of interlaminated and fragmentally included sedimentary material, and the infiltered infilling of vesicles.

The vitreous rock from Pine Hill (1119) has been described above (p. 547). It is more acid than most of the other rocks of spilitic suite in the Eastern Series.

Igneous Rocks in the Middle Devonian Series.

These rocks include many types of dolerite, spilite, and keratophyre, and the pyroclastic rocks, as well as the metamorphosed equivalents of these.

The dolerites differ from one another in texture, the composition of the felspar, and the nature of the pyroxene. The quartz-dolerite, which forms a very small mass in Portion 110, Nemingha (1132), is characterised by the presence of basic andesine or labradorite as the dominant mineral, as is also that which occurs near the magnetite-keratophyre in Portion 175,(1107, 1128), and that which invades the porphyritic spilite on the northern end of East Gap Hill (see Text-fig. 4). These rocks have a granitoid texture, the felspar-prismoids, being approximately idiomorphic, and often strongly zoned. The augite is of the normal character, slightly decomposed, and possessing a large optic axial angle. Quartz occurs in large grains, or in granophyric intergrowth with felspar. Ilmenite is abundant, and apatite rare, though some large prisms occur. The chemical composition of 1132 is given on page 74a; the composition of the felspar calculated from this would be $Or_7Ab_{47}An_{49}$, or, reckoning orthoclase as albite, $Ab_{52}An_{48}$, which corresponds with the result of the optical determination. The dolerite on the north of East Gap Hill contains some highly granophyric masses, while there is also some uralitised albitic dolerite, from Portion 204, Nemingha, which cannot be distinguished macroscopically from the adjacent calcic variety.

The porphyrite, which occurs in Portion 158, Woolomol(1162), is rather different from these. This is so free from any sign of contact-metamorphism, though within the zone of altered rocks, that some doubt must remain, as to whether it is really coeval with the Devonian doleritic series. It is, however, quite unlike any Tertiary basic rock known to the writer. It has a fine-grained base, consisting of prismoids of andesine, with chlorite replacing augite, titanomagnetite, a very little quartz and apatite. The phenocrysts are sometimes as much as 3 mm. in diameter. They consist of plagioclase, with zones of liquid inclusions, and have commenced to decompose. Its composition, determined from the Carlsbad-albite twin by means of Professor Becke's diagram,* is $Ab_{60}An_{40}$. The phenocrysts of augite are generally rather smaller, have a large optic axial angle, and are decomposed on the periphery.

Dolerites also occur with albite as their felspar, and of these there are two main groups, the granitoid and the poryphyritic. Rock 1120, which occurred adjacent to the rocks with basic felspars in Portion 175, Nemingha, is like them in texture and grain-size. The felspars are fresh and dusty, are slightly zoned, and have the composition of albite-oligoclase. They are almost idiomorphic, and are surrounded by a micrographic intergrowth. The pyroxenes are almost completely changed to chlorite, ilmenite is abundant, and quartz appears in a few separate grains, as well as in the intergrowths. A few large grains of apatite occur, but these are not present in the intergrowth. From its textural identity with the calcic rocks of the district, it seems possible that this may have been derived from such rocks by albitisation. Other albitic rocks are represented by slides 1024, 1030, 1039, 1048, 117 occurring respectively with porphyritic spilites at Tintinhull (Portion 123, Tamworth), in Portion 202, Nemingha, with spilites at Pullman's Hill, Portions 205, 48, Nemingha, in Portion 204 (the northward continuation of the belt of calcic dolerite which invades the porphyritic spilite of East Gap Hill), and in Portion 181, at the southern end of West Gap Hill, associated with pyroclastic rocks. The first four of these occur about half a mile from the nearest outcrop of the granite, and there is no definite evidence of contact-metamorphism. The plagioclase is clear, and very little, if at all, spongy. Quartz-grains occur in small amount, but there is no granophyric intergrowth. The ilmenite has been more or less converted into titanomorphite.

The porphyritic dolerites of Tintinhull have already been briefly described. They are sometimes aphanitic, with small often reddish phenocrysts of felspar (1138, 1160). This is a water-clear albite,

* As yet unpublished, but in use in the laboratory at Vienna, during the writer's visit in 1914.

quite idiomorphic, and either isolated, or associated in glomero-porphyritic aggregates, which are sometimes in ophitic relation to pseudomorphs after pyroxene. The original pryoxene phenocrysts were small and not abundant, and are now completely uralitised. The groundmass is very fine-grained, sometimes massive, sometimes with a strongly marked flow-structure, in which there are small string-like accumulations of magnetite. The constituent minerals of the groundmass are minute laths of clear felspar, amphibolitised and chloritised granular pyroxene, and magnetite. Epidote occurs with quartz in the vesicles, which are often abundant. Secondary silicification sometimes has replaced more or less of the felspar-phenocrysts (as in 1138), and veins of quartz may traverse the rock. Small accumulations of dusty hæmatite are not uncommon. The rock of Pullman's Hill, 48 Nemingha, is quite similar to the above, showing a good flow-structure (1130). Its chemical composition is given on p.602; the composition of the felspar calculated from this analysis is $Or_4 Ab_{66} An_{40}$, or $Ab_{64} An_{36}$, which is rather more basic than the composition determined by optical measurements. This discrepancy, no doubt, arises from the presence of chlorite and epidote in the base. The spilite in the eastern side of Portion 65, Nemingha, is similar to the above (1150), so much so that there can be no doubt that it is really a portion of the same rock-mass separated from the Tintinhull and Pullman's Hill spilites by folding and faulting. As remarked, the structure of these rocks is very similar to that shown by the porphyritic spilites in the Eastern Series in the Nundle District, and is sufficiently illustrated by the photomicrograph already given of that rock. (See (**17**), Plate xxv., fig.3).

Associated with these rocks, and apparently passing into them, is a less finely granular albitic rock, which shows the typical sub-variolitic spilite-texture, and has finely crystalline margins about quartz-filled vesicles. Its pyroxene has now been completely uralitised(1166). The albite-dolerite already described (1024) is in similar association with the spilites at Tintinhull.

The porphyritic spilites of East Gap Hill have the same mineralogical features as those of Tintinhull, but differ in grain size. If they be a portion of the same rock-mass as the Tintinhull rocks, as seems very probable, the conditions of consolidation must have been different. The porphyritic spilites on East Gap Hill are very coarsely granular, where they are invaded by the dolerite near the summit of the hill, and diminish in grainsize, and increase in vesicularity as they are traced to the south. The more coarsely granular types contain large phenocrysts in a subvariolitic groundmass (1032, 1033, 1168). The phenocrysts are idiomorphic plagioclases, but are moulded on augite, when the two minerals come into contact. They may be as much as 8 mm. in length. It is difficult to determine their composition, as the crystals are rather dusty, and full of partially chloritised zonary inclusions of the groundmass, and of epidote. They seem to be albite, however. They are not zoned, and have been more or less replaced by a mosaic of minutely granular quartz, which may, in some cases, leave only the outer rim of the felspar intact. Phenocrysts of augite also occur, either singly or in aggregates. They are rather decomposed, and may include large grains of magnetite. Some octahedra of magnetite also form phenocrysts. The groundmass consists of lathy oligoclase with forked microlitic extensions, skeletal forms of ilmenite, as well as definite grains, and small grains of titanomorphite. The pyroxene, which was originally in the form of small prisms, is now completely changed to chlorite and epidote. Irregular patches of secondary quartz-mosaic also occur in the base. The vesicles are numerous, and differ in their content of minerals. The following types have been noted:—

(*a*) Outer margin, epidote; central portion, orthoclase.

(*b*) Outer margin, epidote and chlorite; inner portion, quartz.

(*c*) Outer margin, epidote and chlorite; inner portion, quartz-mosaic.

(*d*) Outer margin, epidote; central portion, chlorite.

(*e*) Outer margin, epidote; inner portion, chlorite; centre, epidote.

(*f*) Epidote, chlorite and axinite, irregularly arranged.

(*g*) Epidote, chlorite, felspar and axinite.

The southern end of this mass is very fine-grained, and exceedingly vesicular, and passes without any definite break into the mass of pyroclastic rocks that are described below.

A single sill of spilitic dolerite invades the clayslates, at the Municipal Quarry in the Tamworth Common. It is a rock of medium to fine grainsize, with a subvariolitic texture(1018). The felspar is clear albite, with a few inclusions of chlorite. It forms long plates with occasional skeletal extensions. Intersertally are minute laths of felspar, and a small amount of granular quartz, mixed with a considerable amount of chlorite. Many small, brown grains of augite occur, together with a few larger ones, which are fairly fresh. There is also a little magnetite. Some secondary carbonates are present.

Specimen 1303, which represents what is probably a small intrusion in Portions 213 and 216, Nemingha, is a most interesting rock. In hand-specimen, it seems to be a normal but rather decomposed dolerite, with large augite-phenocrysts. The microscope shows that its constituent grains are mostly shattered. The phenocrysts are large, zoned augites, similar to those occuring in certain andesites and porphyrites. The edges of the broken fragments of them are quite sharp, and show no sign of resorption. Generally they are yellow-brown or green, and are markedly pleochroic. Frequently adhering to these crystals are fragments of green partially chloritised glass, containing laths of acid plagioclase and spherulites of chlorite. This adheres only to the crystal-edges of the augite, it is not found against the fractured edges. The fragments of crystal and glass alike are embedded in a groundmass, which consists of irresolvable, apparently partly felspathic decomposed matter, which seems to have been produced by the pulverisation of felspar-phenocrysts, together with fragments of pyroxene, chlorite, epidote, calcite, and rarely a little magnetite. This rock is best considered as a brecciated, hypocrystallite augite-porphyrite. (See Plate lii., fig. 2.)

Keratophyres.

These are far less frequent in the massive condition than the spilites or the dolerites, though they are very abundant in the pyroclastic rocks. The largest development is in the complex on Portion 175, Nemingha. They generally contain some quartz. Two types may be specially noted. Specimen 1140 resembles the rocks from Pipeclay Gully, near Bowling Alley Point(17). It is vesicular, with phenocrysts of albite, in a base of finer laths of felspar, and a small amount of quartz with chalcedonic margins. Chalcedony also occurs surrounding the grains of quartz. It is probably intermediate in composition between the porphyritic magnetite-keratophyres and the spilites. The first-named are the more coarsely crystalline. Their large phenocrysts are all albite, or are partly replaced by calcite, and a mosaic of minute prisms of albite; which certainly suggests the secondary nature of the albite. They are also dusted with other secondary material. There are, in addition, large octagonal areas of calcite and chlorite, which doubtless represent former phenocrysts of augite. A few of these have inclusions of felspar. The base consists of minute laths of acid plagioclase, chlorite, and magnetite, the latter occurring abundantly interstitially, and especially segregated about certain lines, as in 1148, and about the calcite-filled vesicles. Specimen 1361 differs from the others in the finer grainsize, and in the absence of phenocrysts of augite, and also in the presence of a large amount of black inclusions in the margins of the felspar-crystals, which inclusions, however, do not seem to be of primary origin, but to have been introduced from the magnetitic matrix, and lie in the cleavage-traces of the felspar, and in other definite directions in the crystals that are not marked by any noticeable cleavage. These two rocks also afford evidence of the pneumatolytic introduction of magnetite, in the later stages of their consolidation.

Magnetite-keratophyre also occurs in Portion 110, Nemingha, in the southern extension of the East Gap Hill zone, but as it has some fragmental characters, it is discussed below.

Some quartz-keratophyres remain for consideration. One of these (1142) occurs in Portion 138, adjacent to the magnetite-keratophyre of Portion 110. It is porphyritic, with phenocrysts of andesine which fill the numerous vesicles. Dusty hæmatite is present in small amount. Specimen 1148 is a fine-grained, vesicular, purplish-grey rock, with small, clear phenocrysts of albite, one of which contains, in its central portion, abundant inclusions of dusty magnetite. These phenocrysts have a roughly trachytic arrangement. The groundmass consists of abundant minute felspar-laths, sprinkled with finely divided hæmatite. Quartz is present in some amount, often chalcedonic, and a little chlorite occurs. There are abundant large vesicles filled with calcite, and chlorite, or quartz and chlorite. There is often a dense segregation of dusty magnetite around the whole, or only a portion of the periphery of the vesicles, and one can see that the zone of vesicles that are most abundantly surrounded by magnetite, corresponds to a zone of enrichment by magnetite of the main mass of the rock, which lies on either side of a narrow crevice, running transversely to the flow-direction of the rock. This is clearly illustrated in the figure given (Plate lii., fig. 3). The presumption is that the magnetite in the rock has been partly, at least, introduced pneumatolytically, and that surrounding the vesicles is due entirely to this method of deposition. This is in accord with the results obtained from the study of the Hyde's Creek complex in the Nundle District(17).

Rather different types of rocks, which, however, are clearly related to the above, are represented by specimens 1360 and 1363, that occurred in association with the agglomerate in the complex illustrated by Text-fig. 13. They were termed spilite-porphyrites in the foregoing. The felspar-phenocrysts may reach 2 mm. in length, are dusty and spotted with chlorite, slightly zoned, and show pericline- as well as albite-twinning. The augite phenocrysts are also large, 3 mm. × 0·5 mm. at most, are fresh or more or less decomposed, and have a large optic axial angle ($2V = 52°$). Magnetite also occurs in large well-formed crystals. The groundmass consists of lathy andesine-oligloclase, quartz in sharply defined crystal-grains, and but rarely intersertal, granular augite, and skeletal ilmenite, with small vesicles filled with quartz, chalcedony, opal and chlorite. This rock is on the borderline between the quartz-dolerite-porphyrites and keratophyres, and, like the adjacent dolerite proper, it has not been albitised.

A more typical keratophyre is that occurring near Gap Creek, half a mile east of this spot (1136). Its composition is shown by the analysis given on p.602. Its texture is very net-like; there is no sign of flow-structure, though the ragged felspar-laths sometimes give a sort of ophitic texture with the small amount of augite, with which they are associated. The latter is now mostly changed to chlorite. The felspar also forms small, interstitial, spherulitic aggregates. Quartz is very abundant, both interstitially and in small veins, but there are no chalcedonic phases. The composition of the felspar, as calculated from the analysis, is $Or_3Ab_{80}An_{16}$, equivalent to $Ab_{84}An_{16}$.

In addition to this, there are a few occurrences of highly crushed quartz-albite-porphyrites, in Portions 168, 213, and 171, Nemingha. These consist (*e.g.*, 1326, 1332) of broken phenocrysts of albite (probably), with all the optical effects of great strain, and a groundmass of finely granular, and intergrown, strained quartz and albite. There is rarely also a little biotite in spangles and crystal-plates, wisps of fibrous, pale green actinolite, both in phenocrysts and base, and a little magnetite and titanomorphite. A similar rock occurs on the north side of Housefield's Hill, Woolomol, forming a vein in the Middle Devonian rocks. The whole appearance of these rocks strongly recalls that of the albitic veins in the serpentines near Bingara, and it is not clear whether they should really be classed with the Devonian keratophyres(**16**, p. 691).

Chemical Characters of the Spilite-Keratophyre Series.

The chemical features of these rocks will be illustrated by the following table, which should be compared with the tables given in previous parts of the series (**16**, p.704; **17**, p.139).

CHEMICAL COMPOSITION OF MIDDLE DEVONIAN IGNEOUS ROCKS.

	1132	1130	1136	A	B	C
SiO_2	49·96	50·17	71·52	72·51	56·06	52·88
Al_2O_3	15·49	15·56	11·76	13·10	18·36	21·25
Fe_2O_3	1·83	2·18	1·52	2·81	4·40	2·73
FeO...	10·85	12·06	3·44	0·90	2·68	3·02
MgO	4·70	3·49	1·18	0·20	4·58	4·93
CaO	8·52	7·77	2·72	1·84	6·06	7·40
Na_2O	2·90	4·12	5·05	6·76	3·71	3·95
K_2O	0·65	0·38	0·26	0·33	0·66	1·15
H_2O+	2·47	1·12	1·25	0·35	2·50	2·53
H_2O-	0·04	0·27	0·14	0·04	0·28	0·25
CO_2	0·05	0·21	0·38	0·76	0·24	0·20
TiO_2	1·40	1·51	0·28	0·31	—	—
P_2O_5	0·38	0·18	0·20	0·06	0·19	0·29
FeS_2 ...	0·10	0·10	0·12	—	—	—
Cr_2O_3	abs.	abs.	abs.	—	—	—
MnO	0·14	0·43	0·04	0·20	—	—
BaO	abs.	abs.	abs.	abs.	—	—
SrO...	abs.	abs.	abs.	—	—	—
	99·48	99·55	99·86	100·17	99·72	100·58
Analyst ...	W.N.B.	W.N.B.	W.N.B.	Radley	Mingaye	White

1132. Labradorite-dolerite, Portion 110, Parish of Nemingha.
1130. Albitic Spilite, Portion 48, Parish of Nemingha.
1136. Quartz-keratophyre, Portion 175, Parish of Nemingha.
A. Soda-granite-porphyry, Tayvallich, Argyllshire, Scotland(**26**).
B. Typical volcanic tuff, Tamworth(**9**).
C. Matrix of coarse volcanic agglomerate, Tamworth(**9**).

The discovery of calcic rocks in this area brings a feature into the discussion of the origin of the albitic rocks in this area, which was not present in the Nundle district; and some of the Tamworth rocks show the same microscopical features as those considered by various authors to indicate the secondary nature of albite in rocks of the spilitic suite, which features were not observable in the rocks described previously(**17**). As investigations are now in progress in the region between the Tamworth and Nundle districts, the further discussion of this question will be postponed till it be finished.*

* The writer has received, too late for consideration in the present paper, Dr. Nils Sundius' work, which deals with this problem. Geologie des Kirunagebiets. 4. Beiträge zur Geologie des südlichen Teils des Kirunagebiets. Vetenskapliga och Praktiska Undersökningar i Lappland. Anordnade af Luossavaara-Kirunavaara Aktiebolag. (Scientific and Practical Researches in Lappland, arranged by the Luossavaara-Kiirunavaara Aktiebolag.) Upsala, 1915.

Pyroclastic Rocks.

It is in this division of the igneous rocks, that the greatest difficulty arises, for they range from types scarcely separable from the normal massive rocks to those which are clearly tuffs, and agglomerates that closely resemble conglomerates. They also have a wide range of composition, corresponding to the range of variation in the massive rocks, and may include fragments of all the known types of massive rocks, as well as others, which have not been found forming separate masses; they may contain also fragments of all types of sedimentary rock in the district. This naturally makes a logical sequence in the description of these rocks almost an impossibility. It seems, therefore, best to divide between pyroclastic masses that are referable to one igneous type only, and those of a mixed composition. The latter can be divided according to their coarseness of fabric. Of these, some of the most coarsely fragmental types have rounded inclusions resembling boulders in conglomerates.

Of the rocks composed of a single type of material, we may, perhaps, take as an instance the augite-porphyrite breccia already described. It certainly is a passage-rock of a nature between massive and fragmental. A similar passage-rock is the spilite-breccia, which lies on the margin of the spilite-dolerite mass at Tintinhull. This rock consists of more or less fragmental phenocrysts of albite, set in a very fine matrix of the same character as that of the adjacent porphyritic spilite(1171). The brecciated quartz-keratophyres should also be mentioned here. Types occur, particularly in Portion 183, Nemingha, on West Gap Hill, which are even more fragmental than the highly strained keratophyres mentioned above. They have a grey quartzite-like appearance, and show small crystals of felspar, and have a more or less well marked bending. They consist of crystals of albite, irregular corroded quartz-grains, and sometimes fragments of a very fine-grained trachytic keratophyre, and aggregates of quartz and magnetite, drawn out into the general direction of the banding. The groundmass consists of the same material very finely divided. It is possible that these are flow-breccias(1052, 1125).

The pyroclastic rocks of the Igneous Zone on East Gap Hill extend down to Portion 138, and near their southern extremity, in Portion 110, is the fragmental magnetite-keratophyre mentioned above(1122). It, also, is possibly a flow-breccia. It is extremely patchy in constitution; adjacent portions are of different composition and texture; and the types of texture seen are usually different from those which are present in the magnetite-keratophyre-breccias at Hyde's Creek, near Bowling Alley Point. The groundmass of the rock is very like a sponge. The "sponge"-fabric is made up of fine laths of albite, clouded by kaolin, etc., and so darkened with abundant masses of minutely divided magnetite, that it is almost opaque. The interstices are filled with minute prisms of glassy albite, generally twinned, and accompanied by a little chlorite. Set in this matrix, are fragments of dense trachytic magnetite-keratophyre, with phenocrysts of albite and sometimes of fresh augite, and, in addition, there are fragments of normal trachytic keratophyre, with very little magnetite or augite. These inclusions vary from very minutely to coarsely crystalline types, and the latter may even be sufficiently rich in augite, to be classed as dolerites (Plate lii., fig. 4). A large vesicle present in the rock has been filled by a spongy mixture of albite and calcite. There can be little doubt that this rock has been affected by pneumatolytic solutions, which introduced the sodic felspar. The abundance of hæmatite, which gives the dominant red colour to the ferruginous pryoclastic rocks at the southern end of East Gap Hill, is probably also due to the action of these solutions, which have oxidised the magnetite in the magnetite-keratophyres. In those ferruginous keratophyres in which the iron ore seems to be of secondary, pneumatolytic origin, it is possible that the ore was deposited in the rock, in part at least, as hæmatite. In those, however, in which the majority of the iron occurs as magnetite, the dark grey colour is the characteristic feature. Of these, Specimen 1178 is typical. It has some macroscopical resemblance to 1122, but has very little groundmass. It consists of fragments of keratophyre, of which twelve different samples are to be found in a slice scarcely two square centimetres in area. These are closely fitted together, with a little cement made of the material of the fragments finely comminuted. The following are the chief types of fragments present:—magnetite-keratophyres, varying in the amount of iron present, more or less trachytic, porphyritic, massive or hypocrystalline, the last being very vesicular; normal keratophyre, porphyritic or massive, trachytic, or with a wavy flow-structure and occasionally vesicular, coarsely crystalline albitite, partially porphyritic keratophyre-dolerite, etc.

The reddened rocks have usually a more ashy appearance, particularly on weathered surfaces. In 1330, the inclusions are mostly fine-grained trachytic keratophyre, with minutely granular augite, and a few more coarsely granular, non-trachytic types are also present. The base resembles that of 1122; it is very spongy, with a few phenocrysts of albite, and abundant secondary albite and chlorite filling the vesicles. In 1336, the same feature are present, but parts of the spongy or pumiceous matrix are free from iron-ore, but shade off irregularly into strongly ferruginous rock.

Hæmatitic breccias similar to these, but much more coarsely fragmental, occur on West Gap Hill. In these, there are large areas of finely divided prehnite and epidote. The matrix is rather spongy, a hypocrystalline confusion of felspar-laths, phenocrysts, and microlites, and abundant hæmatite. The inclusions are of various kinds of keratophyre; the most unusual of these has a texture resembling that of "rhomben-porphyry"; the others resemble those already described.

In addition to the red rocks of this character, there are others in which there is no base. The rocks consist entirely of fragments, which are sometimes half an inch in diameter, and are closely fitted together. These (*e.g.*, 1327) include keratophyre; prophyrite consisting of large rounded phenocrysts of acid plagioclase in a fine-grained subtrachytic base, in which are chlorite-filled vesicles; porphyritic spilite, the felspar albite, and the augite changed to chlorite; devitrified rhyolite with a well marked flow-structure; magnetite-keratophyre of varying character, sometimes extremely rich in iron-ore, sometimes porphyritic with crushed and shattered phenocrysts; and felsites with a minutely crystalline or lithoidal base abundantly charged with calcite, or a more coarsely granular quartz-felspar mosaic, apparently greatly strained. It is, however, just possible that the last two fragments are of altered sedimentary rock.

Rocks similar to these, but with rather smaller grainsize, form the bulk of the Igneous Zone of the Middle Devonian, that sweeps northwards to Moore Creek. They resemble the "Bowling Alley breccias," of the earlier papers, with which they must assuredly be correlated (**16**, p.710-711). An example of these rocks, showing a more diverse composition than usual, is illustrated in Plate liii., fig. 6, which is from slide 1163, from a rock which accompanies the porphyritic spilites in Portion 48, Nemingha. It consists of single crystals and rock-fragments. The former include quartz, uralite, and acid felspar; the latter range from spilites resembling the base of the adjacent porphyritic spilite, to more crystalline trachytic spilites, fine- and medium-grained keratophyres; quartz-keratophyre; quartz-porphyrite; and a soda-granophyre. In addition, there is a fragment of radiolarian mudstone. There is practically no groundmass. The metamorphic effect of the granites, which are exposed within half a mile of here, is seen in the development of abundant little flakes of secondary biotite in the fragments of keratophyre.

Other rocks in this zone differ from this in the presence of fragments of dolerite, of more sedimentary rocks, and sometimes of limestone, or in the presence of crystals of augite or magnetite In others, again, more groundmass is present, generally finely divided quartz, and felspar, with more or less chlorite. These are only differences of degree; no distinct varieties of pyroclastic rock can be separated. In the most finely granular of these rocks, the fragments are usually merely portions of single crystals, or of very minutely crystalline keratophyre. They have often a more abundant base of comminuted quartz and felspar, and, while they are generally unstratified, bedding is at times very clearly marked. Some of the pyroclastic rocks contain very well preserved radiolaria(**10**). The felspar is usually albite. In one instance only has hypersthene been observed in these rocks. As a rule, the presence of stratification and of organic remains are the only means of distinguishing, in *hand-specimen or microscope-slide,* an interstratified from an intrusive tuff.

All along the margin of the granite, these rocks are found to be more or less altered. This metamorphism has been described in general terms in a previous paper(16), and very little additional information has been obtained from the present more detailed study. Generally, the effect has been to convert all the ferromagnesian minerals present into actinolite, which may be scattered all over the rock in secondary sheaf-like recrystallisations. The ilmenite becomes titanomorphite, and the plagioclase, clear albite, which may be more or less crystalloblastic. In more altered rocks, the felspar returns to andesine, which has been found in several instances, particularly in Portion 118, Nemingha. This accords with the behaviour of the spilitic rocks about the granites of Devonshire(**27**). Erdmannsdörfer concludes, from his study of the diabases about the granite of the Harz Mountains, that, whereas the presence of basic felspar is an index that the rock has suffered contact-metamorphism, types with acid felspar result from dynamic metamorphism(**28**, p.73); this conclusion cannot, however, be applied satisfactorily to the rocks of the Tamworth district.

The most altered forms of spilitic rocks are those in Sections 113 and 123, Nemingha. Macroscopically, they are very like the garnet-bearing contact-altered spilites of Walkhampton in Devonshire, which were described by Messrs. Dewey and Flett(**27**). They are banded dark green rocks, with long lenticular patches of quartz and felspar mosaic, probably representing former felspar-phenocrysts, and long bands of epidote and brown garnet, together with a little secondary acid felspar. The dark base consists of very finely matted chlorite and actinolite, while there are also streaks of secondary magnetite. It is not clear whether these are altered vesicular, porphyritic spilites, or pyroclastic rocks. The former is the more probable. Adjacent to these, is the amphibolite (altered dolerite) described above.

Other types of rock occur, of which a few examples will suffice. A rock (1134), which occurs in Portion 173, Tamworth, is an altered breccia, made up of many differing portions, each uniform within itself. The more finely granular fragments consist of small short prisms of hornblende with a roughly parallel arrangement, in a groundmass of small, equant, untwinned grains of quartz, and (probably) andesine; occasionally, there are large, irregular plates of an indeterminable felspar. Surrounding each such fragment is a zone of larger crystals of hornblende, among which are frequently small patches of fresh, new-formed, colourless pyroxene, making irregular poikiloblastic plates. These have very oblique extinction, and a large optic axial angle. Rarely there are also poikiloblasts of hornblende. In the irregular groundmass between the fragments, there are also irregular prismoids of hornblende, granular and poikiloblastic secondary augite, poikiloblastic, dusty, twinned plagioclase, and abundant, usually untwinned oligoclase-andesine(?) in the matrix. Rarely, also, there are poikiloblasts of quartz that are quite free from strain-effects. Magnetite is scattered about.

Slide 1137, from the same locality, differs from 1134 in the presence of large porphyroblasts of andesine. The secondary augite at times shows a sieve-structure, but more usually forms solid grains, or scattered granules. Erdmannsdörfer has described the development of secondary enstatite in the altered diabases by the granite of the Harz(**28**, pp.17-19). The pyroxene in the rocks just described, though it is augite, seems also to be secondary; it is certainly not residual, and as it occurs only in rocks quite close to the granite, it is probably developed under the effects of contact-metamorphism. Erdmannsdörfer observes that the degree of metamorphism necessary to produce secondary pyroxene is greater than that necessary for the change of augite into fibrous amphibole(**28**, p.37); the present rocks seem to exemplify this conclusion.

In the altered limestone of Seven-Mile Creek, is a green felspathic rock (1372), which is probably an altered pyroclastic inclusion. It consist of large poikiloblastic grains of andesine, dotted with small grains of diopside, here and there aggregated into dense masses. Scattered about there is also sphene in irregular grains. A small amount of quartz occurs with the felspar, but iron-ores are not developed.

A very special form of pyroclastic rock is the agglomerate which occurs in Portion 162, Nemingha. As described above, this rock contains a number of rounded pebbles of igneous rock in a tuffaceous matrix. Though several types of rock appear to be represented among the pebbles on macroscopic examination, the miscroscope shows them to be mostly of one type in different stages of alteration. They are porphyrites, with phenocrysts of plagioclase, more or less decomposed, slightly zoned, and, for the most part, determinable as oligoclase. In some of these, the former zoning is strongly marked by the presence of kaolin or dusty matter, though optical tests show the crystal to be of uniform acid composition (cf. **29**, p723). Augite also forms phenocrysts, but is more or less chloritised, and has a strongly marked outer margin of magnetite. There are smaller phenocrysts of magnetite, and corroded quartz, lying in a very fine-grained felsitic base. In addition, there is a porphyritic spilite, with phenocrysts of albite, in a pilotaxitic to subvariolitic groundmass of albite-laths, with chlorite, ilmenite, magnetite, and titanomorphite. Sometimes there are vesicles filled with calcite. One of these rocks is very similar to the spilite of Tintinhull, or of the Eastern Series. Another rock(1355) has a rhyolitic appearance, but is quite holocrystalline, and very finely granular. Its composition is that of a magnetite-keratophyre. There are idiomorphic or slightly corroded phenocrysts of acid felspar, and a few large accretions of minutely granular magnetite, and glomero-porphyritic quartz-felspar aggregates. The groundmass is made up of trachytic microlites of felspar, dotted with dusty magnetite, and interspersed with rounded felspar-crystals, which are not really spherulites, as their appearance suggests. These are arranged in bands, and thus give the rhyolitic appearance to the rock. The matrix of this rock is composed of crystals and fragments apparently derived from the porphyrites, which form the most abundant inclusions.

The pyroclastic rocks in the Upper Middle Devonian Series are similar to those in the Lower Middle Devonian, but are generally more finely granular. The chief distinction, however, lies in the greater abundance of quartz and acid felspar in the newer rocks, fragments of cryptocrystalline and trachytic keratophyre being very common. In addition to this, there is an abundance of purely keratophyric material, which forms the white interlaminations in the claystones; these vary in thickness from some yards down to fractions of a millimetre. Sometimes they have a flat lower side when they have fallen on to partially consolidated clay, or the underside may be indented where the falling grains sank into soft silt. The upper side is quite irregular in both cases (see Plate liii., fig. 7). Such interstratified tuffs may contain radiolaria or plant stems. Intrusions of keratophyric tuff into the sediments are frequently observable under the microscope, a particularly clear instance being that shown in Plate liii., fig. 8. Fig. 9 of the same plate illustrates a clearly clastic rock, which is similar in all respects to the intrusive material in the specimen shown in Fig.8.

The general character of the Upper Middle Devonian and Upper Devonian pyroclastic rocks has been described thus:—"At some depth below the surface the colour of the tuff is greenish-grey, weathering to yellowish-brown or lighter grey at the surface, and thus contrasting strongly with the darker claystones. A chemical analysis of the tuff will be found on p.602. Mr. Card describes them as felsite-tuffs, with numerous fragments of cryptocrystalline felsite (Keratophyre, W.N.B.) entangled in the holocrystalline or microcrystalline groundmass. The latter is composed of broken or corroded crystals of plagioclase, orthoclase, quartz, and augite, with occasionally hornblende, and rarely sphene" (titanomorphite, W.N.B.). "Small crystals of iron pyrites are numerous and grains of titaniferous iron sometimes occur; small and large inclusions of radiolarian rocks abound."(9). The fragments of radiolarian rock in the tuff are often very rounded (see Text-fig. 10), and there is some alteration of the tuff about them. Numerous instances occur in which the inclusion is ringed around by a pinkish-white zone, which is very distinct macroscopically. Under the microscope, however, nothing definite can be learnt as to its nature, and frequently it is not recognisable except in hand-specimen. At other times, there appears to be a slightly greater amount of kaolinisation, and the development of a little prehnite. It is evidently due to some radial diffusion, but does not appear to be connected with any process of albitisation. Prehnite is quite frequently developed in tuffs in patches that are not directly associated with cherty inclusions. So far as can be ascertained, the felspar in these pyroclastic rocks is almost entirely acid; no grain has been noted, of which the refractive index is greater than that of Canada balsam. The analysis (B., p 602) does not indicate any great amount of soda, and the composition of the felspar calculated therefrom is that of labradorite. The entry of alumina into various decomposition-products, probably accounts for the difference between the calculated and observed compositions of the felspar.

Limestones.

The macroscopic features of the limestones of this district have already been described. The following analyses illustrate their chemical composition. These were made by the chemists of the Geological Survey, for a memoir on the limestones of New South Wales, now being prepared by Messrs. J. E. Carne and L. J. Jones. The writer is much indebted to Mr. Carne for his kind permission to use them. Assays 1645-6 were specially made by Mr. Mingaye from specimens chosen by the author.

Assay No. ...	1146	1147	1394	1145	1148	1149
$CaCO_3$ ..	92·77	93·07	98·85	98·70	96·76	92·82
$MgCO_3$ ...	0·89	0·75	0·42	0·25	0·71	0·69
$MnCO_3$ ..	0·16	0·14	0·04	0·02	0 04	0·06
Fe,Al_2O_3 ...	0·42	0·40	0·22	0·19	0·33	0·28
Gangue ..	5·98	5·72	0·64	1·20	1·88	5·72
	100·22	100·08	100·17	100·36	99·72	99·57

Assay.	$CaCO_3$	$MgCO_3$	$FeCO_3$	$MnCO_3$	Fe_2O_3	Al_2O_3	Gangue	P_2O_5	H_2O	$BaCO_3$	*$SrCO_3$	Total.
1645	98·14	0·09	0·05	0·11	0·22	nil	0·98	0·03	0·58	nil	tr.	100·20
1646	97·42	0·04	0·04	0·04	0·44	0·09	1·62	0·02	0·36	nil	tr.	100·08

* Spectroscopic test.

These samples came from the following localities:—

Nemingha limestone.

1146. Portion 118, Nemingha.

1147. Portion 63, Nemingha (formerly Beedle's Freehold).

1645. White marble, Portion 134, Nemingha.

1646. Red marble, Portion 134, Nemingha, (known as the "Nemingha red marble").

Loomberah limestone(?).

1395. Portion 121, Nemingha.

Moore Creek limestone.

1145. Portion 41, Woolomol.

1148. Municipal Quarry, Spring Creek, Tamworth.

1149. Reserve 1472, Woolomol.

It will be seen that the rocks, as a whole, are very free from dolomitisation, and that the limestones of the Nemingha horizon differ from those of the Moore Creek horizon in the slightly greater content of iron, alumina, magnesia, and manganese. This is probably due to their association with igneous rocks, particularly the ferruginous brecciated keratophyres. It is clear that the intrusion of the ferruginous keratophyres was accompanied by the emission of iron-bearing solutions (**17**, pp.14-15). A red colour is a frequent feature of the limestones of this horizon.

The description of the radiolarian limestone given by the previous authors(**9**, **10**) need not be supplemented here. Mr. Mingaye's analysis of this rock is cited below.

Around the margin of the granite, the limestones have suffered much alteration. This was briefly described in an earlier paper(**16**), and also in the paper by Messrs. David and Pittman(**9**). A number of additional slices made subsequently, have added but little to the information here given. The pyroxene developed seems, however, to be a green variety of diopside rather than omphacite. One new type of rock has been discovered in the northern, sharply bent anticline, in Seven-Mile Creek. It consists almost entirely of silky-white wollastonite. Its interstices contain diopside, calcite, and a doubly refracting garnet. In another sample, diopside and garnet predominate over the wollastonite, and the garnet forms aggregates, half an inch in diameter. A third rock contains a little scapolite.

Middle Devonian Cherts and Claystones.

The sedimentary rocks of the Middle Devonian Series have few features of petrological interest. The general characters were described by Messrs. David, Pittman, and Card(**9**), and the writer(**16**). Here and there, they are enriched with tuffaceous matter, where zones of larger grainsize composed of fragments of quartz, felspar, or cryptocrystalline felsite, are interstratified with the normal claystone, into which they gradually shade away. In none of the rocks which the writer has studied microscopically, has he been able to recognise the presence of minerals which ordinarily characterise contact-metamorphism, nor does it appear probable that they would be developed, if the intrusions of the pyroclastic material took place in the manner here described, which would involve an intrusion at a fairly low temperature.

Considerably altered rocks occur about the granite; the most intensely altered are those actually included in the granite in Portion 66, Tamworth. These have abundantly developed biotite, and are interleaved with narrow bands of pegmatite, and granite. A less altered type (1133) is a fine-grained quartz-schist, with minute, chloritised flakes of biotite, and fragments of orthoclase and andesine.

The chemical composition of the sedimentary rocks will be seen in the table herewith, of analyses by Mr. Mingaye(**9**).

Assay number ('97)...	1234	1236	1235	1233
SiO_2	91·06	80·50	67·87	18·05
Al_2O_3	3·79	9·57	15·25	3·49
Fe_2O_3	2·01	2·67	5·08	4·87
MgO	0·46	0·76	1·46	1·65
CaO	0·45	0·60	1·71	38·70
Na_2O	0·28	1·18	1·37	0·29
K_2O	0·84	1·68	2·21	0·44
H_2O	0·97	1·29	2·10	1·42
H_2O –	0·32	0·45	2·37	0·80
CO_2	—	—	abs.	30·15
P_2O_5	tr.	0·11	0·12	0·34
SO_3	0·35	tr.	tr.	tr.
FeS_2	—	—	—	0·24
MnO	tr.	tr.	tr.	tr.
Organic matter	tr.	0·86	—	tr.
	100·53	99·67	99·54	100·44

1234.	Radiolarian black chert.	The exact points at which these rocks were collected are not stated.
1236.	Radiolarian cherty shale.	
1235.	Radiolarian shale.	They all came from the neighbourhood of the Tamworth Common.
1233.	Radiolarian limestone	

Upper Devonian Baldwin Agglomerate.

Messrs. David and Pittman have pointed out that the matrix of the agglomerate occurring on Cleary's Hill, near Tamworth, is identical with the breccias of the Middle Devonian Series(**9**). The writer has shown that this is a part of the Baldwin Agglomerates, and that this similarity is a constant feature; indeed, the agglomerates may be described as an "exaggeration of the features of the breccias of the Tamworth Series," and when they take on a rather finer grainsize than usual, it is impossible to distinguish them from the Middle Devonian rocks. At certain points they are full of rounded boulders, which decrease in size as the strata are traced laterally. Each centre has about the same assortment of boulders, though differences occur. The boulders in the agglomerates at Cleary's Hill include the following:—Porphyritic dolerite, with phenocrysts of albite and augite, and a subvariolitic base; porphyritic spilite, with felspar-phenocrysts and minutely crystalline trachytic base; felspathic dolerite; porphyritic andesite, as described by Mr. Card(**9**, p.**36**), in which the augite has the peculiar brownish tint and appearance characteristic of the brecciated augite-porphyrite described above (p.598); with decreasing amount of ferromagnesian minerals, these dolerites pass into keratophyres, sometimes porphyritic, but with a beautifully trachytic base (a very common rock), or the base may be felsitic or cryptocrystalline; one example is orthophyric and has no phenocrysts. There is also a quartz-keratophyre, the phenocrysts of which are more or less corroded quartz and albite, and the cryptocrystalline base contains long patches of fibrous radiating felspar, and also fragments of magnetite-keratophyre. In addition, there are fragments of previously consolidated tuff, of limestone, and of chert. The matrix consists chiefly of fragments of felspar, often zoned andesine, but also albite, quartz, augite, ilmenite, and a still more minutely comminuted paste of these minerals, with calcite, chlorite, etc. The chemical composition of the matrix has been determined by Mr. White. (See C, p.602).

The agglomerate of Housefield's Hill, in the centre of the Parish of Woolomol, contains approximately the same variety of boulders. The peculiar strained quartz-keratophyre is found also as a dyke beside the hill. The waterworn appearance of the pebbles and boulders is especially marked in this locality.

Serpentines.

The majority of the serpentines seen are similar to the rocks described in the earlier paper(**16**), and do not call for any further comment. One specimen, however, from Portion 118, Parish of Nemingha, is of special interest. It is a typical example of a serpentine derived from diallage The chief constituent of the rock is antigorite, which in some places exhibits the "gitter-struktur" perfectly, but is more usually distributed rather irregularly, or grouped into radiating masses. Some residual diallage is present, into which the antigorite cuts sharply, either as irregularly placed blades, or in lines parallel to a cleavage. The last remnants of the diallage are cloudy grey matter. Small ribbon-like veins and irregular patches of fibrous anthophyllite(?) are also present, sometimes stained brown and matted, but never notably pleochroic. The anthophyllite-fibres may stretch across the whole width of the vein, or may grow out unevenly on either side of a narrow crevice. Very irregularly shaped masses of magnetite are scattered about.

Associated with the serpentine is a little gabbro, which has also been described; it is remarkable for the replacement of its felspar by zoisite. One specimen contained olivine and hypersthene, two minerals which are rarely seen in the gabbros in the Great Serpentine Belt. (See **16**, pp.683-4).

Dykes of Dolerite in the Serpentine.

A number of these have been studied, and found to correspond exactly with those described from the north side of Chrome Hill, Bowling Alley Point, of which an analysis has been made (**17**, p.139). According to the extent of the development of brown hornblende, the rocks may be classed as dolerites, with little hornblende, and proterobases, in which it is more abundant. The hornblende, however, is always subordinate to the augite, and frequently surrounds this mineral. The felspar is difficult of determination, but it seems to be sometimes oligoclase, sometimes andesine. The ilmenite is usually represented by titanomorphite. Some sheared varieties of dolerite occur in which saussuritised felspar alternates with streaks of tremolite.

Granite.

The granite has been described by Mr. Card as follows:—
"6665. Moonbi, close to the railway station. Not conspicuously porphyritic. Sphene readily visible. The quartz is crowded with cavities. Hornblende and magnetite are intimately associated in places, and, together with felspar, give rise by segregation to basic patches. Orthoclase and plagioclase are present. The plagioclase may contain many foreign inclusions, and may show good composition zoning; it appears to be a variety of oligoclase. Sphene is conspicuous, and shows some intergrowth with hornblende.

3728. Moonbi Tobacco Farm. This type is decidedly dioritic, and differs much from that above described. It is non-porphyritic. Sphene is abundant and can be readily obtained (sometimes in well formed crystals) by washing the crumbling material under water. Under the microscope, one of the dominant minerals is hornblende; biotite is scarce. The hornblende is deep green in colour for the most part. It is more or less automorphic, and well cleaved. Sphene is plentiful. There is a little quartz, and practically no plagioclase. Orthoclase is perhaps somewhat larger in quantity than the combined ferromagnesian silicates. The leucocratic constituents are plentifully traversed by highly elongated, colourless, transparent rods. As a handspecimen, this rock would be classed as a quartz-syenite." (**12**).

Sections examined by the writer show similar features to those recorded above, but, in general, orthoclase does not seem to be so abundant as there indicated.

The numerous dykes of pegmatite and aplite have not been subjected to microscopical examination.

The more basic dykes show interesting features; the following may be recorded :—

1302. A dark vein in granite in Portion 114, Nemingha. This consists of a fabric of short laths, and less regular grains of plagioclase and orthoclase with interstitial quartz. A few corroded xenocrysts of the two felspars and quartz are also present; the last is very distinct from the groundmass, and is surrounded by a reaction-ring. In addition, there are abundant fresh grains of augite and platy ilmenite. The rock may be termed a micro-monzonite, or monzonite-aplite.

1308. A vein in Portion 145, Nemingha. This is also a micro-monzonite, but is of a different character. The felspars are larger, more irregular, and partially interlocking. The augite has been replaced by hornblende, and some sphene is present.

1174. A vein in the granite in Portion 73, Moonbi. This is very similar to 1308, but differs in presence of a groundmass of small felspar-laths, and small crystals of hornblende, and rarely a flake of biotite. The felspar seems to be chiefly plagioclase. The rock may be termed a micro-diorite or a diorite-aplite.

1175. A vein in the granite in Portion 139, Moonbi. This is the most unusual rock. It is a minette with spheroidal inclusions, rather different from the "Kugelminette" of the Odenwald and elsewhere(**30**). The rock consists of crystals of brown, almost uniaxial biotite in idiomorphic plates, idiomorphic augite, and magnetite, in a finely granular, felsitic matrix, dotted with minute crystals of magnetite, and a few minute prisms of apatite. The spherules are about 2-3 mm. in diameter. They consist of fibrous radiating felspar, with a little quartz in the central parts. Included in these are large crystals of diopside and biotite, which, in one instance, are in completely parallel intergrowth with each other. A little magnetite is dotted about. There is no bounding zone of coloured minerals marking the outline of the spherules. There are, in addition, druses with an angular, irregular outline surrounded by a "fence" of diopside-prisms, directed radially inwards, followed within by an irregular zone of untwinned felspar, with a central quartz-felspar mosaic. The inner zone is dotted with diopside and magnetite.

Tertiary Basalt.

The basalt is extremely fresh. It consists of small laths of labradorite, slightly zoned, granules of augite, large prismoid, but not idiomorphic grains of olivine, and small irregular grains and aggregates of ilmenite. There is a vesicle about 2 mm. in in diameter, the structure of which is shown in Text-fig.15. All round the vesicle is a thick zone of minutely granular augite,

Fig. 15.—A. Amygdule in Tertiary basalt(1164). Upper and middle portion opal, lower natrolite. The first and last of these contain prisms of augite. B. Spherule of augite-prisms in the same rock as A.

but within are comparatively large idiomorphic prisms of augite, of the same character as that in the groundmass of the rock, but lying more or less isolated in a matrix of opal and natrolite. The prisms are particularly well formed in the opal. The determination of this mineral is rendered certain by the very clear evidence of Becke's line, which shows that the colourless isotropic mineral has a distinctly lower refractive index than the natrolite. It is quite clear, and crossed by irregular cracks, without any sign of cleavage, such as analcite might show. There can be little doubt that the vesicle was filled with magmatic water. It would seem that the jelly-like mother-liquor in the vesicles permitted the growth of well formed prisms of augite, which were pushed aside by the growing and mutually interfering spherical masses of natrolite and opal, in the outer portion of which the augites become imbedded. The growth of large idiomorphic crystals of ferromagnesian minerals in the concentrations of the residual magmatic water is analogous in some respects to the formation of barkevicite in the analcitic lugarites of the Glasgow district described by Tyrrell(**31**). It is also interesting as affording a good instance of the primary nature of a zeolite, upon which subject a considerable literature has accumulated in recent years. [See *e.g.*, Mr. Harker's Presidential Address(**32**), and the article (and bibliography) by Koenigsberger(**33**)]. Beside the vesicles, there are small veins and irregular patches of opal and natrolite, and a little radiating aggregate of augite illustrated in Text-fig. 15B. In addition to these, there are also present a xenolith of olivine, augite, anorthite, and picotite, and isolated grains of the same minerals. Such xenoliths and xenocrysts are commonly present in the Tertiary and Recent basalts throughout the world.

Summary.

The main results of the present work may be stated thus. A more detailed map has been made of the Tamworth district, than that given by the previous authors who studied the district, and the subdivision of the Devonian Series instituted elsewhere in the Serpentine Belt has been applied, with amplifications, to this district. The result has been a general confirmation of the earlier work, with some modification in the details. The history of the area was apparently as follows. In Devonian times, a series of radiolarian claystones was deposited on a steadily sinking sea-floor, which was maintained at a fairly shallow depth. During this period, there were great developments of volcanic activity, producing large amounts of pyroclastic matter, building masses of tuff and agglomerate, which, here and there, may have risen above the surface of the sea, as small, short-lived islands. There were two main

periods of activity, the first of which was also marked by the intrusion of massive and brecciated spilites, dolerites, and keratophyres. Peculiar types of intrusive tuffs were constantly developed, and their probable mode of origin is here discussed. At two or three epochs, limestones were formed, and the fossil-content of these is sufficiently varied to permit of their distinction on palæontological grounds. The total thickness of the series cannot be exactly determined, owing to the presence of an indefinite amount of faulting. An apparent thickness of over 12,000 feet of strata are of Middle and Upper Devonian age. Folding and faulting occurred probably in Carboniferous times. The movements were most pronounced along an axis running N.N.W.-S.S.E., but there is clear evidence of less important movements along a N.E.-S.W. axis. The folding was followed by the intrusion of peridotite, succeeded by that of a mass of granite, which produced interesting contact-metamorphism of the tuffs and limestones. No further events are recorded until the eruption of a small amount of basalt, probably during the Tertiary period. The discussion of the physiography is reserved for a future occasion.

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EXPLANATION OF PLATES XLIX.-LIII.

Plate xlix.

Topographical Map of the Tamworth District, plotted from a plane-table survey, with contour-lines based on aneroid observations.

Plate l.

Geological Map of the Tamworth District.

Plate li.

Geological Sections along certain lines through the Tamworth District. The vertical and horizontal scale is the same.

Plate lii.

Fig.1.—Sheared keratophyre from the Eastern Series (1305); × 16.
Fig.2.—Brecciated hypocrystalline augite-porphyrite (1303); × 13.

Fig.3.—Magnetite-keratophyre with secondarily introduced magnetite (1148); ×13.

Fig.4.—Magnetite-keratophyre-breccia with inclusions of dolerite (1122); ×13.

Fig.5.—Breccia of various types of keratophyre, dolerite, spilite, and chert (1355); ×13.

Plate liii.

Fig.6.—Similar to Plate lii., fig.5, but with large grains of quartz (1163); ×17.

Fig.7.—Crystals of felspar and fragments of microcryptocrystalline keratophyre in radiolarian mudstone (N.S.W.G.S. 627); ×17.

Fig.8.—Intrusion of felspathic tuff into radiolarian mudstone. The clear, colourless casts of radiolaria can be seen in abundance (N.S.W. Geol. Survey, 1190); ×2.

Fig. 9.—Felspathic tuff of the same character as that in Fig.8; ×16 (approx.). Polarised light.

Fig.10,—Intrusion of breccia into banded tuffaceous mudstone; one-half natural size. See Text-fig.5.

Corrigenda to Part iv. (this Volume), pp.121-170.

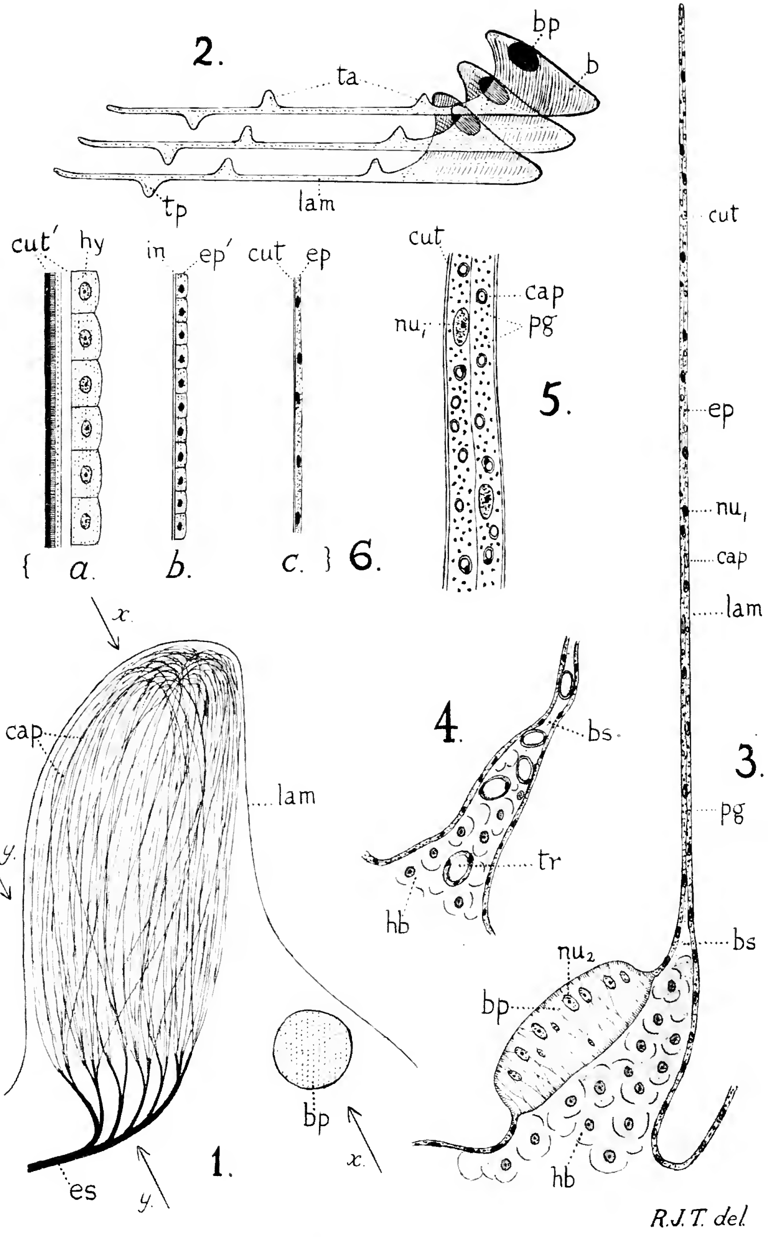
Page 127.—*for* "Text-fig.1. Spilite intrusive into radolarian clay." *read*, "Spilite intermingled with chert."

Page 143, line 12.—*for* "fig.3", *read* "fig.4".

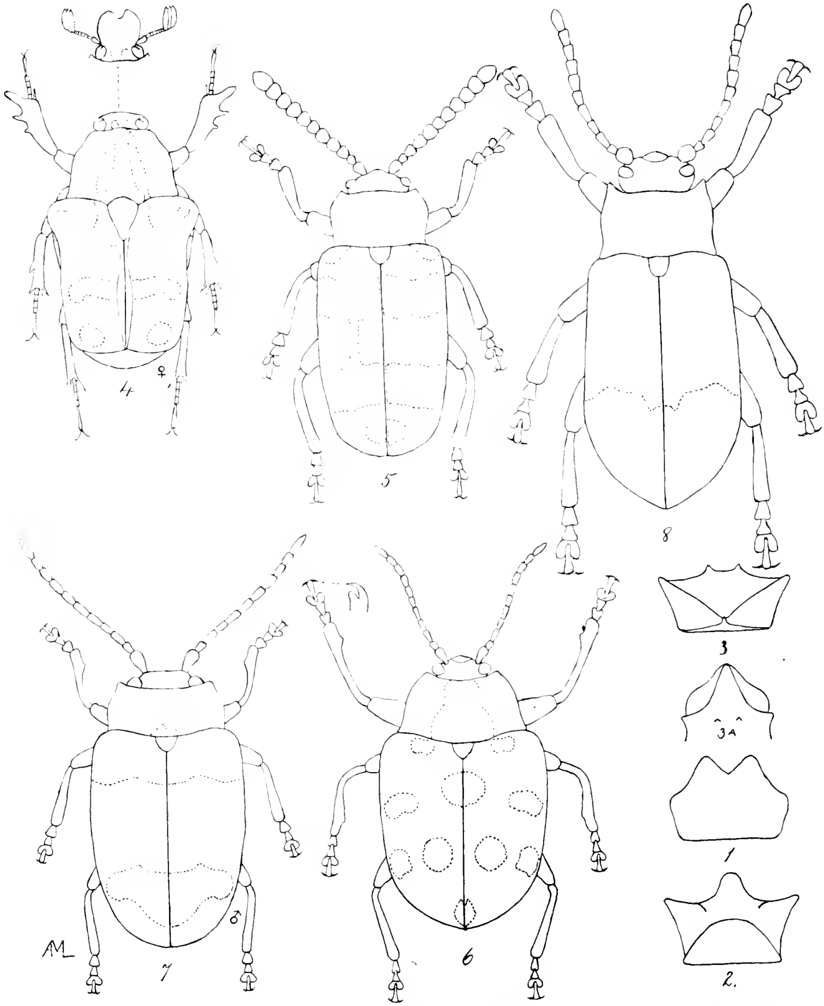
Page 160, lines 17-18.—*for* "From the nature of the case", *read* "For topographical reasons (see Map (1), Plate xxii.)"

Postscript (*added October 28th*, 1915).—M. Giraud's description of the peperites, (basaltic tuff-breccias) of the Auvergne, has come under the writer's notice while the above was in the press (Bull. des Services de la Carte Géologique de la France, No. 87, 1902, pp. 299-367). The author reviews an extensive literature, and concurs with M. Michel Levy in considering that the peperites are instrusive into the Oligocene marls in the Limagne. They form selvedges to basalt-dykes, developed where the dykes traverse weak structures, such as marls, but not where they invade strong structures, such as granite or limestone. Contact-effects are visible above as well as below the peperites. Where the overlying strata are sufficiently thin, the peperites broke through to the surface, and were deposited in water; such sedimentary peperites contain organic remains, *Helix,* etc. M. Michel Levy thought the conversion of the basalt-magma into fragmental material, was perhaps due to the rapid escape of water from the magma, in regions where the containing walls of the dyke offered little resistance. It is often difficult to draw any line between the solid basalt and the marginal breccia, which has been thrust laterally into the weak structures. Sir A. Geikie remarks: "The material of the peperites has undoubtedly here and there filled up the volcanic vents, and has been injected in veins and dykes around their margins. But the main mass of the material was ejected from the vents, and falling, as volcanic dust and sand . . . became interleaved with the contemporaneous sediments" (Textbook of Geology, 4th ed., p.1255, footnote). It seems reasonable to suppose that, if loose marls below solid limestones, permit a magma to break up into pyroclastic material, such an action will be even more favoured in loosely consolidated sediments without a compact covering layer. To this extent, the French peperites help us to understand the features of the Tamworth tuffs. One cannot, however, decide to what extent the pulverisation of the consolidating magma was brought about by the escape of magmatic water, or by the constant forward movement of the magma, or by the strains set up, as in a Prince Rupert drop, by the rapid chilling of the melt. The general absence of recognisable points of eruption makes it also impossible to estimate the distance to which the intrusive tuffs have been thrust laterally into the sediments. But though clearly intrusive tuffs have been found at many points, it is probable that the fossiliferous tuffs and breccias deposited in the normal fashion constitute the greater part of the pyroclastic rocks in the Great Serpentine Belt.

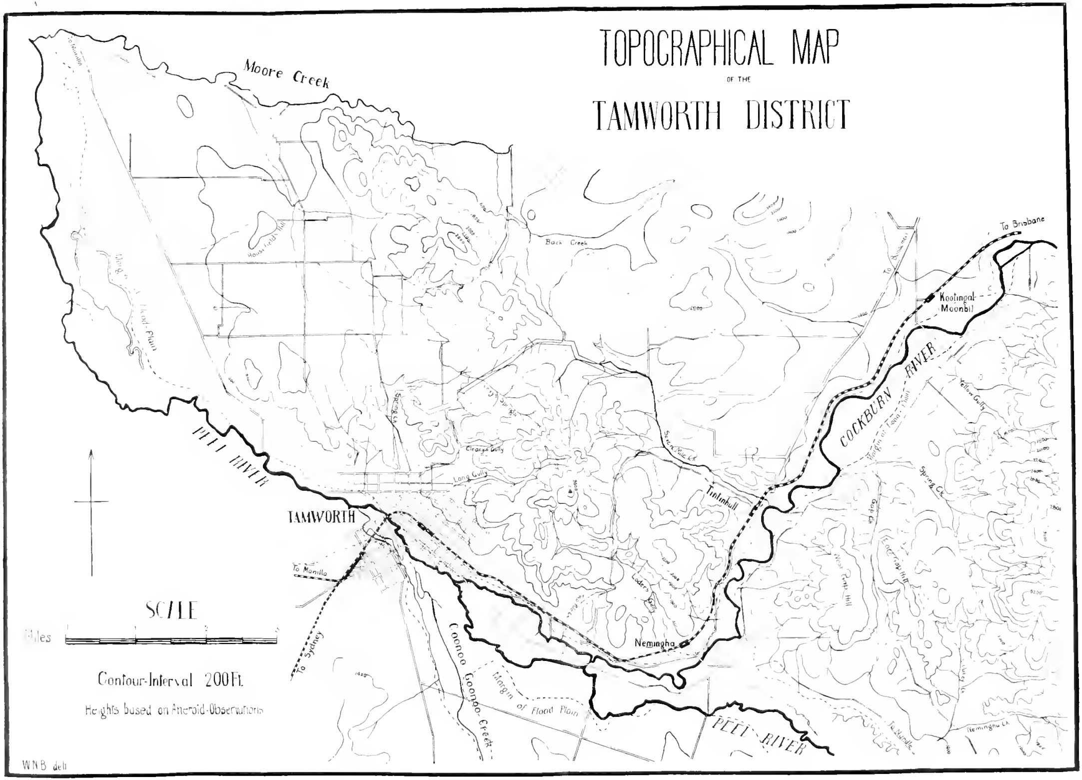
[Printed off, 25th November, 1915.]



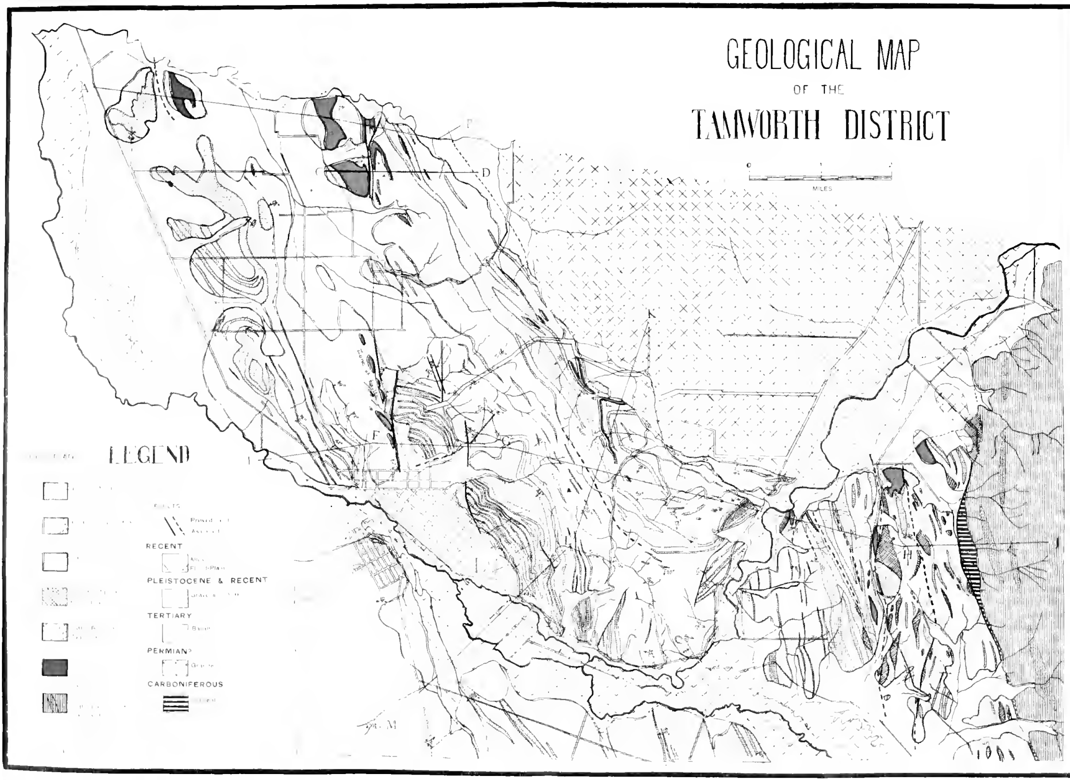
Rectal Gills of Larva of *Hemicordulia tau* Selys.

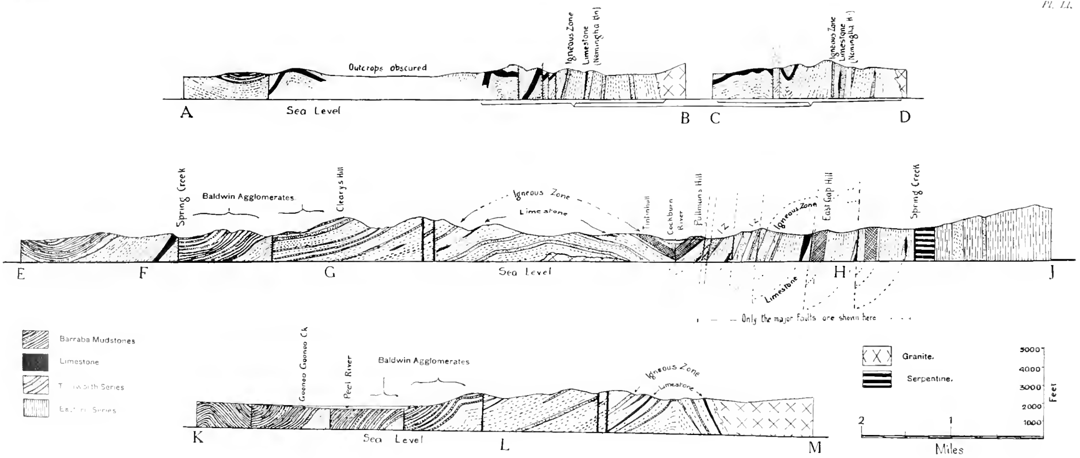


1. *Bolboceras inconsuetum* Lea.
2. *B. variolicolle* Lea.
3. *B. interruptum* Lea.
4. *Polystigma vitticolle* Macl.
5. *Phyllocharis sculpticeps* Lea.
6. *Rhæbomela maculata* Lea.
7. *R. fasciata* Lea.
8. *Æsernia tripartita* Lea.

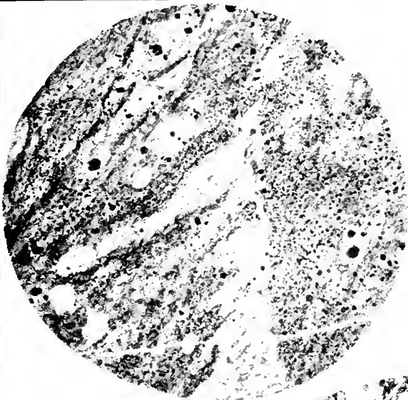


TOPOGRAPHICAL MAP
OF THE
TAMWORTH DISTRICT
Moore Creek
Back Creek
To Brisbane
Kootingal-Moonbil
COCKBURN RIVER
Yellow Gully
Spring Ck
Seven Mile Ck
Tintinhull
Cleary's Gully
Long Gully
Spring Ck
TAMWORTH
PEEL RIVER
To Manilla
To Sydney
Loders Gully
Nemingha
Coonoo Goonoo Creek
Margin of Flood Plain
PEEL RIVER
Nemingha Ck
To Nundle
Gap Ck
Margin of Flood Plain
SCALE
Miles
Contour-Interval 200 Ft.
Heights based on Aneroid-Observations
W.N.B. deli


GEOLOGICAL MAP
OF THE
TAMWORTH DISTRICT
MILES
LEGEND
RECENT
PLEISTOCENE & RECENT
TERTIARY
PERMIAN?
CARBONIFEROUS



GEOLOGICAL SECTIONS ACROSS THE TAMWORTH DISTRICT.



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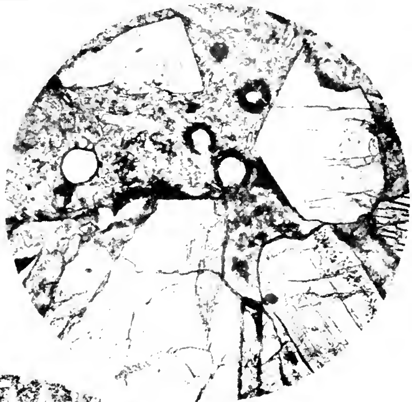

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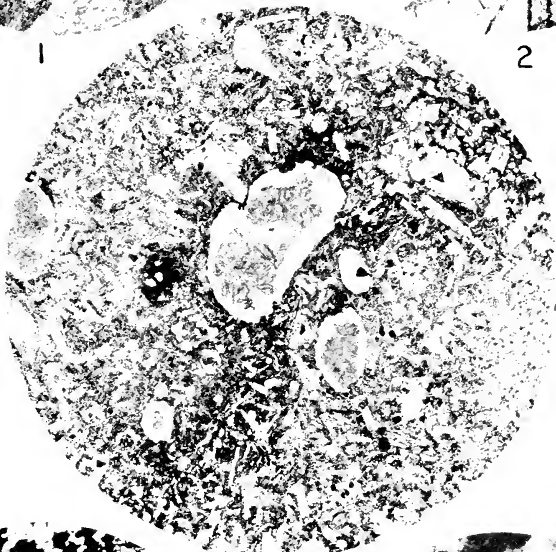

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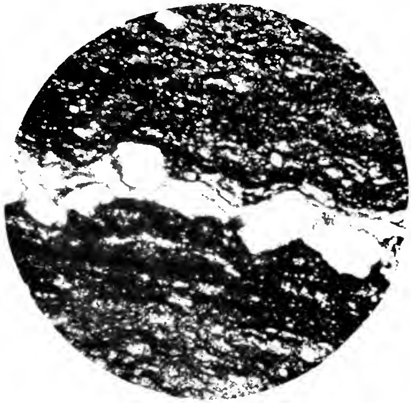

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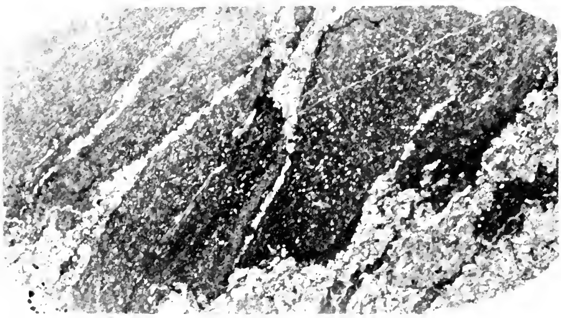

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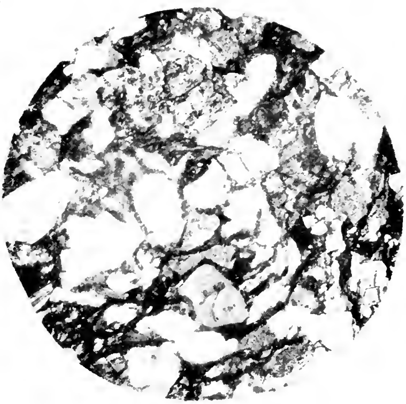

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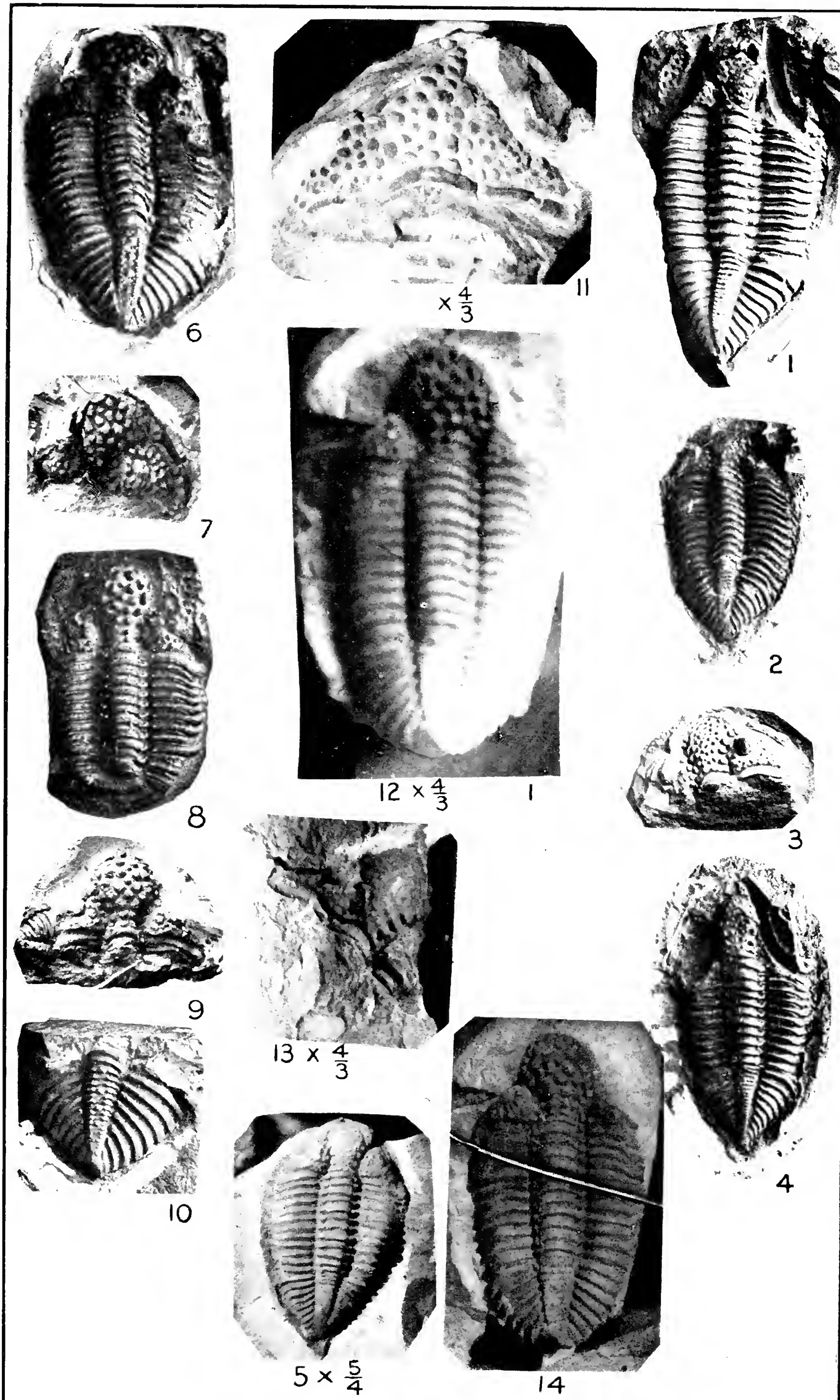
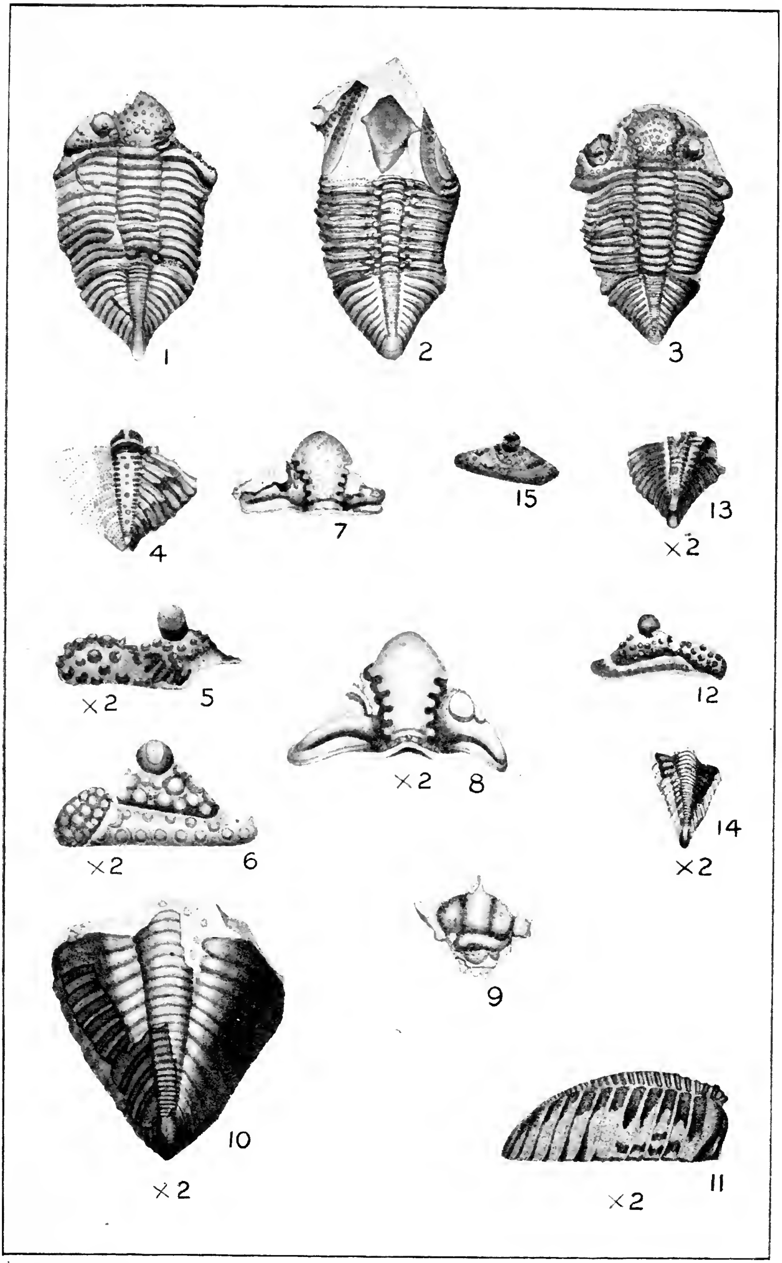
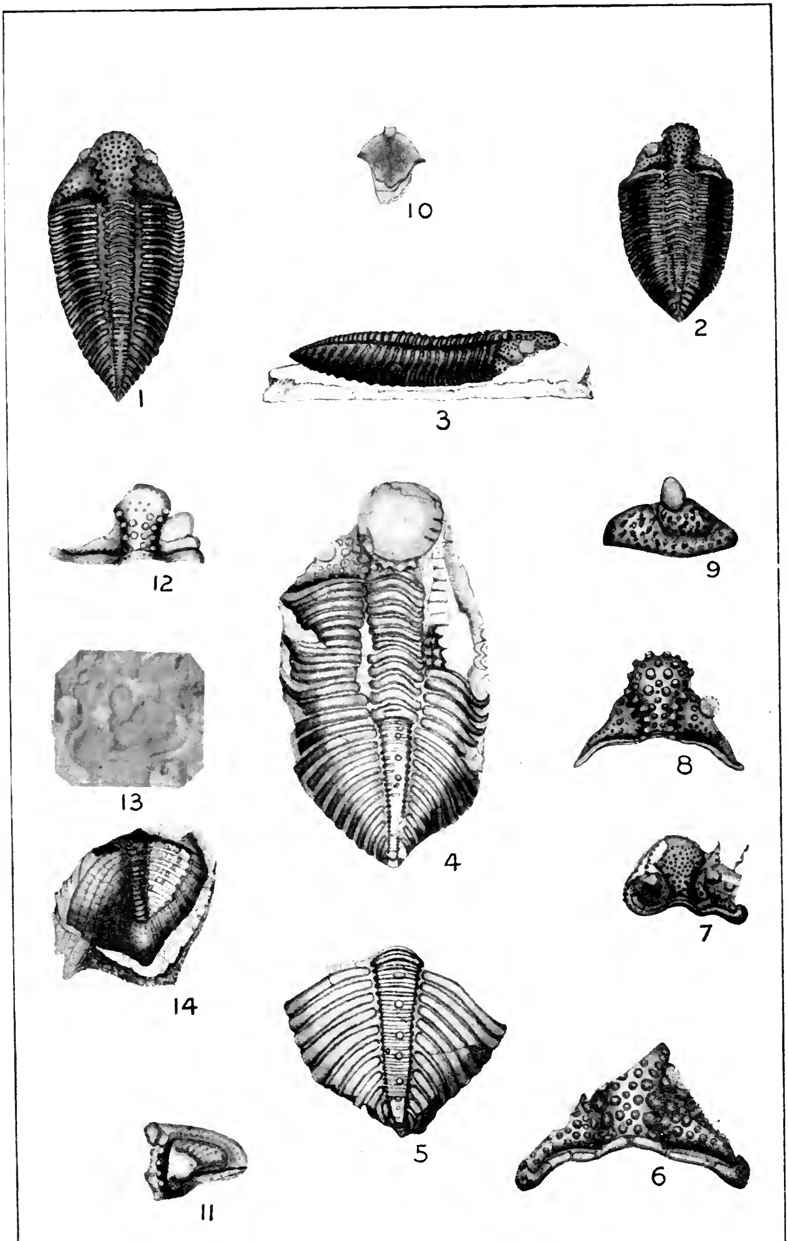


Silurian Trilobites (*Encrinurus* spp.)



A.R,—Del.

Silurian Trilobites (*Encrinurus* spp.)



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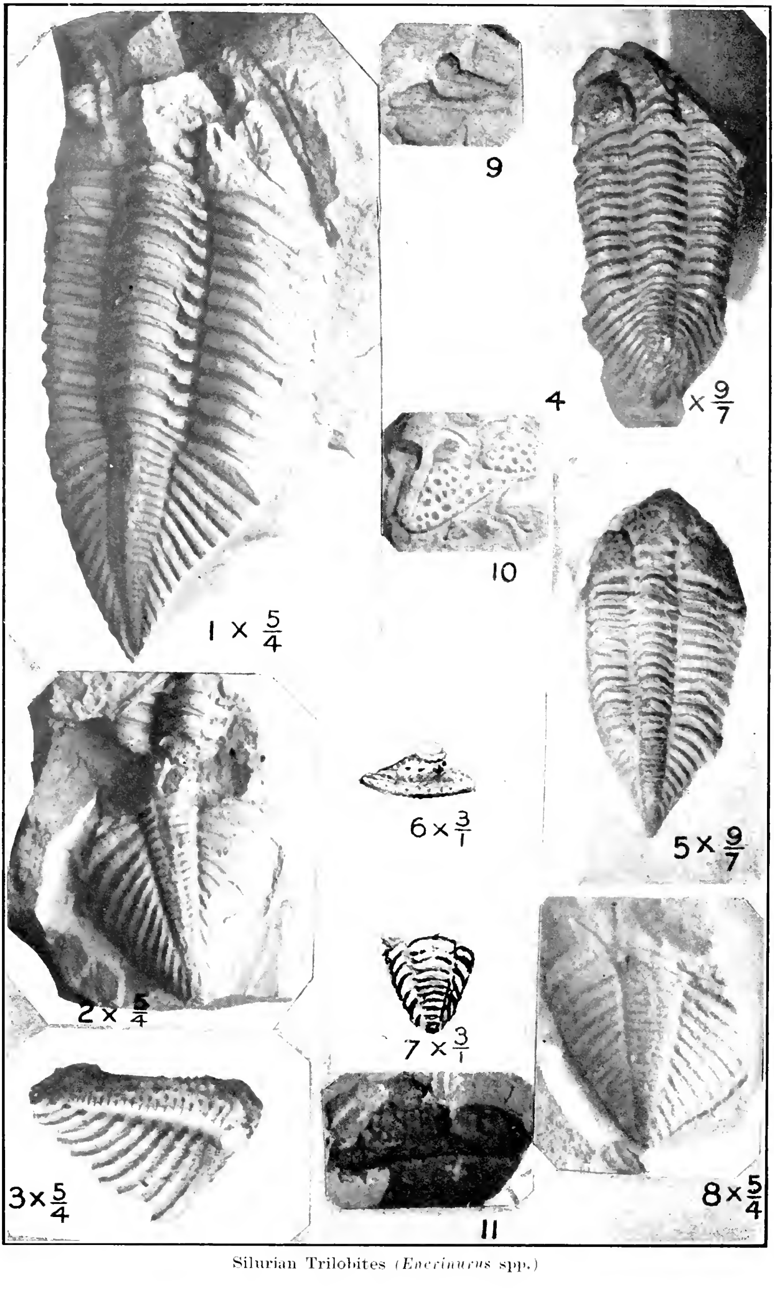
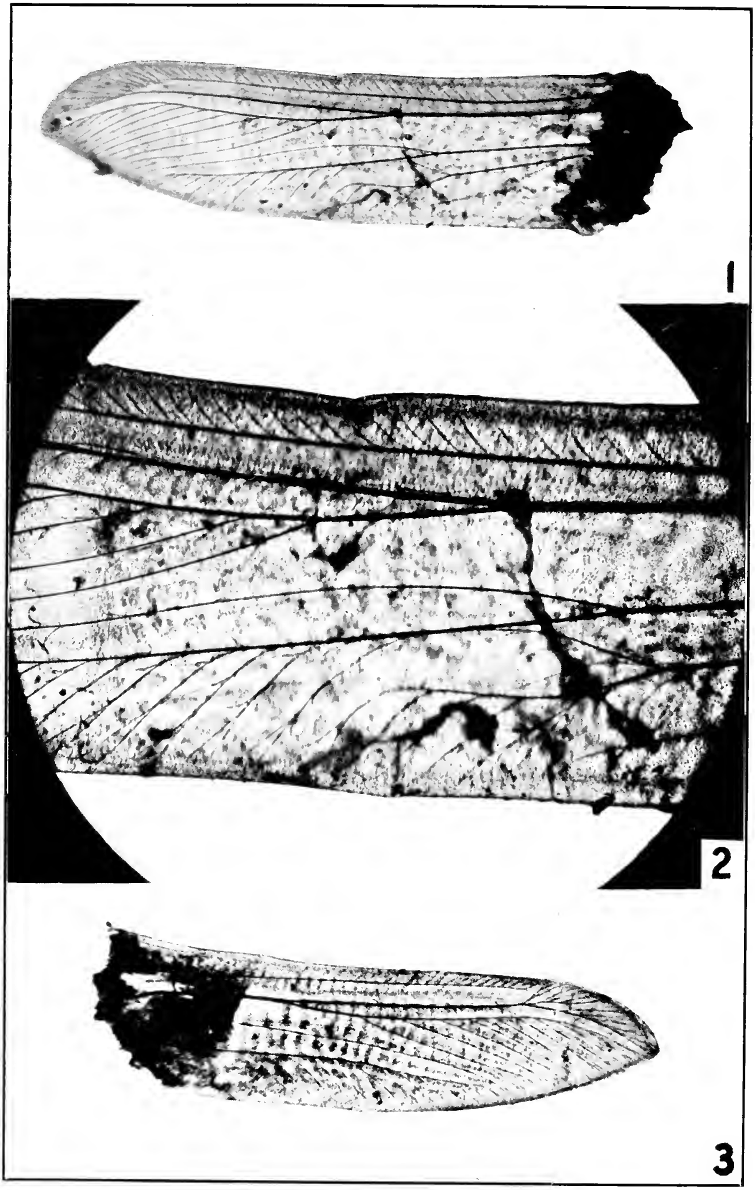
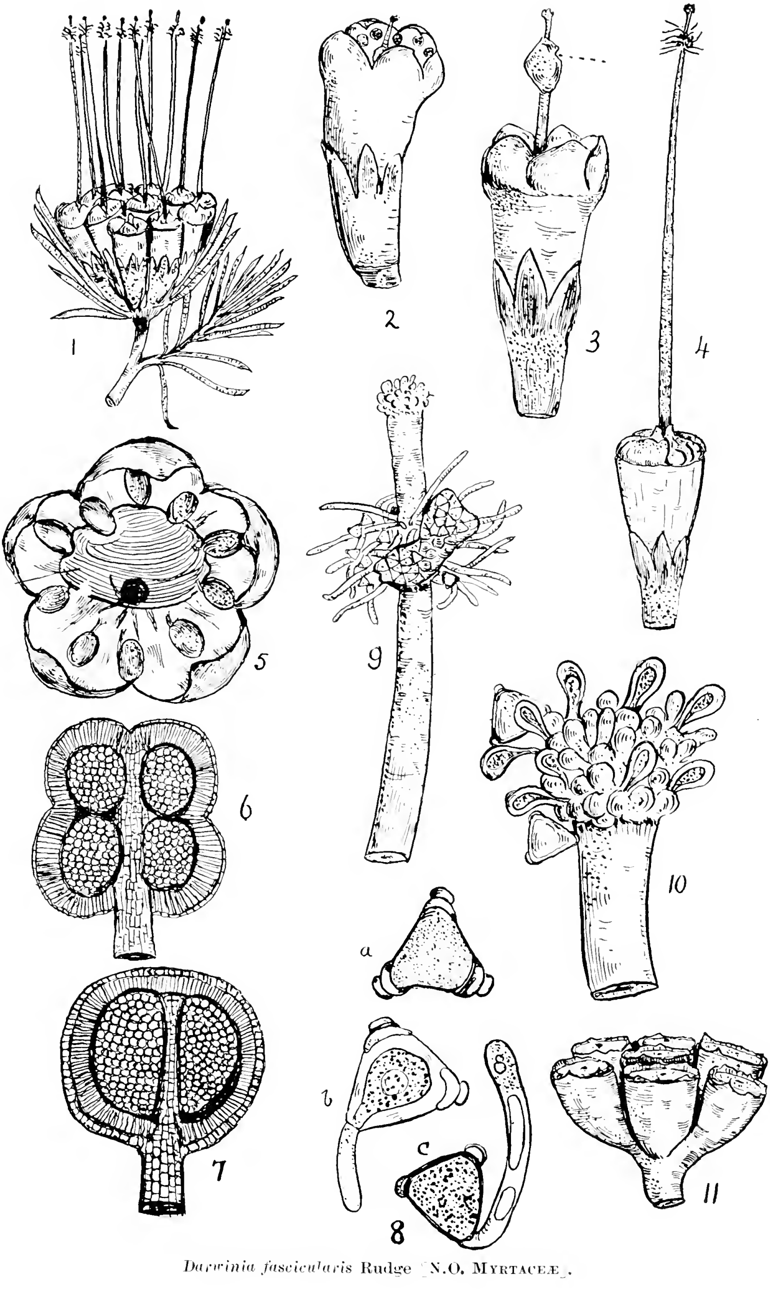
Silurian Trilobites (*Encrinurus* spp.)



Silurian Trilobites (*Encrinurus* spp.)



Wing-venation of *Myrmeleon uniseriatus* Gerst.



Darwinia fascicularis Rudge [N.O. Myrtaceæ].

ORDINARY MONTHLY MEETING.

OCTOBER 27th, 1915.

Mr. A. G. Hamilton, President, in the Chair.

The President announced that the Council was prepared to receive applications for four Linnean Macleay Fellowships tenable for one year from April 1st, 1916, from qualified Candidates. Applications should be lodged with the Secretary, who would afford all necessary information to intending Candidates, not later than 30th November, 1915.

The Donations and Exchanges received since the previous Monthly Meeting (29th September, 1915), amounting to 6 Vols., 65 Parts or Nos., 28 Bulletins, 2 Reports, and 14 Pamphlets, received from 43 Societies and four private donors, were laid upon the table.

NOTES AND EXHIBITS.

Mr. Tillyard exhibited the well-grown larva of a species of the Neuropterous genus *Psychopsis*, found on a large forest-tree on Mount Tambourine, S. Queensland, which may possibly be the larva of *P. illidgei*, a very rare and beautiful species known only from this locality.

Mr. E. Cheel exhibited—A series of specimens of Perennial Red Clover (*Trifolium pratense-perenne*) from Hill Top, infected with Rust, *Uromyces trifolii* (Alb. & Schw.) Wint., in all stages. At previous Meetings, (These Proceedings, 1913, pp.171 and 379; 1915, p.290) examples were shown with the uredo- and teleuto-stages only. On the specimens now brought to notice, collected during the present month, the æcidio-stage occurred in circular clusters on the leaflets, as well as thickly studded on the petioles, showing that the Rust is autœcious. Mr. F. D. Kern, "Phytopathology" (official organ of the American Phytopathological Society), Vol. i. (1911), p.3, states that there is some doubt concerning the life-history of the red-clover rust; he suggests that it is an heterœcious species; and proposed the name *U. fallens* for it. Numerous writers, however, including Miss Howell [who has shown that the rust on red and on white clover (*T. repens*) is identical, and that the uredo- and teleuto-spores can be produced from the æcidium which appears early in the summer] have regarded the rust on perennial red clover as *U. trifolii*. Specimens were submitted to Mr. C. C. Brittlebank, of Melbourne, who has compared the uredospores and æcidiospores of the Perennial Red Clover with those of *U. trifolii-repentis* Tirv., and he states that he cannot separate them.—Fresh flowering-specimens of *Callistemon lophanthus* Sweet, and *C. linearifolius* DC., in cultivation at the new Zoological Gardens at Taronga Park, under the direction of Mr. A. S. Le Souëf. The former is quoted as a synonym by Bentham under *C. salignus* var. *hebestachyus*, but seems quite distinct from any of the forms of *C. salignus*. *C. linearifolius* DC., is also quoted by Bentham under *C. rigidus*. These were both omitted when the key to the species of *Callistemon*, in Illustrations of New South Wales Plants, Part 3, p. iii. (1911), by J. H. Maiden, was drawn up; but abundant material, which has since been received and studied, seems to warrant the view that both should be raised to specific rank again. Fresh specimens of an undescribed species were also shown, which were raised from seed obtained from plants on the Nattai River, viâ Hill Top. A fine series of fresh flowering-specimens of *C. lanceolatus* DC., *C. linearis* DC., *C. rigidus* R.Br., *C. speciosus* DC., *C. phœniceus* Lindl., *C. rugulosus* DC., (*C. coccineus* F.v.M.), *C. pinifolius* DC., and two forms of *C. brachyandrus* Lindl., were also shown for comparison with the above, and *C. acuminatus* Cheel, (together with herbarium specimens of the latter, previously collected at Bulladelah, N.S.W., from a new locality between the 15-16 mile post, Galston Road, Hornsby; W. F. Blakeley; November, 1914).—A series of specimens of *Helichrysum diosmifolium* Less., collected at Hill Top, within a few yards of each other, showing flowers varying in colour from pure white on some plants, through pale pink to a very rich, deeper pink on others.

Mr. A. A. Hamilton exhibited specimens from the National Herbarium, with notes thereon.—*Plantago lanceolata* Linn., (Hornsby; W. F. Blakely; October, 1914) showing axillary floral fission. The flower-spike is bifurcated at the apex, each of the segments attaining a length of $\frac{3}{8}$ inch. The generally healthy and perfect condition of the flowers, on both the normal and bifurcated portions of the spike, point to over-luxuriant, rather than arrested growth. In an article on "Fasciation, its Meaning and Origin" (The New Phytologist, iv., p.55, 1905), W. C. Worsdell (pp.72, 73) refers to this kind of dichotomy as the simplest form of fasciation, and regards it as a reversion to an ancient branching type, A second example of this species from the Hawkesbury College (C. T. Musson), shows lateral prolification of the inflorescence; the flower-spike exhibits arrested growth, and a series of miniature spikelets, reduced to a few, or, in some instances, a single flower, arise on contorted stems from the axils of abortive flowers, these again repeating the process.—*Primula* (*Polyanthus*) Hort., Pennant Hills (T. Steel; August, 1915), showing phyllody of bracts and calyces, and petaloid irregularities. The involucral umbellate bracts are foliaceous, and the floral calyces have developed phyllody; the corolla-lobes are irregular in size and number (4 to 8; normally 5); the corolla-tube is ruptured, and one of the anthers (which are attached to the tube by a dilated membrane) has been carried up on the ruptured edge, and appears as though seated on a diminutive corolla-lobe.—*Phytolacca* sp., Mt. Wilson (Dr. J. B. Cleland; June, 1915), showing foliar prolification. The almost normal condition of the lower stem-leaves, taken in conjunction with the attenuated foliar prolification of the upper branchlets, points to suddenly accelerated growth followed by malnutrition.—A series of specimens from a plant-association collected within a radius of a few hundred yards, on the Woronora River at Heathcote, representative of the flora of the lower slopes of the Blue Mountains:—*Bossiœa rhombifolia* Sieb., *Conospermum tenuifolium* R.Br., *Grevillea asplenifolia* R.Br., *Pomaderris ledifolia* A. Cunn., *Pseudanthus pimeleoides* Sieb., *Lycopodium densum* Labill., *Phebalium squamulosum* Vent., *P. dios-*

meum Juss., *Hibbertia acicularis* F.v.M., *Hakea propinqua* A. Cunn. A preference exhibited by *Acacia trinervata* Sieb., for the north-east rather than the south-east slopes of the Blue Mountains was noted in the Public Service Journal for April, 1915, p.28. At the Meeting of this Society in September, 1915, Messrs. Musson and Fletcher exhibited specimens from a plant-association in the neighbourhood of Wilberforce, among them *A. trinervata* and *Persoonia oblongata* A. Cunn. The exhibitor had many times traversed Erskine and Glenbrook Creeks, and had camped for some days at the "Basin," but had not seen either of these species in the gullies or on the Nepean River south of Emu Plains.—Examples of leaf-variation in: *Smilax australis* R.Br., (Springwood; A. A. Hamilton; April, 1915: and Cook's River; December, 1914); leaves from rotundate to elliptical-lanceolate, with bases from cordate to rotundate, and apices from apiculate to emarginate. Measurements:—6×5 inches, $6 \times 2\frac{1}{2}$, $4 \times 3\frac{1}{2}$, $4 \times 1\frac{1}{2}$, $2\frac{3}{4} \times 2\frac{1}{2}$, $2\frac{1}{2} \times \frac{7}{8}$, $1\frac{1}{2} \times \frac{1}{2}$. The specimens from Cook's River dried brown, while those from Springwood retained their green colour. *Dodonæa triquetra* Wendl., (A. A. Hamilton; Cook's River; December, 1914); leaves from broad-lanceolate to elongate-rhomboidal, and ovate-elliptical, with apices acute, acuminate, obtuse, to emarginate or apiculate, the base either gradually or abruptly narrowed into the petiole. *Gompholobium latifolium* Sm., (A. A. Hamilton; Woy Woy; June, 1915); leaves opposite or alternate, oblong, spathulate to linear, their apices emarginate, truncate, or with a minute mucro, and ranging from $\frac{1}{2}$ to 2 inches in length

Mr. W. W. Froggatt exhibited—A large mass of the cocoons of the blue saw-fly, *Perga dorsalis*, from Salisbury Court, Uralla. The larvæ are very plentiful on the Peppermint-gums at Uralla, and, when full-fed, crawl down the trunks, and keeping together in a mass, move about on the ground for several days before they finally make for the base of a tree, where they bury themselves just under the surface, and form their cocoons.—A small undetermined snake taken near the Experiment Station at Salisbury Court.—A specimen of a centipede, *Scolopendra morsitans*, from

Brewarrina, N.S.W.—Samples of *Opuntia monacantha* infested with *Coccus indicus*, which has destroyed many acres of this particular prickly pear, but does not damage any other species. The Cape Cochineal, on the other hand, does not injure this *Opuntia*.

Miss S. Hynes exhibited an example of *Wahlenbergia gracilis* DC.,[N.O. CAMPANULACEÆ], with double flowers, and a coloured drawing of the flowers when fresh, collected by Mrs. Rowan at Widgiewa, N.S.W.

On behalf of Mr. E. A. Breakwell, the President exhibited, under the microscope, transverse sections of the stem of a western shrub, *Apophyllum anomalum* F.v.M., [N.O. CAPPARIDEÆ]. The anatomy of this Order has been investigated by Solereder (Systematic Anatomy of the Dicotyledons, Vol. i., pp 67-77), but neither in his list of Capparideæ examined does he include *Apophyllum anomalum*; nor does he refer to the presence of palisade-tissue in the stems of any he did examine. The presence of palisade-tissue in an Australian shrub, *Bossiæa scolopendria* Sm., has already been recorded by Mr. A. G. Hamilton. *Apophyllum anomalum* has leaves which are caducous, and which are extremely small in proportion to the size of the plant ($1 \times \frac{1}{4}$ inch in a plant 10 feet high). The palisade-tissue in the leaf is of the bifacial type. The cuticle is very thick, and stomata are developed on both surfaces. The palisade-tissue in the stem extends for some considerable distance towards the centre of the leaf, and is interrupted at intervals by well developed sclereides. The tissue is well seen both in young and mature stems. The cuticle is extremely thick, and the stomata, which are well marked, appear to lead, in some cases, into intercellular cavities. The vascular bundles are strengthened by well developed sclerenchymatous tissue. The stem is thus admirably adapted, in the absence of normal leaf-development, for assimilatory functions. The anatomical structure of leaf and stem shows extreme xerophytic characteristics.

Mr. Fletcher showed a fruiting branchlet of a young tree of *Pisonia Brunoniana* Endl., [N.O. NYCTAGINEÆ] from a garden at Hunter's Hill. The little Blue Wrens (*Malurus cyaneus*), in hunting for insects among the branchlets, occasionally come into contact with the very viscid exudation from the glandular ridges on the fruiting-perianths, and are apt to be caught so securely by the feathers or by the feet, that they are unable to release themselves without assistance. [For a New Zealand record of the victimisation of Silvereyes and a Sparrow under similar circumstances, see, "A Bird-killing Tree." By R. H. Govett. Trans. New Zealand Inst., xvi., p.364 (1884). Also Kirk's Forest Flora of New Zealand, p.293 (1889). (References kindly furnished by Mr. E. Cheel)].

Mr. Benson, who was unable to attend at last Meeting, gave an outline of the geology of the Tamworth District, N.S.W., and described the undoubted occurrence of intrusive tuffs. Some discussion followed, in which Messrs. J. E Carne, E. C. Andrews, and J. Mitchell took part.

The President tendered the thanks of the Society to Mr. C. Hedley, F.L.S., for his donation of a framed portrait of Professor W. A. Herdman, D.Sc., F.R.S., of Liverpool University, whose work on Australian Tunicata was well known to zoological Members.

CONTRIBUTIONS TO OUR KNOWLEDGE OF SOIL-FERTILITY.

No. xiii. The Toxicity of Soils.

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

In previous communications, I have shown that when a soil is shaken up with water in the proportion of 100 grams of soil to 100 c.c. of water, there is obtained an extract which, under certain conditions, is toxic towards bacteria. The bacteria may be very sensitive to the toxin, such for example as *Bac. prodigiosus*, or they may be slightly sensitive, such as a mixture of the soil-bacteria. The toxic effect is shown in the case of *Bac. prodigiosus* as a distinct diminution in the number of bacteria, and, in the soil-bacteria, as a retardation of the speed of the increase.

In the soil-extracts, there are present nutritive as well as toxic substances, and the direct evidence of the action of the toxin in destroying bacteria will naturally depend upon the presence of a preponderating amount. Otherwise, if the nutritive substances are in excess, no direct evidence of toxic action will be obtained. It is easy to demonstrate an indirect toxic action. One has only to prepare a soil-extract, to heat one portion, and to compare the rate of growth of bacteria added to each part. It will generally be found that all heated soil-extracts, when seeded with bacteria, will produce a greater number in, say, twenty-four hours than an unheated but otherwise similar extract. The reason for this is that the toxins have been destroyed, and, with these out of the way, the growth of the bacteria is much increased. The destruction of the toxins by heat may be analogous to the conversion of the petroleum-soluble and preservative hop-constituents into petroleum-insoluble and non-preservative substances upon being boiled with water.*

The presence of the toxin in the soil depends upon the natural conditions to which the soil has been subjected. Rain, for example, washes it out, and the extract, instead of being toxic, is nutritive. The decay of the toxin in the soil is accelerated by dry conditions, so that in dry, as in wet weather, we cannot expect to find the extracts toxic. There is a medium between wet and dry conditions which, while probably not influencing the actual formation of the toxin, yet facilitates our being able to demonstrate its presence.

There is still much to be learned regarding the nature of the toxic solution and of the production of toxins. Several matters relating to these have been investigated, and are here recorded.

The relation of the quantity of Water used in extracting the Soil.—It is curious that the quantity of water used for extraction should have an influence in enabling the toxic effect to be evident, and although this has been shown to occur,† yet the difficulty of explaining the phenomenon caused another test to be made, when time should have modified any personal factor.

A garden-soil, seven days after heavy rain, gave the following result:—

	Cells of *Bac. prodigiosus* in 20 hours at 22°.
Bacteria in control-test	100
Bacteria in extract	40

Two days later, when the soil contained 7·05% of moisture, it was shaken up with varying amounts of water and extracts prepared. These were seeded with a suspension of *Bac. prodigiosus*,

* Chapman, Proc. Chem. Soc., xxix. (417), p.182.
† These Proceedings, 1914, pp.729-731.

and incubated at 22°. Next day, plates were prepared and the bacteria counted.

100 grams of soil to	Cells of *Bac. prodigiosus* in 20 hours at 22°.
30 c.c. of water	94
50 c.c. of water	176
75 c.c. of water	175
100 c.c. of water	67
400 c.c. of water	60
Control-test, water only	100

The results are in keeping with previous tests, in which it was shown that the general tendency was for the extract to be toxic when comparatively small quantities of water relatively to the soil were used; with larger quantities, the extracts became nutritive, but again became toxic at about the 1:1 ratio.

It is difficult to use less than 30 c.c. of water per 100 grams of soil in preparing an extract. In order, therefore, to obtain information regarding the possibility of toxic action in soil-water, the test-bacteria were added to soil directly with varying quantities of water. The test-bacteria are thus in competition with the soil-bacteria, and the conditions are not the same as when extracts are used. At the same time, it has been shown that the presence of soil- and test-bacteria in extracts do not affect the general trend of the toxic or nutritive effect, as indicated by the decrease or increase of the test-bacteria. So far as the test-bacteria are concerned, the soil-bacteria are relatively inert, during the time of the experiment.

Twenty-gram portions of soil were put into petri-dishes, and 1 c.c. of a suspension of *Bac. prodigiosus* was added to each along with varying quantities of water. The soils were thoroughly mixed with the water, and the dishes were put into a damp-chamber and incubated at 28° for 20 hours. They were then transferred to flasks of sterile water, shaken, diluted, and $\frac{1}{40}$ c.c. smeared on agar-plates, dried at 37°, incubated, and counted.

For further information regarding the soils, an extract was made, and the numbers E/C were obtained by dividing the increase during 20 hours at 22° in the extract by the numbers in the control-test. A soil which gives an extract that is neither nutritive nor toxic, shows a growth ratio, E/C = 1, a nutritive soil is greater than 1, and a toxic soil is less.

The numbers in the tables are compared with 100 bacteria added at the start or originally present For the actual numbers, the following are taken from experiments *c* and *d*.

	Bacteria at start in millions per gram of dry soil.	
	Bac. prodigiosus.	Soil-bacteria.
Expt. *c*	0·233	6·074
Expt. *d* .	0·545	7·551

100 bacteria in 20 hours at 20° became										
a		*b*		*c*			*d*			
Moisture.	*Bac. prodigiosus.*	Moisture.	*Bac. prodigiosus.*	Moisture.	*Bac. prodigiosus.*	Soil-bacteria.	Moisture.	*Bac. prodigiosus.*	Soil-bacteria.
8·3	120	9·3	70	7·8	—	232	7·3	—	73
12·5	98	13·5	52	12·2	102	166	11·7	72	99
16·2	99	17·2	51	16·1	151	155	15·7	79	119
19·7	95	20·6	47	19·8	69	143	19·4	65	121
23·0	100	23·8	40	23·1	81	141	22·7	45	99
26·0	96	26·8	38	26·2	56	132	25·8	43	107
28·6	99	29·5	37	29·1	53	109	28·7	43	80
—	—	—	—	31·7	53	114	31·3	36	90
E/C = 1.		E/C = 0·04.		E/C = 0·75.			E/C = 60.		

There are two points in the experiments that are not quite clear. These are, (1) the jump of the soil-bacteria in the ¾ toxic soil (Expt. *c*) from 100 to 232 upon incubating at 28° for 20 hours, and the fall of the soil-bacteria in the nutritive soil (Expt. *d*); (2) the diminution of *Bac. prodigiosus* in a soil which gives a nutritive extract (Expt. *d*).

The general tendency is for the bacteria in the soils to decrease with an increase in the moisture-content. This may have been caused by the water gradually displacing the air in the soil-spaces, but, as the non-toxic and non-nutritive soil of Expt. *a* did not show this tendency, we may be justified in assuming that there was a sufficiency of air under the conditions of the experiments, viz., a shallow layer of soil of about 2 mm. thickness. It appears that an increase in the amount of moisture increases the toxic effect of the soil-water.

When the results of these experiments are considered in conjunction with those of the experiments with soil-extracts, it is seen that the effect of adding water in progressive amounts to the soil is to cause a certain degree of toxicity to become manifest. As the quantity of water relative to the soil is increased, the toxicity becomes less marked. This is when the ratio of soil to water is about 1 : 0·5. Then the toxicity increases, and is generally most pronounced when the ratio is 1:1. In one case,* this occurred at the 1 : 1·5 ratio. With the addition of more water, the toxicity diminishes.

Moisture and Temperature in Formation of Toxin.—In attempting to produce bacteriotoxins in soils in the laboratory, one realises that certain conditions should favour their production. The moisture-content of the soil and the temperature are clearly of outstanding importance. An attempt was accordingly made to investigate these.

A soil was divided into 200 gram portions, and water was added to bring the moisture-contents up to 5, 10, 15, and 20%. Three sets were prepared and stored in bottles in the laboratory. Stumps of matches were set at the sides of the corks to ensure a limited communication with the outside air. At intervals, each set was taken, and the soils shaken up with 200 c.c. of 0·2% of potassium sulphate (added to hasten filtration), and due allowance was made for the water present as moisture. The extracts were, as usual, filtered through paper and porcelain, and seeded

* These Proceedings, 1913, p.773, Experiment xi.

with a suspension of *Bac. prodigiosus*, incubated for 20 hours at 22°, and counted by the plate-method.

Number of cells of *Bac. prodigiosus*.			
	17 days.	32 days.	41 days.
Water-control	100	100	100
Extract of soil with 5% moisture	252	45	115
Extract of soil with 10% moisture	82	96	68
Extract of soil with 15% moisture	142	102	75
Extract of soil with 20% moisture	218	145	86

The water-control was the same dilute potassium sulphate which was used for making the extracts, and, like the extracts, it had been filtered through porcelain to ensure sterility. This is necessary because sterilisation by heat alters the toxic or nutritive effect of the water.

While the extract from the 5% soil was variable, those from the 15% and 20% showed a steady increase of toxicity. The 10% extract was always toxic.

Having determined that about 10% of moisture, or one quarter of the H.W.C., was best for obtaining a soil furnishing a toxic extract, an attempt was made to determine the optimum temperature. For this purpose, the soil was taken soon after rain, when it should have been either feebly toxic or nutritive. Two hundred gram portions were put into bottles, which were corked and incubated at four different temperatures for varying times. At the start, the soil contained 11·05% of moisture.

	Number of cells sf *Bac. prodigiosus* in 20 hours at 22°.			
	2 days.	9 days.	14 days.	26 days.
Water-control	100	100	100	100
Extract of soil, 15°	114	130	60	166
Extract of soil, 22°	107	90	59	169
Extract of soil, 28°	106	90	37	20
Extract of soil, 37°	557	130	40	43

Considering the results generally, it is seen that 15° to 22° give very similar results, and that 28° is the optimum temperature for a rapid development of toxin. The highest temperature, 37°, appears to show that an initial destruction of toxin occurred, and that this was followed by a subsequent formation.

Extracts from chloroformed and air-dried soils.—As a rule, the extract of a soil which has been treated with a volatile antiseptic, such as chloroform, is more nutritive towards bacteria than untreated soil. The amount of moisture in the soil when chloroformed should have some influence, and the nature of the result may depend upon whether the soil has been chloroformed in the natural state, or whether it has been more or less air-dried to obtain a more representative sample. That the moisture has an influence was shown in an experiment in which the soil, with its natural moisture, was passed through a sieve with 13 meshes to the inch, and then treated with 5% of chloroform before and after being air-dried. The disinfectant was aired-off after two days' contact, and extracts of the soils were made in the manner which has been previously described. The extracts were seeded with a suspension of *Bac. prodigiosus*, and incubated for 21 hours at 22° and counted.

	Bacterial growth.
Water-control	100
Extract of soil, chloroformed wet	33,000
Extract of soil, chloroformed dry	216,080

The experiment shows that the moisture in the soil hinders the action of the chloroform in liberating nutritive materials from the soil.

The effect of air-drying alone upon the toxic or nutritive nature of the extract obtained from the soils was investigated upon three occasions.

	Growth of *Bac. prodigiosus*.		
	Sept. 1st.	Sept. 5th.	Sept. 9th, 1914.
Water-control	100	100	100
Extract of moist soil...	16	103	87
Extract of air-dried soil	3	3,730	5,500

The results indicate that if the soil is strongly toxic, as on September 1st, air-drying increases the toxicity of the extract;

but if it is feebly toxic, as on September 9th, or virtually non-toxic, as on September 5th, drying brings about a greater solubility of the nutrients if it does not destroy the bacteriotoxins.*

The number of soil-bacteria in the soil was tested on September 5th, and found to be as follows :—

Raw soil ... 14 millions per gram of dry soil.
Air-dried soil... 3·6 millions per gram of dry soil.

The Development of Soil-Toxins.—Although the development of soil bacteriotoxins has been previously described in these Proceedings, some further work was done during the later months of 1914 by way of confirmation. The garden-soil under grass was passed through a coarse sieve (No.13), and moistened with a small quantity of water to bring the content up to 6%. It was then heated in the oven until a thermometer, with its bulb in the centre of the soil, registered 80° for 10 minutes. After cooling down, the moisture was made up to 10%, and the soil was incubated at 28°. As the soil was contained in an enamelled bucket with a lid, the moisture did not fall rapidly, and any loss was made good from time to time. Extracts were made in the ordinary manner, and these were seeded with *Bac. prodigiosus* and with a suspension of bacteria from the same bucket of soil.

	Bacteria in 1 gram of dry soil, millions.	Bacterial growth in 20 hours at 22°.	
		Bac. prodigiosus.	Soil-bacteria.
At start	1·0	—	—
6 days	77	1140	490
13 days	112	—	390
21 days	51	280	100
27 days	51	200	130
34 days	56	410	230
Water-controls ...	—	100	100

* Buddin (Journ. Agric. Sci., vi., 452) shows that the air-drying of soil causes an increase in the amount of nitrate formed during a period of three months under laboratory conditions; and that a drying to 98 % of dry matter gives a greater nitrate-increase than a drying to 96 %. In another experiment, in which the drying diminished the bacteria from 10 to 4 or 5 millions, no difference was detected in the amount of ammonia and nitrate immediately after treatment, but after an incubation of 4 months, the soils which had not been air-dried contained 28 to 33 parts of nitrate per million, and those which were air-dried contained 41 parts.

The growth of the bacteria in the extract was compared with the growth in the water used in preparing the extracts, both extract and water being primarily freed from bacteria by filtration through porcelain.

At the end of the experiment, the soil was tested for protozoa, and representatives of the three classes, ciliates, monads, and amœbæ, were found.

The experiment is similar to others in which the development of toxicity is not so marked as the lessened nutritive action. It is possible that the preliminary heating played some part in preventing the development of toxins in sufficient quantity to show a direct toxic action, such as was obtained in the moisture-experiment (p.636, *antea*).

Soils seem to develop toxicity much more readily under natural conditions than when bottled up in the laboratory. In casting about for a reason for a difference in the behaviour, one noted that the garden-soil had a covering of grass, which was absent in the experimental soil. This may be a reason for the difference, for the Duke of Bedford and Pickering have recently shown that the leachings of grassed soils are toxic to fruit-trees, to various plants, and to grass itself. They consider that these toxins are not secreted by the plant-roots directly, but result from the decay of the débris of the growing roots. Thus the bacteria are brought into the matter, and an increase of root-débris should mean a greater bacterial fermentation and increased amount of bacterial products, toxic to the bacteria themselves and to plants. Whether these two are the same or not, has yet to be determined, but, at present, these authors have indicated a relation between plant-growth and bacteriotoxins. This relation was to be expected, as any substance which increases bacterial growth will necessarily increase the bacterial by-products.

In commenting upon these experiments of the Duke of Bedford and Pickering, Miller* says, "It does not seem very clear why the leachings from the trays are injurious to the plants in the pots . . . . whilst it is without action, as soil-solution, before it drains out of its own pot." The leachings are really unfiltered

* Annual Reports Progress of Chemistry, Chem. Soc., 1914, 232.

soil-extracts, and my experiments have shown that the toxicity is only apparent when the ratio of water is about 1 : 1. It would be necessary to use this ratio in order to obtain leachings, for a smaller quantity of water, say a ratio of 1 : 0·5, would simply wet the soil. My experiments with bacteriotoxins have shown that the half ratio gives an extract which is nutritive to bacteria, just as it is to plants. The toxicity of the leachings and the beneficial effect of the simple wetting appear to bring the bacteriotoxins into line with the plant-toxins, and make it possible that they are similar, if not identical.

If the root-débris consists of the shrivelled root-hairs, it is a substance which will decay with comparative slowness, and we should expect very little toxin to be developed in a month, a usual time for laboratory experiments. This is really what occurs; a comparatively small amount of toxin does develop. But I have found that, in the open soil under grass, the production of toxin is much quicker, and this leads to the supposition that some quickly decomposing substance is given to the soil by the grass. Some years ago, Mazé* showed that a gramineous plant, maize, secreted dextrose. In water-culture experiments under aseptic conditions, he found this sugar in the water bathing the roots of his plants. If this is the case, for it has not been confirmed, we have a reason for the rapid production of toxin in the soil in which plants such as grass are growing.

It has been known for some time that crops are injuriously affected by the presence of easily fermentable carbohydrates in the soil. The deleterious action of raw farmyard-manure upon certain soils is an example. Russell showed that, unless time were given for starch to decay, its addition to soil was followed by a diminution of the crop. Lipman† showed that the addition of glucose to soil depressed the yield of crop even when an excess of fertilising material, including nitrate, was present, and, furthermore, that the depression of the crop was not due to the action of denitrification of the nitrate by bacteria or moulds, as nitrates were found in the affected crop.

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* Annal. de l'Inst. Pasteur, xxv. (1911), p.724.

† Lipman, New Jersey Agric. Expt. Stn. Rept. No.257.

These considerations lead one to expect that the addition of glucose to soil will bring about a more rapid production of bacteriotoxin. The quantity must not be too great or there will not be a complete fermentation, and any left undecomposed in the soil will, upon extraction with water, act as a nutrient masking the toxic effect.

A preliminary experiment was made with an alluvial soil which had been in store for some time. It was subsequently considered that a raw soil would have been more suitable as probably containing a more diverse flora, but, unfavourable as the conditions were, the experiment showed that dextrose undoubtedly assisted the formation of bacteriotoxins. It was somewhat difficult to decide upon the amount of dextrose to add to the soil. Lipman obtained his toxic effects with 10, 20, and 30 grams of dextrose to 20 pounds of soil, a quantity roughly equivalent to 0·1%, 0·2%, and 0·3%. He got a pronounced diminution of crop with 0·2% Mazé obtained 57 milligrams of glucose from a maize-plant growing in three litres of water. This is approximately equal to 0·02%. These quantities were given and obtained during a growing period, but, to obtain evidence of toxicity in a short time, a smaller amount would probably be better to ensure a complete fermentation.

The experimental soil was accordingly treated with 0·005% of dextrose, and check-tests without sugar were made at the same time. Two of the conditions for toxin-formation had already been determined. These are, that the soil should contain an amount of moisture equal to about one-quarter of the water-holding capacity, and that the temperature of incubation should be from 22° to 28°. As the laboratory temperature was about 25°, the bottles of soil were allowed to stand upon a laboratory-bench.

Bac. prodigiosus in 20 hours at 22°. Control-test = 10.

	4 days.	9 days.
No sugar	56	12
Dextrose 0·005%	23	1

The tests with no sugar behaved just like previous tests. The nutritive effect was reduced upon incubation, and, although this could only occur through the production of bacteriotoxin, the toxic effect was not sufficient to show a direct toxicity. With dextrose, the case was different. The toxicity was so great as to completely overshadow any nutritive action on the ninth day. Further tests were made, but the results were irregular.

EXPERIMENT 12/11/14.

	Bac. prodigiosus; average control-test = 10.		
	4 days.	11 days.	18 days.
No sugar	18	98	8
Dextrose, 0·01% ..	84	100	12
Dextrose, 0·1% ...	172	21	5

EXPERIMENT 25/11/14.

	Bac. prodigiosus; average control-test = 10.		
	1 day.	8 days	15 days.
No sugar	16	28	8
Dextrose, 0·005% ...	19	31	3
Dextrose, 0·01% ...	15	43	6
Dextrose, 0·02% ...	17	23	8

It appeared possible that aëration of the soil might hasten the production of toxin, and, accordingly, a current of air was passed over the soil contained in bottles.

EXPERIMENT 18/12/14.

	Bac. prodigiosus; average control-test = 10. 4 days.	
—	Air passing.	No air passing.
No sugar	16	13
Dextrose, 0·005%	23	1

The aëration of the soil containing dextrose did not appear to assist the formation of toxin, and, accordingly, further tests were made to confirm the result. These showed that the time of aëration was of importance.

	Bac. prodigiosus; average control-test = 10.		
		Air passing.	No air passing.
Dextrose, 0·005% ... 8/2/15	1 day.	7 6	21 26
25/2/15		21 7	11 11
10/3/15		14 20	10 13
25/2/15		15 12	23 1
	average	13	18
Dextrose, 0·005% ... 25/1/15	3 days	12 14	1 2
15/2/15		19 17	15 13
	average ..	15	8
Dextrose, 0·005% ... 1/2/15	5 days	47 15	5 4
Dextrose, 0·01%... ... 16/3/15	2 days	9 12	16 13
8/4/15	4 days	5 23	17 17
23/3/15	6 days	1 5	13 21

The duplicates of the tests are so irregular that conclusions regarding the effect of aëration cannot be definitely drawn.

But after making allowance for apparent discrepancies, it appears that, with the smallest amount of dextrose, viz., 0·005%, the passing of air over the soil makes it at first more toxic, then more nutritive. This is presumably caused by the decomposition or decay of toxin rapidly formed from the small quantity of sugar. With 0·01% of dextrose, aëration makes the soil toxic in about five days, with an air-temperature running about 25°. Simple storage of the soil containing the smaller amount of dextrose, results in the formation of toxin in five days, while with the larger quantity, a toxic effect does not become apparent in that time. On the whole, aëration appears to hasten the formation and destruction of toxins formed from the sugar.

These experiments with dextrose and soil show that the presence of small quantities of sugar undoubtedly increases the toxicity of the soil, when a sufficient time is given for the sugar to become decomposed. The determination of the time will naturally depend upon the conditions which govern microbic fermentation, and include the quantity of sugar, the aëration, the temperature, etc.

The preceding experiments were made with the test-organism, *Bac. prodigiosus*, which can give direct evidence of toxicity in soil-extracts. The soil-bacteria have not been found to do this; they show the toxicity indirectly by a diminished growth under the conditions of the experiments, as has been shown in previous papers. A diminished development of bacteria is also seen in the following experiment in which a rather large quantity of dextrose, viz., 0·1%, was added to the soil. This contained 8·3% of moisture, and was stored at laboratory-temperature. The bacteria used for infecting the extracts and water-controls were obtained by shaking some of the same soil with sterile water, and using the suspension. As in other experiments, the growth was determined by counting the bacteria after an incubation at 22° for 20 hours. (See Table on next page).

A diminution of the bacterial growth is evident, but, unfortunately, the gradual loss of nutritive effect, in the absence of a direct evidence of toxic action, may be capable of two explanations. The gradually diminished growth may be caused by the production of toxin, or by the gradual loss, by decomposition, of the nutritive sugar added to the soil.

	Bacteria in millions per gram of dry soil.	Growth of soil-bacteria in the soil-extract; water-control = 10.
At start	17	302
8 days	84	122
28 days	163	109
57 days	47	84

It is concluded from the experimental work detailed in this paper that:—(1) The formation of toxins in the soil, free from vegetation, occurs most rapidly when the temperature is near 28°, and the moisture-content is one-fourth of the water-holding capacity.

(2) The soil-extract is, as a rule, either nutritive or toxic according to the volume of water, relative to the soil, used in preparing the extract. It is most nutritive when the ratio of soil to water is 1 : 0·5, and most toxic when it is 1 : 1.

(3) A previous drying or chloroforming of the soil generally causes the extract to be much more nutritive than when the raw soil is used.

(4) The addition of small quantities of dextrose to soil brings about a more rapid production of toxin, while aëration of the treated soil accelerates the formation and decay of the toxin.

THE SILURIAN TRILOBITES OF NEW SOUTH WALES, WITH REFERENCES TO THOSE OF OTHER PARTS OF AUSTRALIA.

By R. Etheridge, J.P., Junr., Curator of the Australian Museum, and John Mitchell, late Principal of the Newcastle Technical College.

Part V.

The ENCRINURIDÆ.

(Plates liv.-lvii.)

i. Introduction.

It is now some years since the Fourth Part of our joint studies on the Silurian Trilobites of New South Wales appeared. This lapse of time is easily accounted for by the pressure of public duties entailed on both of us.

The last family described was that of the Odontopleuridæ. We now purpose describing the members of the Encrinuridæ. In this family are placed the following limited number of genera, viz.:—

Encrinurus, Emmrich.
Cromus, Barrande.
Cybele, Loven.
Dindymene, Hawle and Corda.

Of these, the first is the only genus yet found in Australia with certainty.

ii. The Genera *Encrinurus* and *Cromus*.

Some authors regard these as synonymous; by others, on the contrary, they are accepted as closely allied but distinct genera.

Encrinurus was proposed by Emmrich, in 1845, to include the *Trilobites punctatus* of Brünnich, which we presume (we have not access to the original description) became the generic type. We are, however, able to refer to Hawle & Corda's work,* published only two years after the appearance of Emmrich's description. These authors describe the above trilobite as it is now generally accepted, and very carefully traced the course of that most important feature, the facial suture, in the following words:—"The frontal suture arises on the exterior margin of the cephalon below the spine (genal) . . . . . passes obliquely upwards and inwards to the posterior angle of the eye, round the eye operculum [palpebral lobe] and curves inwards from the anterior angle of the eye and the two (facial sutures) unite on the point of the forehead above the inflected somewhat serrated head margin." They also note eleven segments in the thorax, and the non-segmented condition of the pygidial axis; but no remarks whatever are made about the existence of glabella furrows.

The type, *Encrinurus punctatus* (as *Cybele punctata*), was described from Wenlock Limestone specimens by Mr. J. W. Fletcher;† and his remarks are important in that his description of the glabella clearly indicates the difference existing between that portion in *Encrinurus* and *Cromus* respectively. He said that "two or three large tubercles arranged on each side of the lower half of the glabella, occupying the situation of the lateral lobes, the *furrows between which are not visible*" (the italics are ours). To follow the whole literature bearing on *Encrinurus* would be tedious, and is unnecessary, but two references in particular may be quoted. The first comprises the beautifully engraved figures of three species (*E. sexcostatus*, Salter, *E. variolaris*, Brongniart, and *E. punctatus*, Brünnich).‡ In the three views of the glabella of the first of these, lateral furrows are clearly represented and described, but in the other two these furrows are not. *E. sexcostatus* is, therefore, from our point of view, a *Cromus*, and no doubt would have been so designated by

* Hawle & Corda, Prod. Mon. böhem. Trilobiten, 1847, p.90.

† Fletcher, Quart. Journ. Geol. Soc., 1850, vi., p.403, Pl. xxxii., figs.1-5.

‡ Salter, Mem. Geol. Survey U. Kingdom. Figs. and Descriptions Brit. Org. Remains, 1853, Dec. vii., No.4, Pl. iv.

Salter, had he been familiar with the latter genus. It must not be forgotten, however, that as Salter's memoir was published in 1853, and Barrande's description of *Cromus* only appeared in 1852, it is quite probable the English Palæontologist was unaware of his French colleague's labours.

We know of no more instructive and complete figures of *Encrinurus punctatus* than those by Mr. E. Hoffmann,* of specimens from the Island of Oesel, in the Baltic. Herein are shown the course of the facial sutures on the front of the glabella centre, the peduncular eyes, and the characteristic granulation of the pygidium.

On the other hand, an equally good illustration of a non-testiferous example is that of Hawle & Corda's generic figure.† Here are shown the large marginal tubercles along the axial furrows of the glabella, and when in this condition, the spaces between them simulate very short lateral glabella furrows; but, as a matter of fact, this simulation is only produced by the projection of the tubercles in question. Similar features are shown in Angelin's figure of *E. punctatus.*‡

Barrande's enumeration of *Cromus* appeared in his monumental work "Système Silurien du Centre de la Bohême."§

In general features, *Cromus* resembles *Encrinurus*, particularly in the form of the thoracic segments, test-ornamentation, outline of the pygidium, etc. On the contrary, the glabella bears four pairs of distinct lateral furrows, the hypostome lacks the forward prolongation of that of *Encrinurus*, the eyes are sessile, poorly developed, and, so far as known, there are but ten segments in the thorax as against eleven in that of *Encrinurus.*

It is perhaps worthy of remark that Zittel, in his "Handbuch der Palæontologie,"|| retained *Encrinurus* and *Cromus* as distinct

* Hoffmann, Verhandl. Rus.-Kaierl. Min. Gesellschaft. St. Petersburg, 1857-58(1858), Pl. iii., fig.5*a*.

† Hawle & Corda, *loc. cit.*, Pl. v., fig.55.

‡ Angelin, Pal. Scandinavica, 1878, Pt.1, Pl. iv., fig.4 (as *Cryptonymus punctatus*).

§ i., 1852, p.821.

|| Zittel, i., Abh., ii. Band, p.621.

genera, and in this instance is followed by his French translator, Dr. C. Barrois;* but in Eastman's English translation, Prof. C. E. Beecher, who edited the Trilobita, made *Cromus* a synonym of *Encrinurus*.†

In the face of Barrande's detailed description and finely executed figures, we fail to see how it is possible to unite the genera under discussion. Failure to thoroughly grasp the importance of some of the structural details disclosed above, has caused us, in the past, to make erroneous determinations, but now that we have an opportunity of studying the Australian Encrinurids as a whole, we hope to rectify these.

The following are the more important characters of *Encrinurus* :—

A pyriform, forwardly inflated glabella, devoid of lateral furrows, highly clothed with tubercles of which five pairs border the axial grooves, and the three pairs of these placed between the anterior and posterior pairs are larger than the others; facial sutures either openly V-shaped or bi-sigmoidal, meeting anteriorly in the middle line of the glabella and cutting the anterior cephalic margin as a single suture; eyes pedunculate and faceted; axial grooves curve outwards to the antero-lateral margins of the cephalon, crossed by the facial sutures, and distinctly divide the free cheeks into two unequal portions; hypostome subrhomboidal, anteriorly cucullate; thorax of eleven somites; pygidium triangular, its axial rings anchylosed, and the pleuræ composed of from seven‡ to thirteen or more simple, rounded, and unfurrowed segments.

iii. AUSTRALIAN HISTORY OF THE ENCRINURIDÆ.

1. New South Wales.

The first writer to detect the presence of this family in Australian Silurian rocks was Mr. J. W. Salter, for amongst his

* Barrois, Traité de Palaéontologie, ii., pp.617-18.

† Zittel's Textbook Pal., 1900, i., p.634.

‡ *E. ornatus*, Hall & Whitfield, of the Niagara Group of Ohio, possesses but seven (Geol. Survey Ohio, Pal. ii., Pt. ii., p.154, Pl. vi., fig.16); probably an abnormal form.

determinations of fossils from the "Southern Districts of New South Wales," collected by the Rev. W. B. Clarke, occurs the name of *Encrinurus australis*, Salter.* No locality was mentioned, and nothing beyond the name is known of it. It appears this was included in a collection "forwarded to the Woodwardian Museum, Cambridge; borrowed from Prof. Sedgwick by Sir R. I. Murchison, in 1856, for examination and description by Mr. Salter, from whose MS. notes sent to Mr. Clarke in 1858, the following are named, etc."† In a letter to Clarke, Salter wrote as follows‡—"The abstract sent to you by Sir Roderick (Murchison) will have clearly answered one of your important queries, since there can be no doubt of a true Upper Silurian formation among your fresh fossils; the presence of *Calymene*, *Encrinurus*, and a plaited pentamerus quite settles that question."

The study of Clarke's great collection of New South Wales Palæozoic fossils, as a whole, was ultimately undertaken by Prof. L. G. de Koninck of Liége, Belgium. He recorded the presence of four species of Encrinurids from New South Wales Silurian rocks, as follows:—§

Encrinurus punctatus, Brünnich.	Yass District—a pygidium. Duntroon—a nearly complete specimen.
Encrinurus barrandei, De Koninck.	Yarralumla—several examples.
Cromus bohemicus, Barrande.	Yarralumla—cephalon and pygidium.
Cromus murchisoni, De Koninck,	Yarralumla—a cephalon. Quedong—a cephalon.

In 1880, a short paper by one of us was published|| on a small series of New South Wales Palæozoic fossils presented by Prof. A. Liversidge to the British Museum. Amongst these were

* Clarke, S. Goldfields of N. S. Wales, 1860, p.286.

† Clarke, Remarks Sed. Formtn. N. S. Wales, 4th Ed., 1878, p.151.

‡ Salter in Clarke, Remarks, *ibid.*, p.154.

§ De Koninck, Foss. Pal. Nouv.-Galles du Sud, Pt.1, 1876, pp.49-55, Pl. i., figs.8, 9, 9*a-b*.

|| Etheridge, Journ. Roy. Soc. N. S. Wales, 1880, xiv., p.251, Pl., figs. 11 and 12.

several pygidia and portion of a cephalic shield from Bombala. These were referred to *Encrinurus punctatus*, but now, from an extended knowledge of Australian Encrinurids, we have reason to doubt the accuracy of this determination. The figured examples of pygidia, judging by the outlines, may be those of *E. rothwellæ*, nobis, but, in connection with those figures, an admission of carelessness must be made. The illustrations in question show a continuously annulated axis, whereas, in the text, a centrally unsegmented axis is described. The latter is probably correct; but under the circumstances is practically of no value.

The only other descriptions of members of this family we are acquainted with from New South Wales, are those of *Encrinurus mitchelli* and *E. bowningensis* by Mr. A. F. Foerste,* of the Denison University, Granville, Ohio, from material supplied by one of us. This was of poor preservation, but Foerste's descriptions render it quite easy to recognise the species proposed by him.

It will save repetition if we now proceed to make a few critical remarks on these organic remains, rather than with the descriptions of the species it is our intention to describe later.

Of *Encrinurus australis*, Salter, nothing is known, and, in accordance with a remark already made, is dismissed from further consideration.

E. punctatus, Brünnich, a fossil highly typical of the Wenlock division of the Upper Silurian, notwithstanding the very extensive series of *Encrinuri* that have passed through our hands, we have never seen. Both the cephalon, in the possession of genal spines, and the pygidium in that of a mucro or telson, are so conspicuous, it is hardly possible we would have neglected to notice them had they come under our review. In this instance, as in some others throughout his work, we cannot divest our minds of the suspicion that De Koninck, in his remarks on this trilobite, did not describe the Australian fossil at all, but simply indicated the principal features of *E. punctatus*, leaving it to be inferred

* Foerste, Bull. Sci. Lab. Denison Univ., 1888, iii., Pt.2, pp.121-126, Pl. xiii., figs.2, 3, 7, 20.

that the Australian fossil exhibited the same characters. Indeed, it seems to us that his opening paragraph can have no other construction put upon it. He said:—"Cette espèce a été si bien décrite et figurée par M. Fletcher et par Salter, que je puis me dispenser d'entrer dans le détail des caractères qui la distinguent et dont le principal et le plus facile à reconnaître, consiste . . ."* but not a word as to which of these characters were visible on the Australian specimen. De Koninck's *E. punctatus* may be the equivalent of *E. mitchelli*, Foerste. As to De Koninck's qualified identification of *Cromus bohemicus*, Barr., but which he did not figure, we can only say we have no evidence of a *Cromus* in Australian rocks, but that in itself cannot be accepted as a proof of non-occurrence. De Koninck's remark "Elle est garnie de chaque côté de quatre sillons étroits," if it be an actual description of the Australian fossil, so completely accords with the principal characters of *Cromus*, that we must accept the determination in the meantime. Mr. Foerste regarded his *E. mitchelli* and *C. bohemicus*, De Koninck, as "distinct although clearly related." The identification of De Koninck's two remaining species is rendered very uncertain by an unfortunate difference between his description in the text, and the figure-references in the explanation of Plate i. As *Encrinurus barrandei* were described a cephalon and a pygidium, and the former was figured under its name,† the latter not so. Several specimens were found at Yarralumla, but how many cephalons or how many pygidia is not stated. Whatever this may be, it is not *E. mitchelli*, Foerste. As *Cromus murchisoni* were included two cephalons,‡ and a pygidium referred to in the explanation of Plate i.,§ but there is no description of, nor reference to this tail in the text.

In the first place, the structure of neither of the glabellæ of these cephalic shields accords with Barrande's definition of *Cromus*. One (Fig.9*a*) displays no trace of the four pairs of

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* De Koninck, *Loc. cit.*, p.50.
† De Koninck, *Loc. cit.*, Pl. i., fig.8.
‡ De Koninck, *Loc. cit.*, Pl. i., figs.9 and 9*a*.
§ De Koninck, *Loc. cit.*, Pl. i., fig.9*b*.

glabella furrows of *Cromus*, the other (Fig.9) is said to "porte quatre sillons transverses non interrompus," which is not a character of the genus in question. Now what happened we believe to be this. The pygidium referred to *C. murchisoni* (Fig.9*b*) is probably that described (but not ostensibly figured) under *E. Barrandei*, for De Koninck says of the former—"La joue mobile et l'angle génal me sont inconnus. *Il en est de même du thorax et du pygidium*" (the italics are ours). If, therefore, the pygidium is unknown, how can the subject of Fig.9*b* be referred to *Cromus murchisoni*, as it is in the explanation of Plate i.? Accepting the illustrations of the two cephalons in good faith, they appear to us to represent distinct forms of *Encrinurus* pure and simple, one with a broad-necked glabella (Fig.9*a*), and scattered small granules, the other with a distinctly pyriform glabella, and four very marked, continuous, posterior, transverse lines of granules parallel to the neck-ring, in addition to the scattered ones on the fore part of the glabella.

2. Victoria.

One species only is so far known from this State—*Encrinurus* (*Cromus*) *spryi*, Chapman,* from the Upper Silurian rocks exposed in the progress of the Improvement Works, South Yarra, Melbourne, and other neighbouring localities. It appears to differ from our type-species, *E. mitchelli*, chiefly by the presence of "two deep transverse sulci above the neck rings interrupted in the middle." The presence of these sulci forbids a reference to *Encrinurus* as here understood by us, and equally the existence of only two pairs is fatal to the inclusion of this trilobite in *Cromus*, as established and defined by Barrande, in which there are four pairs of glabella furrows.

3. Tasmania.

In the "Report of the Secretary for Mines [of Tasmania] for 1895-6" are the descriptions of Tasmanian Silurian fossils presented to the Australian Museum by Mr. A. Montgomery, Gov-

* Chapman, Proc. Roy. Soc. Vict., 1911, xxiv. (n.s.), Pt.1, p.397, Pl. lxii., fig. 1.

ernment Geologist. In the blue-grey schistose rock of both Heazelwood, County Russell, and Zeehan, County Montagu, occurs, amongst other trilobites, one referred to *Cromus murchisoni*, De Koninck,* but which can no longer be admitted as this species or even genus. There were the larger portion of a cephalic shield and four pygidia. The former is certainly of the type of *E. silverdalensis*, nobis.

iv. NEW SOUTH WALES.

Species admitted and described.

In New South Wales, *Encrinurus* is confined to beds of Upper Silurian age in the Upper Murrumbidgee Valley, at Delegate, and in the upper reaches of the Tarlo River, County Argyle. We are not aware of its occurrence in any other portion of the State.

The Species admitted by us are:—

Encrinurus mitchelli, Foerste.
E. bowningensis, Foerste.†
E. silverdalensis, nobis.
E. etheridgei, Mitchell.
E. rothwellæ, nobis.
E. duntroonensis, nobis.

Besides the above species, several cephalons and pygidia are described and figured; but to which we refrain at present to give specific names.

v. SOME STRUCTURAL FEATURES.

There are a few structural matters we wish to refer to in particular, two of which we at first thought might prove to be of generic importance, but although they do seem to occupy this position in Australian forms of the *genus*, there is not the same community of structure in foreign species. In every instance examined, there are constantly five pairs of primary tubercles along the axial edge of the glabella irrespective of any similar tubercles which may occur in a like position on the neck-ring. In testaceous specimens, these are but little seen; on the other hand, in non-testiferous, or decorticated ones, they become a very

* Etheridge, p. xliv., Pl.. figs.7 and 8.
† Emended from *Browningi*, as written by Foerste.

prominent and important feature. In *Encrinurus punctatus*, Fletcher described two or three large tubercles, "arranged on each side of the lower half of the glabella."* Hawle and Corda figure four pairs in this species.† Angelin four pairs,§ and Schmidt figures five pairs.‡ Under these circumstances, in view of these discrepancies, if the separate descriptions are correct, the number of tubercles in the positions referred to can only be regarded as of specific value. But from the constancy with which the five pairs of axial glabella tubercles occur on all the Australian *Encrinuri* [except the singular *E. duntroonensis*, on which only four are visible, but in this species the fifth pair may be present and hidden by the clasping frontal portion of the free cheek] which have come under our notice, we are inclined to accept Schmidt's declaration of the presence of five pairs in *E. punctatus*, as correct. In Australian species, when the free cheeks are in place, it is often difficult to see the anterior pair, and they are still more obscure when the test is also present. Reviewing all the evidence available to us, we must confess to a strong inclination to look upon the presence of five pairs of axial glabella tubercles as probably of generic significance.

It would appear also to us that these tubercles may mark internal indentations of the cephalic shield made by muscles which operated mandibulary or other appendages of the cephalon, just as in many Pelecypoda the adductor muscles indent the interior of their shells; and when such shells become fossilised so that only internal casts remain, the muscular indents are represented by more or less tubercular-like prominences.

Along the axial furrows of the thorax, these tubercles are even more noticeable features in non-testiferous Australian thoraces, showing up as large tubercular bodies at the outer ends of the axial annulations, but, when the test is preserved, dwindle to

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* Fletcher, Quart. Journ. Geol. Soc., 1850, p.403.

† Hawle and Corda, Prod. Mon. böhm. Trilobiten, 1847, Pl. v., fig.55.

‡ Angelin, Pal. Scandinavica, 1878, Pt.1, Pl. iv., fig.4.

§ Schmidt, Revision Ostbaltischen Sil. Trilobiten, Obth. i., 1881, Pl.xiv., fig.11*a*.

mere thickenings. On the other hand, in the figure of *E. punctatus* by A. Brongniart,* these prominences appear to be, in the perfect form, definite tubercles, and, in consequence, this feature does not appear to have generic value, although they, too, whether mere thickenings or distinct tubercles, may have been produced by muscular insertions at these points.

We have already stated our disbelief in the presence of glabella furrows in *Encrinurus*, *i.e.*, in the perfect testaceous condition. On the other hand, in non-testaceous specimens or "*casts*," as they are often called, there are short spaces between the axial tubercles which simulate furrows, but we believe these arise solely, (1) from the projection of the tubercles in question into or over the cephalic axial furrows, and (2) by the removal of the test from between them during the process of decay. Hence the size and amount of projection of these prominences becomes a specific character. Amongst Australian species, the false furrows are shown at their greatest development in *E. etheridgei*. At the same time, should there be a census of opinion that these are true furrows, then we are prepared to admit the identity of *Cromus* with *Encrinurus*, but not otherwise.

The pygidial axes of all the five species, *E. mitchelli*, *E. bowningensis*, *E. etheridgei*, *E. silverdalensis*, and *E. rothwellæ*, in the non-testiferous condition, possess a central longitudinal area across which the annulation grooves are discontinuous; when, however, the test is preserved, in some of these species these annulations are continuous, and no interruption is visible along the whole length of the pygidial axis. This is the case in some pygidia from Bowning, which, at present, we place with *E. etheridgei*; and some pygidia from Duntroon are similar in this respect. In *E. mitchelli*, testaceous specimens indicate continuity of the pygidial axial annulations. *E. bowningensis* and *E. silverdalensis* appear to possess a well marked central axial area on their pygidia even in the testaceous state, and in this resemble *E. punctatus*. These variations are of specific value.

* A. Brongniart, Hist. Nat. Crust. Foss.: Les Trilobites, 1822, Pl. i., fig.3A (as *Calymene variolaris*).

Another feature we have observed is, that the cephalic axial grooves anteriorly do not terminate or pass out in the same way in all the species of our Australian *Encrinuri*. For instance, in *E. mitchelli* they do not cross the anterior border of the cephalon; but merely communicate with the furrows on those portions of the free cheeks outward and laterally from them; and neither axial grooves nor free cheek furrows extend along the inner and frontal portions of the free cheeks. On the other hand, the axial grooves of *E. bowningensis* and *E. silverdalensis* pass outward (or backward) and laterally into the free cheek furrows, and also branch inwardly and obliquely downward along the frontal lobe-like portions of the free cheeks, issuing with the facial sutures medially in front. Another variation of the anterior termination of these axial grooves occurs in *E. duntroonensis*. In this species, they communicate with the axial furrows of the outward portion of the cheeks, and also turn inwards and extend rather more than half-way across the inner lobes of the free cheeks, ending abruptly. These different variations of the axial grooves as they traverse the free cheeks and terminate, appear to us to be of much specific value.

vi. DESCRIPTION OF THE SPECIES.

ENCRINURUS MITCHELLI, Foerste.

(Pl. liv., figs. 1, 2, 3, 4, 5; Pl. lv., figs. 1, 2, 3, 15; Pl. lvi., figs. 2, 10; Pl. lvii., fig. 9.)

Encrinurus mitchelli, Foerste, Bull. Sci. Lab. Denison Univ., 1888, iii., Pt. 2, p. 124, Pl. xiii., figs. 2, 3, 20.

(?)*Cromus murchisoni*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1876, Pt. 1, Pl. i., fig. 9 (exclude figs. 9*a* and 9*b*).

*Sp. chars.**—Complete form subellipsoidal to some extent, with a flattened appearance. *Cephalon* subsemicircular, length approximately seven-sixteenths of the width between the genal angles; glabella subpyriform with greatest convexity midway between

* Where not otherwise stated, the descriptions of all the *Encrinuri* in this paper have been made from *non-testiferous* specimens.

the anterior and posterior extremities, whence it slopes gently to the anterior border, widest between the anterior pair of lateral tubercles (pseudo-lobes); front border, when the free cheeks are absent, having a subbattleaxe contour; general surface copiously granulated, granules variable in size, imperforate, posteriorly arranged in two or three transverse parallel rows, anteriorly one or more rows concentric with the front cephalic border, but on the general surface a quincuncial arrangement is assumed, or in oblique irregular rows; five pairs of tubercles bordering the axial furrows only of moderate size, the anterior and posterior pairs much smaller than the intermediate pairs; neck-furrow inconspicuous, but its lateral extensions across the fixed cheeks rather wide and shallow; neck-ring similar to the adjoining thoracic ring but rather more arched; axial furrows pronounced (inconspicuous in testiferous specimens); fixed cheeks tumid, similarly granulated to the glabella centre, tubercles along the inner border abutting the axial grooves only moderately prominent; palpebral, or ocular lobes, prominent and bounded by well marked sulci, posterior border narrow but distinct; genal angles rounded and thickened. Free cheeks tumid, granulate, the anterior portions lobe-like, the latero-posterior portions rising abruptly to support the pedunculate, faceted, convex eyes; peduncles bounded by sulci, border thickened, bearing one row of conspicuous, and other irregularly placed tubercles, furrow within the border distinct and posteriorly communicates with the transverse furrow of the fixed cheeks, and anteriorly with the axial grooves and stops there, the transverse distance between the eyes is about equal to the length of the glabella. Facial sutures bisigmoidal or rolling V-shaped, the sigma anterior to the eyes, the shorter and more acute, the posterior terminating in front of the genal angles. Hypostome rhomboidal; tumid, centrally nonlobate, but anteriorly cucullate. *Thorax*: length about equal to that of the combined width of the axis and one pleura, finely granulate. Axis slightly subfusiform, width about five-sixths of that of a side-lobe, the annulations tuberculate at their extremities, and moderately arched transversely and anteriorly. Pleural segments moderately geniculate. *Pygidium* wider than long and only moderately tumid. Axis terminating submucronately, annulations twenty-six, and cease at two-elevenths short of the whole length, the first two or three usually continuous (*vide Obs.*); free central area bears five small tubercles, rarely more. Pleuræ of ten segments (doubtfully in some cases there appear to be eleven); more acutely geniculate than those of the thorax, the first pair with strong facets; last pair almost parallel with the axis.

Obs.—Foerste assigned twelve thoracic segments to *E. mitchelli*; such, however, is not the case. There are constantly eleven, in accordance with the generic definition.

From *Ecrinurus punctatus*, Emmrich, the generic type, this, the Australian type, differs by (1)—blunt instead of spined genal angles; (2)—absence of spines on the fourth and tenth thoracic axial segments; (3)—faceted instead of smooth lentiferous eyes; (4)—absence of a true or extended pygidial mucro or telson; (5)—a much less inflated and straighter-sided glabella; (6)—a larger number of segments in the pygidial pleuræ; and (7)—smaller tubercles on the central area of the pygidial axis. Other than these differences, there is a rather close affinity between the Australian and European species.

If De Koninck's description of the Duntroon specimen referred by him to *E. punctatus* is that of the actual fossil, it must have been not merely "presque complet" as he terms it, but a remarkably well preserved trilobite for a New South Wales fossil. Were it not for certain points in the description of the Duntroon specimen, we would have felt inclined to regard it as *E. mitchelli*, but the presence of genal spines and a full pygidial mucro, or telson, in the former is fatal. It is strange no Encrinurid from the Silurian rocks of this State has come under our notice, possessing the above features.

An important point in nomenclature, to say nothing of the morphological aspect, is the relation between *E. mitchelli* and *Cromus murchisoni* De Koninck. We have already expressed our disbelief in the occurrence of *Cromus* in New South Wales, so far as published evidence enables us to judge, and our belief that, under this name, De Koninck figured cephalons of two distinct species. To which of these is the name of *C. murchisoni* to be restricted in the first place? To the Quedong example most certainly! because it is that one "qui a servi à ma description," and because it accords with the description in having a glabella "in the form of a club," and four transverse non-interrupted grooves, which are not grooves at all, but merely interspaces between lines of granules. Therefore, the name *Cromus murchisoni* should be restricted to De Koninck's Pl. i., fig. 9. Now, whether or no this restricted cephalon is identical with that of Foerste's *E. mitchelli* is very difficult to say, but we have a lurking suspicion that it may be, on account of a pyriform glabella and transverse lines of granules at its base parallel with the neck-ring and furrow in both; in some young specimens this is very marked indeed, and we figure one such. But against this, is the apparent absence of the large axial tubercles in De Koninck's figure, and the very differently situated eyes; this absence of the large axial tubercles in the illustration referred to was also noticed by Mr. Foerste. There also occurs here one of those little errors which we are all liable to, for although Prof. De Koninck said "la joue mobile et l'angle génal me sont inconnus," the free cheeks are shown in his fig. 9.

By what name is this trilobite to be known? In consideration of the doubts raised in the preceding paragraphs, it appears to us that Foerste's name must be recognised. Any claim to recognition of De Koninck's appellation would seem to be in a great measure nullified by the inclusion under it of more than one form, but had it been possible to show that *Cromus murchisoni* and *Encrinurus mitchelli* were one and the same, then certainly the former would have precedence.

In the numerous specimens of *E. mitchelli* examined by us, there appears to be no definite proportion between the axial length of the glabella and thorax, as the following proportions will show—6:10, 8:11, 9:11, 5:9, etc. The equality between the antero-posterior length of the glabella and the distance between the eye-lobes is very constant. In some specimens, the eye-section appears to be subelliptical, but this arises from lateral compression. Nor does there appear to be any constant ratio, in most specimens, between the entire length of the body and that of either the cephalon or pygidium, but, in a few mature individuals, the length of the thorax and pygidium were found to be equal, yet in many cases the former exceeded the latter in length. It should be noted, too, that the whole of the submucronate extension of the pygidial axis is seldom preserved, and, therefore, the actual length of the pygidium rarely determinable. Although nearly all the pygidia, which are very many, show only ten pleural segments in each side-lobe, two or three have come under notice which faintly indicate an additional one very intimately fused to the submucronate tail terminal. Hence it may be that, in this species, the normal number of segments in the pleural lobes of the tail is eleven instead of ten, as indicated in our description.

E. konghsaensis, Reid,* from the Lower Palæozoic rocks of Burma, presents many points in common with *E. mitchelli*, particularly in the form and position of the cephalic axial tubercles; the two species, however, are distinct. *E. mitchelli* is the commonest trilobite in the Lower Trilobite Bed of the Bowning (Yass and Hume) Series.

Loc. and Hor.—Lower Trilobite Bed, Bowning Series, Parish Bowning, County Harden, N. S. Wales; Hatton's Corner, Yass River, Parish Yass, County Harden, N. S. Wales; Silverdale Limestone and Jones' or Derrengullen Creeks, Parish Bowning, County Harden, and Parish Derrengullen, County Murray; Warroo Creek, Parish Warroo, County Murray (J.M.); shale and limestone bands west of contorted shales, Boambola Crossing, Murrumbidgee River (A. J. Shearsby; Coll. Aust Mus.); Hatton's Corner, shale below the limestone, Hardy's or Limestone Creek, Parish Derrengullen, County King (Coll. Aust. Museum; presented by A. J. Shearsby).

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* Reid, Lower Pal. Foss. N. Shan States, Burma (Pal. Ind., N.S. ii., Mem.3), 1906, Pl. vii., fig.21.

ENCRINURUS BOWNINGENSIS, Foerste (emend.).

(Pl. liv., figs.6, 7, 8, 9, 10, 12, 14; Pl. lv., figs.5, 6, 12; Pl. lvi., fig.8.)

E. Browningi (in error) Foerste, Bull. Sci. Lab. Denison Univ., iii., Pt.2, 1888, p.122, Pl. xiii., fig.7.

Sp. Chars.—*Cephalon* subsemicircular, length half its width, highly tuberculate; glabella very tumid, strongly pyriform, very contracted posteriorly, front portion semiglobular; tubercles large and strawberry-like, with a fairly constant and symmetrical arrangement, thus—protruding into the axial furrows are the generic five pairs (the anterior and posterior pairs of which are not conspicuous), on the contracted glabella neck are two or three pairs (small), and in advance of these latter is the general cluster which usually assume a more or less circular arrangement around a central one; these are nearly all large and bear fine granules; axial furrows impinged upon by the marginal glabella tubercles, neck-furrow indistinct but its lateral extension across the fixed cheek narrow and deep, neck-ring strongly arched, its lateral extension narrow and prominent. Fixed cheeks inflated, tuberculate, axial border margined by fine tubercles interspacing with those on the sides, the others of variable size and arrangement, but longitudinally rows of three occupy the median lines of the cheek, and a posterior transverse line overhangs the lateral extensions of the neck-furrow; genal angles rounded and bearing a few small tubercles. Free cheeks relatively large, the smaller portions which clasp the front of the glabella subrectangular and densely covered with large, low tubercles; the larger lateral portions widely triangular but densely covered with low irregularly sized tubercles, borders on the posterior larger portions relatively large and tumid, furrows distinct, axial grooves in crossing the borders of the free cheeks bifurcate, one branching backward joining the free cheek furrow and the other proceeding inward and forward, passing out just before the middle line of the glabella is reached. Eyes prominent, pedunculate, highly convex, circular in cross-section, surrounded by distinct sulci, which are made increasingly pronounced by rows of bordering tubercles. Facial sutures openly V-shaped.

Thorax.—Length approximately two-thirds of the width; axis strongly arched, of uniform width to the eighth annulation, the three remaining ones narrower; all the annulations tuberculate at their bases, and granulate along their medial lines; pleural segments wider than the axis, moderately geniculate, finely granulate.

Pygidium widely triangular, relatively large, but bearing no constant ratio to other parts of the body; axis moderately prominent, bearing twenty or more annulations, the first only continuous; median free area bearing usually seven or eight tubercles of which five or six are prominent, yet not restricted to any particular annulations, but the second mostly bears one, pleural lobes transversely convex, and as compared with those of the thorax depressed, the segments increasingly inclined backwards until the last pair, which are nearly parallel with the pygidial axis.

Obs.—The cephalon of this trilobite, or rather a portion of a cephalon, was described by Mr. Foerste from material supplied by one of us.

E. bowningensis differs from the European *E. punctatus* in precisely the same manner as does *E. mitchelli*, except that, unlike the latter, it agrees with it in the shape and tuberculation of the glabella. When examples of the two Australian forms are compared, the differences are so obvious, and at once apparent as to hardly need comment. The form of the glabella, tuberbulation, outline of the pygidia, and the manner in which the axial furrows traverse the free cheeks can be relied on for separation,

De Koninck's *E. barrandei*, from Yarralumla, was compared by Mr. Foerste with the present species, and his words referring to the former are as follows:—"This is evidently the most closely related species, but if his [De Koninck's] is at all correct then our species [*E. bowningensis*] is quite distinct." Mr. Foerste's specimen was devoid of eyes; had it not been so, De Koninck's remark that these organs were only raised a little above the surface in *E. barrandei*, his remark would have probably been still more emphatic.

The prominence and subglobular form of the eyes are just as characteristic features of *E. bowningensis* as is the tuberculation of the glabella. We can only again express our regret at our absolute inability to unravel the identity of De Koninck's Australian trilobites.

The tuberculation of the glabella is a most marked feature in this trilobite. In an exceptionally well preserved example, the tubercles on the semiglobular anterior portion of the glabella are in three concentric rows around a central one. The first is a circlet round this last, formed of five or six tubercles, the second is a semicircle commencing at the anterior pair at the anterior (third) pair on the glabella *neck*, and the third, also semicircular, passes round the front bordering the anterior branches of the facial sutures, and is continuous with the marginal tubercles overhanging the axial grooves.

The hypostome, so far as a mutilated specimen enables us to judge, resembles that of *E. mitchelli*. As in the preceding species and in accordance with the generic formula, there are eleven thoracic segments. In the pygidium there is no constant ratio between its length and that of either the cephalon or thorax. In a number of specimens the length appears about equal to the axial length of nine of the thoracic segments.

Both Mr. A. Brongniart and Mr. Fletcher stated the tubercles of *E. punctatus* to be perforate, and the latter so figured them,* but we have not detected this in either *E. mitchelli* or *E. bowningensis*. In the tuberculation of the central area of the axis of its pygidium, *E bowningensis* closely resembles *E. punctatus*.

Loc. and Hor.—Bowning Creek, Parish Bowning, County Harden (J.M.); Limestone Creek, Parish Yass, County King (J.M.); Jones' or Derrengullen Creek, Parish Yass, County King (J.M.); Hatton's Corner, shale below the limestone, Parish Yass, County King; Burrowa Road, near Bowning, Parish Bowning, County Harden. (Coll. Aust. Mus., presented by A. J. Shearsby).

Lower Trilobite Bed, Bowning Series. Upper Silurian, = ?Wenlock Beds of Great Britain.

* Fletcher, Quart. Journ. Geol. Soc., 1850, vi., p. 403, Pl. xxxii., fig. 9*b*.

ENCRINURUS SILVERDALENSIS, *sp.nov.*

(Pl. liv., fig.11; Pl. lv., figs.4, 9; Pl. lvi., figs.4, 5, 6, 14; Pl. lvii., figs.3, 10.)

Sp. Char.—General form suboval. *Cephalon* subsemicircular, and therefore approximately half as long as wide, moderately inflated, densely tuberculate, tubercles variable in size, many very large, conical, and all microscopically granulate. Glabella separated, pyriform, tubercles in oblique rows or quincuncially arranged, the large ones along the axial grooves somewhat flattened. Neck-furrow narrow and inconspicuous, its lateral extension across the fixed cheeks also narrow but deep. Neck-ring strong, wide, and moderately arched. Fixed cheeks moderately inflated, bearing tubercles similar to those of the glabella and arranged similarly; posterior border (extension of neck-ring) narrow, but strong; genal angles rounded, thickened, and bearing a few irregularly arranged tubercles. Free cheeks large, especially so are those portions inside of the axial grooves, and rest on the glabella front; tuberculated in a similar way to that of the glabella, border wide, bearing one row of large, rather flat tubercles along its inner border, and another row of smaller and less regularly arranged ones along the outer margin; on both inward and outward portions above the furrow the tubercles are arranged in three more or less regular rows. Axial grooves join the outward or lateral cheek-furrows, and also trend inward and obliquely downward along the inner or frontal portions of the cheek, passing out in front with the facial sutures. Eyes pedunculate, convex or subconical, peduncles surrounded by inconspicuous sulci. Facial sutures are of the usual generic type.

Thorax almost rectangular, about two-thirds as long as wide, microscopically granulate. Axis tapering almost imperceptibly posteriorly, the last annulation being much stronger and wider than first one of pygidial axis, annulations not tuberculate at their bases but somewhat thickened; pleuræ only moderately geniculate.

Pygidium large, widely triangular, much wider than long, and longer than the thorax, granulated in a similar way to that of the thorax; axis tapering very gradually from before backwards, and terminating in a rather fine point; annulations thirty or more, the first only continuous, and, together with the next three or four succeeding, tuberculate; central area distinct, bearing seven or more tubercles, five of which are usually very conspicuous, only the first annulation decidedly arched, the others flat above with steep sides; pleural lobes very moderately geniculate, anteriorly about twice as wide as the anterior width of the axis; annulations are of the usual Encrinurid character, and are twelve in number.

Obs.—This is a robust species, and reaches a length of two or more inches. Its cephalon in general form and tuberculation approaches more nearly to that of *E. variolaris* than to any other European member of the genus, but its relatively enormous pygidium separates it from this species. The coarse cephalic tuberculation at first sight might cause it to be mistaken for *E. bowningensis*; but the larger size, more acutely conical nature, and conspicuous granulation of the tubercles of *E. silverdalensis* easily separate it from that species. The general form of the cephalic shield, and larger pygidium with the greater number of pleural segments of *E. silverdalensis* renders its distinction from *E. bowningensis* and other species we are acquainted with very simple. The pygidium is only approached in size by that of *E. etheridgei*, Mit.; but other features in the two widely differ. In its inconspicuous neck-furrow, coarse tuberculation of the cephalon, the strong tubercles on the central space of the pygidial axis, it resembles the typical Wenlock forms, *E. punctatus*, Brün., and *E. variolaris*, Brong.; but the tubercles in both instances are of a different type. The genal angles are not produced into spines, nor the pygidium into a telson as in *E. punctatus*. This trilobite was evidently very local in distribution, and restricted stratigraphically, for it is only known from the Lower Trilobite Bed of the Bowning Series (= Hume Beds) at the one locality. It is there associated with *Mucophyllum crateroides*, Eth. fil., *Heliophyllum yassense*, Eth. fil., *Rhizophyllum interpunctatum*, De Kon., and other corals typical of the Bowning-Yass beds.

There is a close similarity between this species and the Tasmanian form erroneously named *Cromus murchisoni*, De Kon., by one of us, and already referred to. It is possible the two may be identical.

Loc. and Hor.—Silverdale, Limestone Creek, and doubtfully from Bowning Creek, Parish Bowning, County Harden. Lower Trilobite Bed = Upper Silurian (Wenlock), Coll. J.M. Hardy's or Limestone Creek, Parish Derrengullen, County King. (Coll. Aust. Mus.; A. J. Shearsby).

ENCRINURUS ETHERIDGEI, *sp.nov.* (Mitchell).
(Pl. liv., fig. 13; Pl. lv., figs. 7, 8, 10, 11.; Pl. lvi., fig. 9; Pl. lvii., figs. 1, 2, 4, 8.)

Sp. Chars.—Complete form elongately oval. *Cephalon* subsemicircular, rugo-tuberculate, approximately length equal to the width between the genal angles, or as long as nine thoracic segments. Glabella elongately pyriform, tapering from the anterior pair of axial tubercles forward to a rather acute point, giving it a mucronate appearance when the free cheeks are absent, tuberculate, tubercles rather small and subeven in size, the five pairs of axial tubercles very even in size and distinctness, the second, third, and fourth pairs, as is usual with other species, the most distinct. Neck-furrow moderately distinct, its extension across the posterior border of the fixed cheeks similarly so. Neck-annulation narrow and prominently arched, its lateral extension narrow. Axial furrows narrow and deep; fixed cheeks tumid, rather small, faintly tuberculate; axial tubercles only moderately distinct, rugoid, and between the eye-lobe and the posterior furrow arranged in three irregular rows, which, towards the genal angle, converge to one; genal angles rounded and only slightly thickened, sulci of the eye-lobes distinct. Free cheeks large, tuberculation similar to that of the fixed cheeks, border and furrow pronounced; eyes very prominent, conical, pedunculate, and surrounded by sulci. Facial sutures of the usual character.

Thorax subrectangular, length approximately two-thirds the width, very lightly if at all granulate; axis almost of uniform width throughout, arched transversely and anteriorly, basal ends strongly thickened; axial grooves pronounced; side-lobes flat between the axial grooves and fulcra, thence steeply deflected.

Pygidium triangular, wider than long and longer than the thorax, surface apparently smooth; axis wide anteriorly, but the first annulation narrower than the last of the thoracic axis; each of the first three annulations contract somewhat rapidly, and thence the contraction is gradual to the blunt termination, rings approximately thirty-six, of which the first three are continuous, anterior half prominent and arched, but becomes decreasingly so posteriorly; medial tubercles inconspicuous; pleuræ normally of thirteen pairs of annulations; each pleura much wider than the greatest width of the axis; only the anterior pair have distinct fulcra, the others more or less slope steeply from the axial grooves downwards and increasingly backwards, the last being parallel with the axis terminal; anterior pair very strongly faceted; axial grooves distinct anteriorly, but becoming quite indistinct posteriorly.

Obs.—This is the largest of the Australian *Encrinuri* known to us, the type-specimen having a length of two and a half inches, of which the tail accounts for one inch. In several features, as for instance the general form of the complete fossil, glabella, and the anterior portion of the pygidial axis, this species resembles *E. mitchelli.* The much greater relative size of the pygidium, greater number of segments in the pleuræ and axis of the pygidium, the more prominent eyes, and wrinkled nature of the cephalic tubercles, easily separates it from that species. It is so evidently distinct from all other species that we deem it quite unnecessary to note the differences.

Named after Mr. Robert Etheridge, J.P., Curator of the Australian Museum, Sydney, N. S. Wales, as a small token of the appreciation in which he is held as a friend and collaborator by me (J.M.). The type-specimen was found by Mr. Etheridge during one of our geological excursions.

Loc. and Hor.—Yarralumla Plains (Limestone Plains), Parish of Narrabundah, County Murray (Etheridge and Mitchell). Gurnett's Farm, Parish Bowning, County Harden,(J.M.). ?Up. Sil.

ENCRINURUS ROTHWELLÆ, *sp. nov.*.

(Pl. lvi., figs. 1, 3; Pl. lvii., fig. 5.)

Sp. Chars.—Body long, narrowly suboval, with high steep sides. *Cephalon* approximately semicircular, length about half the width between the genal angles, densely covered with small tubercles. Glabella markedly pyriform and with a narrow neck, front broad, rounded, tumid, and relatively very wide between the anterior pair of axial tubercles; on the bulbous anterior portion the tubercles are arranged more or less concentrically around a central one, on the contracted posterior part in irregular transverse rows, one row extending around the front, between the anterior axial pair; all the tubercles fairly even in size; neck-furrow narrow, as is also its lateral extensions; neck-ring stout and strongly arched; axial tubercles prominent and of moderate size, interspaces between them wide and fairly deep; axial furrows very deep. Fixed cheeks relatively large, very tumid, granules between the eye-lobe and posterior furrow arranged in transverse and longitudinal rows, the axial ones (five) being the larger; the succeeding outward parallel row also consists of five, the other rows diminishing in number of tubercles until they converge to one at the junction of the posterior lateral cheek furrows; eye-lobe situated far forward and inward, sulci very faint; genal angles rounded. Free cheeks unknown. Facial sutures of the usual character.

Thorax steep-sided and practically subrectangular, width greater than the length, finely granulate; axis very prominent, almost of uniform width throughout, annulations moderately thickened at their bases: axial grooves deep; pleuræ highly geniculate, steep-sided.

Pygidium triangular, almost equiangularly so; axis very prominent between the front and the point where segmentation ceases, terminates rather acutely, but nonmucronate, and with a decided droop, twenty-two or more annulations, the first only continuous; central tubercles small and inconspicuous, five or six in number. Pleuræ strongly deflected, arched, the four anterior pairs strongly geniculate, the others sloping very steeply from the axial furrows, front pair highly faceted.

Obs.—The subrectangular and steep-sided thorax, very prominent thoracic and pygidial axes, acicular terminal of the tail-axis, eleven pleural segments in the pygidium, widely expanded, rounded and tumid glabella anteriorly. forward eye-lobes, and strong drooping of the pygidium posteriorly, separate this species from *E. mitchelli*, its nearest relative. When specimens of the two are placed side by side, the differences become at once apparent, and more particularly in that of the outline. In the Australian type-species, this is broad-oval forwards, whereas *E. rothwellæ* is narrow-oval. Another marked difference is that in *E. rothwellæ* the axes of the thorax and pygidium diminish gradually and regularly from the neck-ring to the pygidial terminal, whereas in *E. mitchelli* the axis of the thorax is subfusiform, and the last ring of the thorax is much wider than the first ring of the pygidial axis, which narrows rapidly in the distance between the first and third annulations, thence gradually becoming narrower and ending in a submucronate appendage. Again, the entire body of *E. mitchelli* presents an appearance of flattening, as compared with *E. rothwellæ.*

As regards the pygidium, in outline it resembles very much that of *E. etheridgei*, but the latter usually has thirteen pleural segments instead of the eleven normal in *E. rothwellæ.*

Named after Miss Rothwell, Headmistress of the District School, Lismore, who was associated with one of us as student and assistant.

Loc. and Hor.—Railway Cutting just west of Bowning Railway Station, Parish Bowning, County Harden; Upper Trilobite Bed, Bowning Series. Upper Silurian (=?Wenlock).

ENCRINURUS(?) DUNTROONENSIS, *sp.nov.*

(Pl. lvi., figs.11, 13.)

Sp. Chars.—Complete form unknown. *Cephalon* transversely subelliptical, much wider than long, moderately inflated and tuberculate. Glabella approximately one-third as long as the width between the genal angles, elongately subpyriform, sides subparallel, anterior portion or lobe bluntly rounded in front and tumid, strongly arched transversely, sparsely granulate, four large lateral (axial) tubercles visible and separated by wide, deep furrow-like spaces, anterior or fifth apparently covered by the embracing and inner lobe of the free cheek; neck-furrow absent, but its lateral extension over the fixed cheek very deep; neck-ring also absent, and its lateral extension narrow and strongly geniculate; axial grooves very deep; fixed cheeks very tumid, ridge-like, decidedly geniculate, rising very abruptly both from axial and posterior furrows, tuberculate, tubercles small, uneven in size and sparse, hence the eye-lobes are also close to these furrows; genal lobe very small, narrow, bearing one row of small tubercles and overhanging the posterior transverse furrows; genal angles rounded and only slightly thickened, granulate; free cheeks relatively large, placed anteriorly, tuberculation inconspicuous and tubercles of variable size, borders moderately thickened, furrows shallow, joining inwardly with the axial furrows and outward with the posterior furrows of the fixed cheeks, inwardly they pass about half-way across the inner lobe; that is, the axial grooves, instead of distinctly crossing the front border of the cephalon, bifurcate, and one branch proceeds outward and the other inward along the free cheek furrows. Facial sntures anteriorly pass out in the manner usual in the Encrinuri; the posterior portion passes straightly outward from about the middle of the lateral side of the eye, cutting the border well in front of the genal angles; this portion is practically at right angles with the axial grooves. Eyes conical, faceted, prominent, pedunculate, and surrounded by distinct sulci.

Obs.—The fragmentary cephalon and detached free cheeks described above are so strikingly different from all other Australian, as well as from foreign species of *Encrinurus* known to us, that we have no hesitation in giving it specific rank.

The features which separate it from other species are—(1) the transversely elongate elliptical form of the cephalon, with its nearly straight anterior border; (2) the closeness of the anterior branches of the facial sutures and the perpendicularity of the posterior branches of these, with the axial furrows, or central axial line; (3) the long, narrow and straight-sided glabella; (4) the anteriorly situated free cheeks; (5) the sparse tuberculation;

(6) the backward and inward situation of the eyes; and (7) the manner in which the axial furrows bifurcate outward and inward on reaching the frontal borders of the free cheeks.

So different are the posterior branches of the facial sutures of this species, in more than one particular, we are rather inclined to the opinion that in this fossil we have a new genus.

Besides the portions above-described, several pygidia were found associated with them, which may or may not prove to belong to the same species; and because of their association and dissimilarity to all other pygidia, it is not unreasonable to assume that they probably do. They will be described separately.

Loc. and Hor.—Near Duntroon Homestead, Parish Canberra, County Murray, N. S. Wales. Upper Silurian(?). Coll. Mitchell.

vii. PORTIONS OF ENCRINURI.

1. *Cephala.*

a.—Portion of a single cephalon (Pl. lvi., fig.7) differs from all the others described *ante*, in the form and proportions of the fixed cheeks. The entire shield is unknown, but probably possessed a subsemicircular outline. It is strongly inflated and granulate on all parts preserved. The pyriform glabella is very convex and bold anteriorly, the neck-ring narrow but distinct and much arched, but the neck-furrow narrow and shallow. The features which distinguish this cephalon are the form of the fixed cheeks, position of the eyes, and the course of the facial sutures. These latter, between the eye-position and the lateral borders of the cephalon, are straight, *i.e.*, practically parallel to the neck segment, with the result that the fixed cheeks, instead of being sublunate in some degree or other, as in most of our *Encrinuri*, are more or less parallelogramatic, the facial sutures cutting the lateral borders some distance in advance of the bluntly rounded genal angles. The eye-positions are close to the axial furrows, and as between anterior and posterior, almost median. The fixed cheeks also appear to be much more inflated than ordinarily. We are not able to associate this specimen with any of the preceding remains, but found in company with pygidia described later on, and a Brachiopod resembling *Meristella tumida.*

Loc. and Hor.—Gurnett's Farm, three miles west of Bowning, on the Binalong Road, and the west side of the Bowning Anticline, Parish Bowning, County Harden; Bowning Series (probably Lower Trilobite Bed), Upper Silurian.

b.—With the above occurs a form of cephalon (Pl. lv., fig.8) which to us seems to agree so closely with the cephalon of *E. etheridgei*, that we place it with that species provisionally. The occurrence of pygidia in association with it which we, at present, are unable to separate from the pygidia of *E. etheridgei*, gives support to this conclusion.

c.—Still another cephalon (Pl. lvi., fig.12) occurs with the two preceding ones, which we are unable to determine specifically. Its fixed cheeks resemble those of *E. mitchelli*; but its glabella is much more robust and more strongly tuberculate than is that of the latter. The neck-annulation and its lateral extensions are more strongly arched and tuberculate than is the case in *E. mitchelli*. No portions of the latter species have been found in the same locality.

Loc. and Hor.—Gurnett's Farm, Parish Bowning, County Harden, (?) Upper Silurian (Coll. Mitchell).

2. *Pygidia.*

a.—The following (Pl. lv., figs.10, 11) are the specific characters of a number of pygidia collected from Gurnett's Farm, west of the Bowning Anticline, and which have been referred to in our description of some cephala from the same place Acutely triangular, slightly wider than long, very much arched transversely and longitudinally, evidently finely granulate; axis very wide in front, decreasing gradually posteriorly and terminating in a moderately fine point closely invested by the last pair of pleuræ, not at all prominent, very slightly arched, annulations continuous throughout when testaceous as are most of the specimens under our notice; but on nontestaceous specimens a distinct central space appears to be present, and only the first three annulations or so are continuous; medial tubercles seldom visible, and when so are faint (testaceous); pleuræ of twelve to thirteen pairs of segments, sloping very steeply from the axis, only the first pair strongly geniculate; axial grooves faint.

The triangular outline is close to that of *E. rothwellæ*, but the very prominent axis and smaller number of pleural annulations in the latter clearly separate it from this form. In contour, it approaches the pygidium of *E. siebachi*; but most of all it resembles our *E. etheridgei* in the nontestaceous condition, and until we obtain further evidence and material, we are unable to determine the species with certainty. The fragmentary cephala already described as agreeing in specific features with that of *E. etheridgei*, which were found associated with these pygidia, and the occurrence of free cheeks, which at present appear to us to be practically identical with those of *E. etheridgei*, also in association, still further incline us to the belief that their specific identity is the same. If, however, a testaceous specimen of the pygidium of *E. etheridgei* be discovered later on, and be found in that state not to have the axial rings wholly continuous, we would then be disposed to give this fossil specific rank under the name of *E. loomesi*, as a mark of gratitude for assistance received by one of us from Mr. F. Loomes, of Bowning, in the collection of specimens.

Loc. and Hor.—Gurnett's Farm, three miles west of Bowning township, Parish Bowning, County Harden. Lower Trilobite Beds(?), Bowning Series (Hume Beds, etc.). Upper Silurian = (?) Wenlock. (Coll. Mitchell).

b.—From Duntroon, several pygidia (Pl. lv., fig.14) have been collected, associated with *E. duntroonensis*, nobis. They probably include two types. Of the first, the specific characters are—Acutely triangular, length greater than width (4 : 3 approximately), very faintly or microscopically granulate, droops intensely posteriorly. Axis very narrow and prominent, tapering gradually and ending in a fine point between the last pair of pleural segments; annulations continuous and numerous; medial tubercles not apparent; axial grooves faint. Pleuræ with twelve pairs of annulations at least, sloping *very* steeply from the axial grooves, having generally a compressed aspect.

The outstanding features of this pygidium are its narrowness, steep compressed high sides, narrow, prominent, posteriorly strongly deflected axis, continuity of the axial rings, and the absence of medial axial tubercles.

Although this pygidium occurs associated with *E. duntroonensis*, from its small width we are disinclined to consider it as belonging to this species, neither are we disposed to give it a specific name.

Loc. and Hor.—Same as *E. duntroonensis.*

c.—The other type (Pl. lv., fig.13) referred to as occurring with the above, is wider than long, almost equiangularly triangular and steep-sided, finely granulate. Axis not prominent, rather wide in front, contracting somewhat rapidly between the first and third annulations, thence gradually, and terminating in a fine point between the last pair of pleural annulations, apparently a little short of the margin; annulations continuous, some very fine; medial granules visible with the aid of a lens, posteriorly very steeply depressed; axial grooves faint Pleuræ of twelve segments, granulate, and sharply deflected.

This pygidium closely resembles the preceding, with which it occurs, and only differs from it in the less prominent and anteriorly wider axis, greater width, distincter granulation of the pleuræ, and the apparently more rapid contraction of the axis posteriorly. It is possible they are identical; and the differences in the forms under notice arise from compression. The present pygidium very closely resembles those from Gurnett's Farm, and which we, for the time being, have placed with *E. etheridgei.* Like the latter, it approaches the *E. siebachi* type of pygidium.

Loc. and Hor.—Same as *E. duntroonensis.*

d.—From a new locality, one of us collected in March, 1914, a few fragments of trilobites among which were specimens of a free cheek and a tail referable to *Encrinurus.* The free cheek (Pl. lvii., fig.6) belongs to the type in which the axial furrows communicate with lateral cheek furrows outwardly and inwardly, proceed obliquely downward along the inner and smaller cheek lobes, passing out at the frontal passage of the facial sutures, and of which, perhaps, the free cheeks of *E. bowningensis* afford the most typical examples of this feature. The border of the larger cheek lobe is prominent and tuberculate, but less so on the smaller one; the furrow also is distinct on the larger portion. The palpebral lobe bearing the eye is small and very narrow between the latter and the marginal furrow, also sparsely tuberculate; the eye, front to back, is relatively long, and occupies practically the whole of the space between the axial furrow anteriorly and the posterior branch of the facial suture; it is slightly pedunculate and subconical, with the peduncle surrounded by a sulcus.

The vertical shallowness of the lobe which bears the eye and its great relative size place the specimen apart from other Australian *Encrinuri*. Found associated with an *Odontopleura*, near *O. rattei*, E. & M.

Loc. and Hor.—Tarlo River, near its head-waters, Parish Turrallo, County Argyle. Upper Silurian(?).

e.—The imperfect pygidium (Pl. lvii., fig. 7) is moderately tumid, axis moderately arched, twelve annulations are present, but the posterior portion is missing; annulations are apparently continuous. Only six segments of the pleural lobes are present; but when complete would seem to have possessed eight. Regarding it, we can only say definitely that it is the pygidium of an *Encrinurus*, and probably belongs to the same species as does the preceding free-cheek.

Both the preceding free-cheek and this pygidium are distinct from any we are acquainted with.

Loc. and Hor.—Tarlo River, Parish Turrallo, County Argyle. (?)Upper Silurian.

EXPLANATION OF PLATES LIV.-LVII.

Plate liv.

ENCRINURUS MITCHELLI, *Foerste.*

Fig. 1.—An almost entire specimen, with the free cheeks turned outwards; slightly enlarged. Bowning. *Coll. Mitchell.*

Fig. 2.—Another nearly complete specimen. Bowning. *Coll. Mitchell.*

Fig. 3.—A cephalon with free cheeks in position, the left one being imperfect. On the right side, the eye and the tubercles bordering the

axial groove are clearly visible, also the two rows of tubercles at the base of the glabella parallel with the neck-furrow. Bowning. *Coll. Mitchall.*

Fig. 4.—Another almost perfect specimen; the form of the glabella, especially the semielliptical contour of its frontal margin, is distinctly shown. The pygidium of this specimen is about perfect, and distinctly shows the axis of the pleural lobe-divisions. Bowning. *Coll. Mitchell.*

Fig. 5.—A perfect specimen, slightly enlarged. The lobe-like character of the portions of the free cheeks embracing the front portion of the glabella is well shown, as are also the natural outline, and the various parts of the animal as viewed from above. Bowning. *Coll. Mitchell.*

ENCRINURUS BOWNINGENSIS, *Foerste.*

Fig. 6.—A complete specimen except for tha absence of the free cheeks, exhibiting all the features of the glabella, thorax, and pygidium. Bowning. *Coll. Mitchell.*

Fig. 7.—A cephalon with the right free cheek in position, and showing the character of the tuberculation, the deep axial grooves, and the manner in which these traverse the free cheeks. Bowning. *Coll. Mitchell.*

Fig. 8.—A cephalon and thorax, showing the concentric and quincuncial arrangement of the tuberculation on the glabella. Bowning. *Coll. Mitchell.*

Fig. 9.—A cephalon showing the tuberculation of the glabella very distinctly. Bowning. *Coll. Mitchell.*

Fig. 10.—A perfect pygidium, which exhibits very clearly all the pygidial features of the species. Bowning. *Coll. Mitchell.*

Fig. 12.—A very fine and mature specimen ($\times \frac{4}{3}$), to show the general outline and glabella tuberculation.

Fig. 14.—The same as the above, natural size. Bowning. *Coll. Mitchell.* [The light line across the figure arises from a crack in the negative from which the print was made].

ENCRINURUS SILVERDALENSIS, *E. & M.*

Fig. 11.—A portion of a cephalon ($\times \frac{4}{3}$), showing the character of the tuberculation and the terminal conical tubercles surmounting the larger ones, and the fixed cheeks, inconspicuous neck-furrow, but strong neck-annulation, the rounded and tuberculate genal angle. Silverdale, near Bowning. *Coll. Mitchell.*

ENCRINURUS ETHERIDGEI, *Mit.*

Fig. 13.—A cephalon without the free cheeks ($\times \frac{4}{3}$). It shows the subtriangular or acutely elliptical contour of the anterior portion of the glabella, the deep axial grooves, the five pronounced lateral tubercles, and the deep spaces between these latter. Yarralumla. *Coll. Aust. Museum.*

Plate lv.

ENCRINURUS MITCHELLI, *Foerste.*

Fig.1.—A nearly perfect testiferous specimen, the test being absent from the glabella and pygidial axis only. The submucronate termination of the pygidium is well shown. Bowning. *Coll. Mitchell.*

Fig.2.—Shows the almost perfect hypostome in position. Bowning. *Coll. Mitchell.*

Fig.3.—Another testiferous specimen, exhibiting the much greater size of the last annulation of the thoracic axis than that of the first of the pygidial axis, and which is very characteristic in this species; also continuity of six of the annulations of the pygidial axis anteriorly, whereas, in non-testiferous specimens, three only are usually so. Bowning. *Coll. Mitchell.*

Fig.15.—A left free cheek, to show the eye and the non-inward trend of the axial groove. Bowning. *Coll. Mitchell.*

ENCRINURUS SILVERDALENSIS, *E. & M.*

Fig.4.—An imperfect tail showing eight or nine tubercles on the central area. Bowning. *Coll. Mitchell.*

Fig.9.—Hypostome showing lobation, etc. Silverdale. *Coll. Mitchell.*

ENCRINURUS BOWNINGENSIS, *Foerste.*

Fig.5.—A portion of a cephalon, to show the prominent eye. Bowning. *Coll. Mitchell.*

Fig.6.—Left free cheek (× 2), to show how the axial furrow passes outwardly into the side-furrow of the cheek, and obliquely inwardly across the inner lobes. [The artist has here intensified the obliquity] Bowning. *Coll. Mitchell.*

Fig.12.—A right free cheek, to show the same features as Fig.6 more correctly. Bowning. *Coll. Mitchell.*

ENCRINURUS ETHERIDGEI, *Mitchell.*

Fig.7.- A portion of a cephalon [*vide* Pl. liv., fig.13, *ante*].

Fig.8.—Portion of a cephalon (× 2), showing identity of features with the above Fig.7. Bowning. *Coll. Mitchell.*

ENCRINURUS *sp.*(?) *undet.*

Fig.13.—Pygidium with continuous axial annulations, and twelve pairs of pleural segments. Found associated with *E. duntroonensis.* This and the following (Fig.14) are distinct from all pygidia known to us, and if not belonging to *E. duntroonensis*, represent one, if not two, new species. Duntroon. *Coll. Mitchell.*

ENCRINURUS *sp.*(?), *undet.*

Fig.14.—Pygidium with axial annulations continuous, and ten pairs of pleural segments. (See remarks above, Fig.13). Duntroon. *Coll. Mitchell.*

ENCRINURUS (?) ETHERIDGEI, *Mit.*

Fig. 10.—An almost completely testiferous specimen (× 2), with continuous axial annulation, and thirteen pairs of pleural segments. Found associated with the cephalon represented in Fig. 8, and tentatively is placed specifically with it (× 2). Bowning. *Coll. Mitchell.*

Fig. 11.—A side-view of another pygidium of the same species showing thirteen pleural segments. Bowning. *Coll. Mitchell.*

Plate lvi.

ENCRINURUS ROTHWELLÆ, *E. & M.*

Fig. 1.—An almost complete individual; the free cheeks are absent, and the artist has incorrectly shown the eyes apparently present; also the pleural lobes of the thorax are too intensely spread marginally; otherwise it is a good figure. Bowning. *Coll. Mitchell.*

Fig. 3.—A side-view of another specimen to show the rather prominent axis. Bowning. *Coll. Mitchell.*

ENCRINURUS MITCHELLI, *Foerste.*

Fig. 2.—A very fine specimen, complete except the free cheeks. Bowning. *Coll. Mitchell.*

ENCRINURUS SILVERDALENSIS, *E. & M.*

Fig 4.—A nearly complete specimen of an almost mature individual. Silverdale. *Coll. Mitchell.*

Fig. 5.—A large pygidium showing seven tubercles distinctly on the central area of the axis, and the eighth faintly. Silverdale. *Coll. Mitchell.*

Fig. 6.—A portion of a cephalon of a mature individual showing the general tuberculation, the large lateral tubercles of the glabella, the stout neck-ring and its lateral extensions, and the rounded, thickened, and tuberculate genal angles. [See Pl. liv., fig. 11, of the same specimen]. Silverdale *Coll. Mitchell.*

Fig. 14.—Another pygidium.

ENCRINURUS *sp.* (?), *undet.*

Fig. 7.—Imperfect cephalon, undet. Bowning. *Coll. Mitchell.*

ENCRINURUS BOWNINGENSIS, *Foerste.*

Fig. 8.—An imperfect cephalon, which shows the tuberculation of the glabella.

ENCRINURUS (?) ETHERIDGEI, *Mit.*

Fig. 9. —Free cheek with prominent conoid eye. Bowning. *Coll. Mitchell.*

ENCRINURUS MITCHELLI, *Foerste.*

Fig. 10.—Hypostome.

ENCRINURUS DUNTROONENSIS, *E. & M.*

Fig. 11.—Right half of a cephalon showing all the features referred to in the description.

Fig.13.—Left free cheek of the above showing prominent conical eye, small inner lobe, and the inward trend of the axial groove reaching about half-way along the inner cheek-lobe. The posterior or outward part bordered by the posterior suture is incomplete. *Coll. Mitchell.*

ENCRINURUS *sp. undet.*

Fig.12.—Not correctly represented. *Coll. Mitchell.*

Plate lvii.

ENCRINURUS ETHERIDGEI, *Mit.*

Fig.1.—An almost complete specimen of a mature individual, showing most of the specific features fairly well. Yarralumla. *Coll. Australian Museum.*

Fig.2. - A pygidium showing 12-13 pairs of pleural divisions. Yarralumla. *Coll. Aust. Museum.*

Fig.4.—A smaller specimen. Yarralumla. *Coll. Mitchell.*

Fig.8.—Another pygidium, thirteen pleural segments. Yarralumla. *Coll. Aust. Museum.*

ENCRINURUS SILVERDALENSIS, *E. & M.*

Fig.3.—Axis and right pleural lobe of a large pygidium showing seven large tubercles and several smaller ones on the central area of the axis, and twelve pleural segments.

ENCRINURUS ROTHWELLÆ, *E. & M.*

Fig.5.—A nearly complete specimen, showing the characteristic features fairly distinctly. Bowning. *Coll. Mitchell.*

ENCRINURUS *sp. undet.*

Fig.6.—A right free cheek. Tarlo River. *Coll. Mitchell.*

Fig.7.—Portion of a pygidium. Tarlo River. *Coll. Mitchell.*

ENCRINURUS MITCHELLI, *Foerste.*

Fig.9.—A left free cheek, to show that the axial furrow does not traverse inwardly along the smaller lobe of the cheek. Bowning. *Coll. Mitchell.*

ENCRINURUS SILVERDALENSIS.

Fig.10.—A right free cheek, to show the passage of the axial groove inwardly along the small lobe of the cheek, and passing out at the junction of the facial sutures in front of the glabella. Silverdale. *Coll. Mitchell.*

ENCRINURUS BOWNINGENSIS.

Fig.11.—A right free cheek, showing the passage of the axial groove inwardly along the smaller lobe of the cheek, as is the case in *E. Silverdalensis.* Slightly enlarged-

[Photos by H.B. and J.M.]

NOTES ON A COLLECTION OF AUSTRALIAN AND OTHER MYRIAPODA.

By Walter W. Froggatt, F.L.S.

In 1912, Mr. Brölemann contributed a paper to the Records of the Australian Museum (Vol. ix., pp.37-75), dealing with the Myriapoda collection in that Institution. In this paper, he described a number of new species, and gave some interesting notes on the range of a number of Australian centipedes.

In 1914, I sent him a small collection, chiefly obtained in the western country of New South Wales, which he kindly determined, and also sent me the description of a new species, accompanied by drawings (*postea*).

Scolopendra morsitans Linn.

The type was described from India, but the species has a very wide distribution in other parts of the world. In Australia, it is the common centipede in the interior. I have specimens from West Australia, South Australia, Pera Bore, Bourke, and Brewarrina. In the western country, these centipedes live deep down in the dry, cracked soil; whence, when the heavy rains set in, and the billabongs and gilgis are flooded, they swarm out, and seek shelter under the dry bark on the tree-trunks, or fallen timber and logs. At our Experiment Camp at Yarrawin, north-east of Brewarrina, they were common in our tents in the rainy season. Mr. Brölemann has added the following notes on specimens sent—"No.3. Pera Bore, Darling River. The pink colour of the antennæ, and generally that of the body has no specific meaning, although I do not recollect having met with a similar case before. All other particulars are typical." Later on, he said—"With reference to these specimens, it is to be mentioned that the pleuræ are truncate instead of being provided with a process, and bear, near the inner angle, the two tiny spines which are typically found at the apex of the process. A similar structure is found now and then amongst Scolopendrids, but always bears the characters of an accidental, asymmetrical traumatism. The case of these specimens is different, as the symmetry is preserved, both pleuræ being perfectly alike in all the specimens examined. This, together with the fact that the dentate sternal plates of the maxillipedes are longer than usual, might represent a local race of the Linnean *S. morsitans.*"

Scolopendra læta Haase.

In the Australian Museum Collection, this species is recorded from Penrith, N.S.W. I have it from Gatton, Queensland; and Tumut and Nevertire, N.S.W.

Cormocephalus westwoodi Newport.

This is one of the common species about Syduey. I have it also from Gatton, Queensland; and Vila, New Hebrides.

Cormocephalus brevispinatus L'K., subsp. sulcatus Bröl.

This is a common species in the west, at Brewarrina and Pera Bore, N.S.W., under logs. I have specimens also from Paterson River, N.S.W.

Cormocephalus aurantiipes Haase, subsp. marginatus.

Specimens are in the Australian Museum from Port Stephens, and Parramatta, N.S.W. I have specimens from Gatton, Queensland; and others from Sydney.

Cormocephalus turneri Pocock.

I collected this species at Vila, New Hebrides.

Ethonostigmus rubripes Brandt.

Two specimens from Sydney are in my collection. The Australian Museum Collection contains specimens from Bourke and Wilcannia, N.S.W.; the Condamine River, Queensland; and the Solomon Islands.

Rhysida subinermis Meinart.

Two specimens from Sydney, and others from the Paterson River, N.S.W.

Otostigmus punctiventris Iomosvary.

Specimens from Vila, New Hebrides

DESCRIPTION OF A NEW SPECIES OF MYRIAPODA FROM NEW SOUTH WALES.

By H. W. Broelemann.

Schizoribautia aggregatum, n.sp.

Closely related to *Schizoribautia Rainbowi* Bröl., from which it is to be distinguished by the following particulars.

Median plate of labrum fringed with delicate ramose lashes.

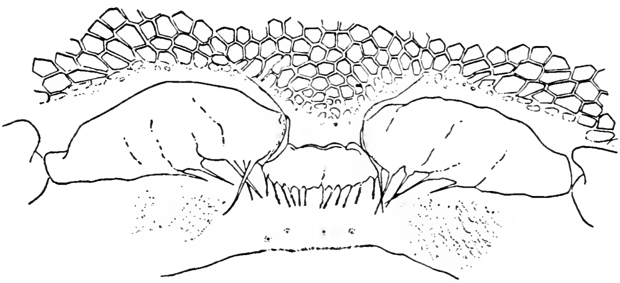

Fig. 1.—Labrum.

Femora of maxillipedes bearing a rounded, wart-like tubercle near the distal end of its inner edge.

Second sternite provided with a porous area pierced with numerous pores. The median sulcus of the following sterna is deeper and wider in the anterior half of the sternal plate than in its posterior half.

Last tergite with lateral margins straight, not excised.

Coxæ of anal legs not particularly swollen; inner edge clothed distally with very short and tiny hairs, but its distal margin does not overlap angularly the following joint. The coxal glands are aggregated into two bunches, the pores of which open in a rounded pouch at least partly concealed under the margin of the last sternite.

No anal pores could be detected

♀. 67 to 71 pairs of legs. Length about 50mm.

Hab.—N.S.W.: Brewarrina, one specimen; Nevertire, one specimen (W. W. Froggatt).

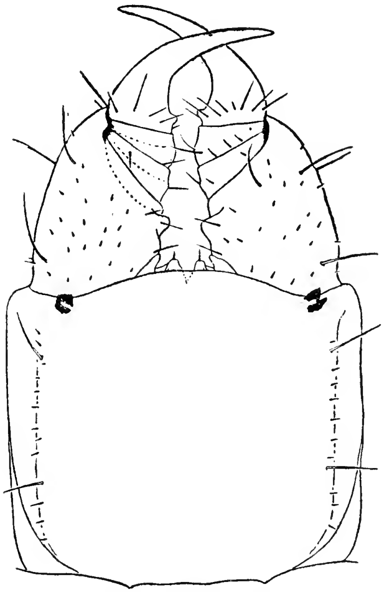

Fig. 2.—Maxillipedes.

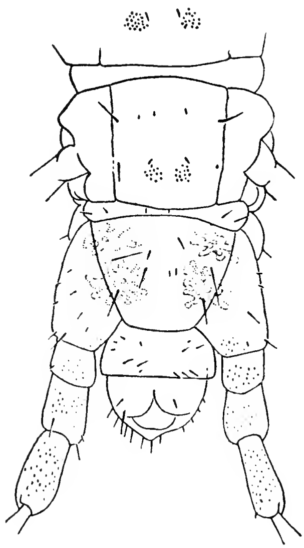

Fig. 3.—Posterior end of the body, ventral view.

It has been stated in the diagnosis of the genus *Schizoribautia*, that the median plate of the labrum is not fringed. Since this character lacks constancy, the diagnosis needs to be altered accordingly.

REVISION OF THE AMYCTERIDES.

Part iv. *Sclerorinus* [Section i.]. [Coleoptera].

By Eustace W. Ferguson, M.B., Ch.M.

(Continued from Vol. xxxix., p.252.)

Sclerorinus* Macleay.

Macleay, Trans. Ent. Soc. N. S. Wales, i., 245, 1865.

Form elongate, subparallel, or elliptical; size moderate to large, female generally larger and more robust than the male; black, elytral tubercles sometimes reddish; clothing variable.

Head convex, generally separated from rostrum by a feeble transverse impression above, the rostral ridges frequently extending on to the forehead. Rostrum comparatively short, thick, little excavate above; upper surface bounded by subparallel external ridges; median area not depressed, carinate; sublateral sulci broad, shallow, with deeper basal foveæ. Prothorax generally dilate or subdilate on the sides, very little produced above, with well-developed ocular lobes; granulate. Elytra gently rounded on sides, base gently emarginate; disc puncto-striate or foveo-striate; interstices tuberculate, occasionally subcostate, the alternate interstices sometimes without tubercles.

♂. Ventral surface either (1), maculate, with a median channel on the fifth segment; or (2), with a median hirsute vitta, the fifth segment not depressed.

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* *Sclerorinus* is the original spelling, as it appears in the Transactions of the Entomological Society of New South Wales. In Gemminger and Harold's Catalogue, it appears as *Sclerorrhinus*, from sclerus=durus, and rhinus=nasus; this spelling has been followed by Masters, and later by Lea. Although this would be the correct spelling if the derivation be correct, I think that it is by no means certain that Macleay was alluding to the character of the rostrum, and not merely using the termination—inus. The spelling *Sclerorhinus*, as used by Pascoe, Sloane, and Blackburn, is in any case erroneous.

♀. More robust than male. Ventral surface convex.

This genus was proposed, by Macleay, for what must be regarded, on the whole, as a very homogeneous group of species, "the greater number [of which], and all the more typical ones, are inhabitants of the great basin of the interior, which has its outlet in the colony of South Australia." Macleay, in his remarks on the genus, says—"the main feature of the genus is the broad flat rostrum, with a central ridge extending in most cases to the vertex." While this is true of the typical species, there are cases, however, where the centre of the rostrum cannot strictly be called carinate. As there are, at present, included in *Talaurinus*, many species in which the internal rostral ridges are obsolete, confusion of the genera may arise, and, in the past, has arisen. It seems to me, however, after examining large series of specimens, that, in cases where doubt might arise, the obvious affinities of the species are sufficient to indicate their true position; and, although the median area may not be distinctly carinate, it is generally raised, or convex, and never depressed, or sulciform, as it is so generally in *Talaurinus*.

The lateral, or, more correctly, the sublateral, sulci are broad, and extend for the greater part of the rostrum, generally with a deeper basal fovea; in some species, however, through the subtriangular elevation of the median area, the sulci are practically limited to these basal foveæ. Internal ridges are never present, though the edges of the median area, being often marked by vittæ, may give the appearance of internal ridges. The scrobes and the relative position of the eyes do not exhibit any great degree of variation. The prothorax is generally more or less ampliate on the sides, and the ocular lobes are, on the whole, fairly strongly marked; the granules or tubercles on the disc vary, and are not always constant in shape or size in the same species.

The elytra do not present the wide divergence in sculpture so characteristic of *Talaurinus*; practically all the species may be described as tuberculate. The tuberculation, however, is variable, the tubercles in some species being small and granuliform; in others, showing a tendency to coalesce to form costæ; in all cases, the fundamental tuberculiform nature of the structure is traceable.

The tubercles occur practically always in single series, almost the only exception known to me, being a tendency in some species of the *sabulosus*-type towards reduplication in the middle of the third interstice, this, however, being an individual variation, and not constant in the species, or on both sides of the same specimen. The third interstice is generally, and the sixth almost invariably, continuously tuberculate; the second and fourth always have fewer, and may have no, tubercles; while the fifth is very variable, sometimes continuously tuberculate, in other species only at the humeral angle. The seriate punctures are small and shallow, often completely obscured, and almost invariably never foveiform; the only exception being in the aberrant *convexus*-group, where the punctures are large and foveiform. One other point in the elytral sculpture may be mentioned here, as I have made use of it in grouping the species; that is the approximation, in some species, of the third elytral interstices on the declivity; in these species, the second interstice is crowded out on the declivity; in other cases, the second interstice (though not necessarily the tubercles) is continued to the apex.

The ventral surface presents two forms of structure, in the male, which I regard as of primary importance in the classification of the genus. In the first section, the ventral segments are more or less strongly maculate, with short subpubescence, near the centre; and the apical segment, in the male, is channelled in the middle, the channel being bordered, as a rule, on either side by a small elevation. In the other section, the fifth segment is not excavate, but there is a strong median ventral vitta of long setose hair, extending from the metasternum to the apex of the abdomen. The metasternum is short, but presents no special features.

The legs are moderately long; the anterior femora, in many species, bear a narrow ridge along the outer half of the undersurface. In the male of some species, the middle tibiæ have a strong subapical emargination; the posterior tibiæ are similarly notched in the *subcostatus*-group. The anterior tarsi are comparatively short, and the posterior elongate. In some species, the undersurface, on each side of the median channel, is spongiose; this is most marked in *S. tristis* and its allies. The posterior tarsi generally bear long, setose bristles.

The male genitalia vary a good deal in different species; more dissections are required, however, before it will be possible to assess the value of the differences in grouping the species. In all, the forceps are short, bluntly acuminate, with the apex set with stout bristles, and chitinous. In some species, the two parts of the forceps are separate, or only united at the base by membrane; in others, there is a thin, chitinous septum uniting the two halves. In some species, there is a median vertical plate present, as in *Psalidura*, the lower border of which divides behind into two rami, attached to the ends of the forceps; in other species, there is no such plate. The penis varies in different species, but is of the same general type as in other Amycterides. Pending further dissections, I have not described these structures in detail, as they appear in the few specimens so far dissected. I believe, however, that they will prove of taxonomic importance, though, unless differences in the genitalia are correlated with differences in elytral or other external structure, they will not be of much service in identifying species.

Among the Amycterides described previous to the institution of the genus, only eleven can be referred to *Sclerorinus*; and, of these, the names of three must be regarded as synonyms.

Curculio bubalus Olivier (Ent. v. 83, p.399, t.25, f.354) is certainly a *Sclerorinus*, and a common Tasmanian species.

Hipporhinus nigrospinosus Don., (Epitom. Ins. N. Holl., 1805) is, from the figure, clearly a *Sclerorinus*.

Boisduval (Voy. Astrolabe, ii., 1835) described four species which appear to belong to the present genus. *Amycterus morosus* (*loc. cit.*, p.386), though long regarded as a Cubicorrhynchus, is a Sclerorinus, and synonymous with *S. bubalus* Oliv. *S. carinatus* (*loc. cit.*, p.385) is probably synonymous with *S. nigrospinosus* Don. *S. tristis* (*loc. cit.*, p.388) is a well known Tasmanian and Victorian species. *S. dolens* (*loc. cit.*, p.376) is unknown to me.

Amycterus Kirbyi Guérin, (Voy. Coquille, ii., (2), 1830, p.121) is a species of *Sclerorinus*, and, almost certainly, conspecific with *S. subcostatus* Macleay. The name *Kirbyi* would appear to be preoccupied by the *Psalidura Kirbyi* of W. S. Macleay (King's Survey, App. ii., p.444, 1827), *Psalidura* being, at that time, regarded as synonymous with *Amycterus*. Later, *Psalidura Kirbyi* W. S. Macleay, was transferred to *Talaurinus*, but I do not think that Guérin's name can now be revived for the Sclerorinus. Bohemann (Schönn., Gen. Insect. vii. (1), 1843) described, among other species of *Amycterus*, three which belong to *Sclerorinus*—*A. elongatus*, *A. Hopei*, and *A. Spencei*. Fuller reference will be made to these species later.

Germar (Linn. Ent. iii., 1848, p.217) described a single species, *S. sublineatus*, which is common in South Australia.

Macleay (Trans. Ent. Soc. N. S. Wales, i., 1865) proposed the genus, and added the names of thirty-six new species. Subsequently, he described nine others (*loc. cit.*, 1866, pp.322-6). There can be no doubt that Macleay relied far too much on variable points of structure in separating his species, consequently the list of synonyms is a heavy one; but, even with his types before me, and with fairly extensive series of most species, I have found it difficult, in some cases, to decide as to the validity of a species. I regard the following synonymy as fairly certain; fuller reference to some of the discarded species will be made under the specific descriptions.

S. Adelaidæ = *S. nodulosus* and *S. divaricatus*; *S. Waterhousei* = *S. interioris*; *S. Angasi* and *S. rugicollis* are fairly certainly referable to *S. vittatus*; while I regard *S. conspersus* and *S. fuscus* as variations of the same species; *S. confusus*, distinguished mainly by its light-coloured setæ, is also doubtfully distinct from *S. vittatus*; *S. sordidus* and *S. acuminatus* are evidently sexes of the same species; *S. asper* and *S. Howitti* I cannot separate from *S. tristis* Boisd.; *S. sabulosus* and *S. arenosus* are the same; *S. angustatus* is a small male of *S. exilis*, with lighter-coloured setæ; *S. subcostatus* = *S. vermiculatus*; *S. interruptus* is a form of *S. subsequens*, a variable species. *S. Riverinæ* is possibly not a *Sclerorinus*; if the species be referred to *Talaurinus*, the synonym *alternus* must be used, as *T. Riverinæ* is already preoccupied. The type of *S. mucronatus* has been mislaid, but I think the species will prove to be synonymous with *S. tuberculosus.*

In accordance with my plan, I have endeavoured to redescribe Macleay's species from the types; owing to alterations in the Macleay Museum, I have been unable to do this in all cases, and I have been compelled to redescribe several from my own specimens, all of which, however, have been compared with the types.

Pascoe (Journ. Linn. Soc., xii., 1873) described, as new, five species of *Sclerorinus*—*S. tæniatus*, *S. marginatus*, *S. echinops*, *S. meliceps*, and *S. molestus*; also, as a Talaurinus, *T. molossus*, a species which I would refer to *Sclerorinus*. Of these species, *S. tæniatus* = *S. Stewarti* Macl.; *S. marginatus* = *S. sublineatus* Germ.; while *S. echinops* appears to belong to *Talaurinus*. *S. molossus* and *S. molestus* belong to the *sabulosus*-group, while *S. meliceps* from Queensland is unknown to me.

Sloane (Trans. Roy. Soc. S. Aust., xvi.), among the Amycterini of the Elder Expedition, described three species of *Sclerorinus* —*S. Elderi*, *S. occidentalis*, and *S. angustipennis*, the types of which have been kindly lent to me for examination by the authorities of the South Australian Museum; they are all distinct species of the *sabulosus*-group. *S. Elderi* is most nearly allied to *S. molossus* Pasc., while *S. occidentalis* and *S. angustipennis* are closely allied, *inter se*, and come nearest to *S. molestus*. In addition to these, Sloane (*loc. cit.*) described several species of *Talaurinus*, some of which certainly appear to be more at home in *Sclerorinus*. Of these, Blackburn (Report of the Horn Exped., Part ii., p.291) has referred *T. convexus* to *Sclerorinus*. I would also refer *T. insignis* and *T. noctis* to the same genus. Of the true position of *T. obscurus*, I have considerable doubt. Mr. Sloane regarded it as closely allied to *S. convexus* and the other two species, and the general structure is very similar; but the rostral characters are certainly more suggestive of *Talaurinus* than *Sclerorinus*, whereas, in the other three species, the reverse is the case. Unfortunately, the type is a female, and at present remains the unique example of the species known; the discovery of the male would probably throw light on its position. I believe a new genus is required for its reception, but, until the male is known, I am content to leave it in *Talaurinus.*

Lea (Mém. Soc. Ent. Belg., 1910, p.77) described a single species from Mt. Kosciusko, *S. inconstans*, a member of the *vestitus*-group. He also (Deutsch. Ent. Zeitschr., 1910, p.161) described a species, *S. multigranulatus*, which I have already referred to *Talaurinus.**

Within recent years, a number of species have been described by myself. Of these, *S. amycteroides* (Proc. Roy. Soc. Victoria, 1914, p.254) is a member of Group ii.; *S. regularis*, *S. neglectus*, and *S. albovittatus* (Trans. Roy. Soc. S. Australia, 1914) belong to Group i; *S. Blackburni*, *S. alpicola*, and *S. mucronipennis* (*loc. cit.*) to Group v.; while the descriptions of three other species, *S. inornatus*, *S. Dixoni*, and *S. Goudiei* have been sent to the Royal Society of Victoria for publication.†

In Masters' Catalogue, 54 species of *Sclerorinus* are listed; three (*S. carinatus* Boisd., *S. hopei* Bohem., *S. Spencei* Bohem.,) are included under *Psalidura*; one (*S. molossus* Pasc.) under *Talaurinus*, and one (*S. nigrospinosus* Don.) under *Hipporhinus*. To this number, 18 have been added of recent years. The removal of synonyms, doubtfully valid species, and species removed to other genera, reduces the number to 54. To these are now added seven new species, making a total of 61. It is possible, however, that some of the names on the unidentified list will be found to belong to well-known species, in which case the number of species will be further reduced.

Classification.—In such a comparatively homogeneous genus, there is little difficulty in arriving at a fairly satisfactory grouping of the species. In *Talaurinus*, this will always be the great difficulty, and even if that genus be subdivided, it will always be hard to assign some species to their correct position. In *Sclerorinus*, on the other hand, the chief stumbling block lies in the great variability of many species, so that it is hard to say

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* These Proceedings, 1912, p.112.

† Since published, Proc. Roy. Soc. Victoria, 1915, pp.253-254.

what features can be regarded as of specific value; but the species, as a whole, fall into fairly definite groups.

Macleay, in his second paper, divided the genus into four Sections, depending upon the characters of the elytral interstices, in particular upon the fifth or humeral, termed by Macleay the fourth. At first sight, this would appear a satisfactory method, the genus being subdivided into the following groups:

1. Fourth interstice of the elytra closely and continuously tuberculated.

2. Fourth interstice not tuberculated, or only close to the shoulder.

3. Fourth interstice remotely tuberculated or slightly elevated.

4. Interstices of the elytra somewhat costate.

A closer examination of the species arranged by Macleay under these groups revealed the existence of several anomalies, and it seemed to me that some underlying primary factor had been overlooked. Such a factor, I think I have discovered in the characters of the ventral surface (in the male), two main types of structure existing in the genus. As a rule, it is not desirable to form primary divisions on sexual characters, but this seems unavoidable in the Amycterides. I would, therefore, divide the genus into two primary sections.

Section i.—Median ventral segments at most maculate, never vittate; fifth segment longitudinally channelled in the ♂.

Section ii.—Ventral surface with a strong, median, longitudinal vitta, fifth segment not channelled in the ♂.

The first Section comprises Group i., which may be conveniently termed the *Adelaidæ*-group, and it contains the type of the genus. The number of species belonging to the Section is comparatively small, so that I have not considered it necessary to subdivide them into groups, though they exhibit variation in characters utilised for further subdividing Section ii.

The second Section comprises the bulk of the species, and, for convenience, may be subdivided into four groups. The relations of the groups may be conveniently stated as follows:—

Section i.—No median ventral vitta, apical segment channelled in the ♂ ....Group i.—*Adelaidæ*-group.

Section ii.—Median ventral vitta present.

A. Fifth interstice strongly tuberculate throughout.

B. Intermediate tibiæ not notched within apex.

C. Third interstices convergent on declivity... ....Group ii.—*sabulosus*-group.

CC. Third interstices subparallel on declivity....................Group iii.—*Stutchburyi*-group.

BB. Intermediate tibiæ with strong subapical notch ....Group iv.—*subcostatus*-group.

AA. Fifth interstice only tuberculate near humeral angle, or with only a few isolated tubercles... ....Group v.—*vestitus*-group.

It is sometimes difficult, with single specimens, to determine the group to which they properly belong; for instance, members of the *Stutchburyi*-group may show some deficiency in the tuberculation of the fifth interstice, this being, in most cases, an individual variation, and readily corrected by the examination of a series. Besides the members of the *subcostatus*-group, a number of other species possess intermediate tibiæ with subapical emargination; some of these are members of the first Section, but others belong to the *vestitus*-group, and are separated from the members of the *subcostatus*-group by the character of the fifth interstice. *S. convexus*, *S. insignis*, and *S. noctis*, I have placed in the *sabulosus*-group, though they should, perhaps, constitute a separate subdivision; and, in places, I have alluded to these three species as the *convexus*-group.

The only species which do not lend themselves readily to this grouping are three in number.

1. *S. albovittatus* Ferg., a species in general facies resembling the *vestitus*-group, but probably an aberrant member of Section i.

2. *S. horridus* Macl., apparently related to the *vestitus*-group, but falling, according to my tabulation, into the *Stutchburyi*-group.

3. *S. Riverinæ* Macl., a species with a ventral surface not vittate nor maculate. Possibly it is not really a Sclerorinus.

Distribution.—While the majority of the species are inhabitants of the Eyrean subregion, in Victoria a number of species have crossed over into the Bassian subregion. The route followed by these species seems to have been different from that followed by the species found to the north of the Dividing Range, in the Mallee-districts of Victoria. The species found in the Mallee-country are almost all different from those of Southern Victoria, although both types are found in South Australia. The southern forms have extended further into Tasmania.

The distribution of the genus may, perhaps, be most clearly indicated according to its component groups.

Group i. is strongly represented in South Australia by a majority of the species, extending, on the east, into the coastal and mountain-districts of Victoria and Tasmania, although the exact number of species found in Victoria is doubtful. In South Australia, the group appears to have its headquarters to the north of Spencer and St. Vincent Gulfs; further west, in Eyre's Peninsula, it is represented by the *dimidiatus*-subgroup, of which an isolated species occurs on the western seaboard of Western Australia. In New South Wales, another subgroup, of which *S. carinatus* is the only described species, extends along the southern mountains as far north as Orange.

Group ii. radiates from South Australia east into the Mallee-districts of Victoria, north into Central Australia (*convexus*-subgroup), and west into Western Australia. The majority of the West Australian species belong to this group.

Group iii. extends along the mountain-ridges of the Main Dividing Range in New South Wales, from the borders of Victoria into Queensland. Two other species, of somewhat dissimilar habit to the other members of the group, are, however, found in South Australia and Victoria, and one of them in Tasmania.

Group iv. appears to be limited to New South Wales; its dis tribution is rather along the tablelands and western slopes beyond the Dividing Range.

Group v. also belongs more properly to South Australia, extending thence into the adjoining parts of Victoria, and into Riverina in New South Wales. *S. queenslandicus* appears to belong to this group, which is further represented in the south-west of Queensland (Cunnamulla) by an undescribed species.

The distribution of the various groups within the States would probably repay investigation, but the data available to me are too scanty for more than generalisation.

South Australia contains the greater number of species of Groups i., ii., and v., and one or two examples of Group iii.

Central Australia has only an aberrant Subgroup of Group ii., so far recorded.

Western Australia has mostly representatives of Group ii., but a single species of Group i. occurs on the western seaboard, and also a representative (at present undescribed) of Group v.

Victoria has representatives of Groups i., ii., iii., and v. As noted above, the Mallee-fauna, which is characteristically South Australian, differs from that of the mountain-ranges and coastal districts.

Tasmania.—Two species have been described, both also found in Victoria, one a member of Group i., and the other of Group iii.

New South Wales.—Group i. is represented on the southern highlands; Group iii. along the whole length of the mountain-chain; and Group iv. on the tablelands, especially in the southern half of the State. Group v. is represented by one species at Mt Kosciusko, and another in Riverina.

Queensland.—Only two species have been described from this State *S. meliceps* Pasc., I am unable to place, while *S. queenslandicus* is an aberrant member of Group v.

It may be well to point out that the Amycterid fauna of the vast district lying to the west of the Darling, and of similar portions of Queensland, is quite unknown. The Northern Territory and North-West Australia also have never been searched for these insects, although I do not think that the genus will be found to extend to these regions.

Synonymy.

S. Adelaidæ Macl.	= *S. divaricatus* Macl.
	= *S. nodulosus* Macl.
S. vittatus Macl.	= *S. Angasi* Macl
	= *S. rugicollis* Macl.
	= *S. conspersus* Macl.
	= *S. fuscus* Macl.

S. Waterhousei Macl.	= *S. interioris* Macl.
S. sordidus Macl.	= *S. acuminatus* Macl.
S. tristis Boisd.	= *S. asper* Macl.
	= *S. Howitti* Macl.
S. sabulosus Macl.	= *S. arenosus* Macl.
S. sublineatus Germ.	= *S. marginatus* Pasc.
S. Stewarti Macl.	= *S. tæniatus* Pasc.
S. bubalus Oliv.	= *S. morosus* Boisd.
S. exilis Macl.	= *S. angustatus* Macl.
S. subcostatus Macl.	= *S. vermiculatus* Macl.
	= (?) *S. Kirbyi* Guérin.
S. subsequens Macl.	= *S. interruptus* Macl.
S. Riverinæ Macl.	= *S. alternus* Macl.

Doubtfully valid species.

S. confusus Macl.—The type is greatly abraded; the setæ are light-coloured, otherwise I should have little hesitation in sinking it as a synonym of *S. vittatus* Macl.

S. mucronatus Macl.—Under the name-label, in the Macleay Museum, is a female specimen of *S. vestitus*, which does not agree with the description or dimensions of *S. mucronatus*. Another specimen, labelled Victoria, but without a name-label, in the same Collection, agrees well with the description, and is probably the misplaced type. Apart from the mucronation, it does not differ materially from *S. tuberculosus* Macl.

S. carinatus Boisd.—Judging from the figure of the latter, this name should be a synonym of *S. nigrospinosus* Don.

Unidentified, or doubtfully identified species.

S. dolens Boisd.—May be the same as *S. subsequens* Macl.

S. elongatus Bohem.—Doubtfully identified from the Blue Mountains, N.S.W.

S. Hopei Bohem.—Doubtfully identified as a species found on the south-western slopes in New South Wales.

S. Spencei Bohem.—May be the same as *S. obliteratus* Macl.

S. meliceps Pasc.—Unknown to me.

SECTION i.

Apical segment of abdomen with a median longitudinal channel in the ♂; no ventral vitta present.

I regard the species comprised in this Section as constituting but one group, although they fall into three subgroups, varying in the characters utilised in the second Section for subdividing into groups.

Subgroup A.—Species with all the elytral interstices tuberculate; the intermediate tibiæ simple.

Subgroup B.—Species with the intermediate tibiæ, in the ♂, with a strong subapical notch.

Subgroup C.—Species with the third and fifth interstices costiform, and the second and fourth neither tuberculate nor costiform.

The species of this Section have proved the most difficult to define satisfactorily in regard to their specific characters and range of variation. The separation off of the second and third Subgroups, still leaves a large number of species showing great variation, and running, the one into the other, in a most bewildering fashion. The confusion has not been lessened by the fact that a number of the species have been proposed for single specimens, many of which appear to be somewhat aberrant forms of commoner species; and of which, in some instances, I have not been able to procure an exactly identical specimen.

A feature of importance, previously overlooked by me, in the separation of the species, lies in the structure of the anterior tarsi. In *S. Adelaidæ*, for example, the three basal joints are subequal in width, each joint being symmetrical; whereas, in *S. tristis*, the third joint, and, to a less extent, the second, are asymmetrical, the inner portion being more expanded than the outer. My failure to note the two types of tarsal structure has led, in a former publication, to a misidentification of *S. sordidus* Macl. The type, fortunately, has the three basal joints of the anterior tarsi remaining on one side; these are as in *S. tristis*, and I have no doubt now that *S. sordidus* is the male of *S. acuminatus*.

The species with simple tarsi show a remarkable gradation in the size of the elytral tubercles, and, to a less extent, in the size of the insect. *S. Waterhousei* is the largest and most conspicuously tuberculate, but grades down into *S. Adelaidæ*; this latter species, in turn, runs into *S. vittatus*, without any apparent line of demarcation.

Under *S. vittatus*, I have grouped a number of forms, most of them represented by single specimens, differing in the size and conspicuousness of the tubercles; among these are included *S. conspersus*, *S. fuscus*, and the form previously identified by me as *S. sordidus*. In view of the transition between the various forms, it is questionable whether they should not be regarded as constituting but one variable species; the extremes of the series are, however, very distinct; and I have thought it better to retain the names of the principal forms. It is possible that further collecting will show that some of the varieties, at present included under *S. vittatus*, are worthy of specific rank. There are, of course, one or two species with symmetrical tarsi, that are quite distinct.

The species with the third anterior tarsal joint asymmetrical are in a somewhat better position, though considerable confusion has, in the past, existed about them. *S. tristis*, I regard as typical of these species, and, with it, I unite *S. Howitti* and *S. asper* as synonyms. *S. sordidus* and *S. acuminatus*, I regard as sexes of the same species, and separate them from *S. tristis*. *S. inornatus* is also distinct from *S. tristis*. The position of *S. obliteratus* is still open to question; the type is a female, and differs from the female of *S. tristis* in the structure of the apical ventral segment. There are two species before me, which possess a similar structure; one is *S. inornatus*, which has a more obliterate sculpture; and the other is a species from the Victorian Alps, which is rougher, but shows considerable variation in this respect. Tentatively, I regard this species as *S. obliteratus*, but, as the male has simple tarsi, it should come in the first portion of the Group. It is possible that *S. obliteratus* will be sunk ultimately as a synonym of *S. Spencei* Bohem.

In addition to the species described in this paper, I have seen a number of others, differing in various features, and represented mostly by single specimens, which I have thought better to leave undescribed for the present.

Of the species with deeply emarginate intermediate tibiæ, *S. Mastersi* is the most distinct. The others are closely related, *inter se*, and might, perhaps, be more properly regarded as geographical or local races.

Subgroup C contains, at present, but one described species.

Table of Species, Group i.

Subgroup A.—Elytral interstices all more or less tuberculate; intermediate tibiæ not notched.

1(4). Anterior tarsal joints symmetrical.
2(3). Tubercles varying in size, all distinct and in single series.
  a. Size large, broad; tubercles large, not clothed...*S. Waterhousei* Macl.
  b. Size large; tubercles smaller, clothed at base ......*S. Adelaidæ* Macl.
  c. Size moderate to large, narrower; tubercles distinct, smaller, more completely clothed.......................... .....*S. vittatus* Macl.
  d. Size moderate to smaller; tubercles less distinct, especially at the base of the third interstice, completely clothed ....*S. vittatus* Macl., var. ?
  e. As in *d*, but setæ yellowish (doubtful species).......*S. confusus* Macl.
  f. As in *c*, but without clothing above, setæ yellowish.............. ....*S. irregularis* Macl.
3(2). Tubercles small, granuliform, in double series at base of third interstice .. ..*S. oblongatus*, n.sp.
4(1). Anterior tarsi asymmetrically dilatate on the inner side of the second and third joints in ♂.
5(8). Apical ventral segment tuberculate on either side of median channel in ♂.
6(7). Intrastrial ridges prominent; scape comparatively strongly incrassate ... .*S. tristis* Boisd.
7(6). Sculpture more obliterate than in *S. tristis*; scape more slender ....*S. sordidus* Macl., (*S. acuminatus* Macl.).
8(5). Apical ventral segment without tubercles in ♂ ......*S. inornatus* Ferg.

Subgroup B.—Intermediate tibiæ with a strong subapical emargination.
9(12). Prothoracic tubercles rounded.
10(11). Third elytral interstices costiform from base to edge of declivity......... ....*S. dimidiatus* Macl.
11(10). Elytral interstices regularly and evidently tuberculate......... ....*S. regularis* Ferg.
12(9). Prothoracic tubercles more or less elongate and obsolescent in the centre.

13(14). Size large, with tubercles small and obscured by the clothing ....*S. Mastersi* Macl.
14(13). Size smaller, tubercles less obscured.
15(16). Elytral tubercles comparatively large, elongate at base of third interstice . ...*S. neglectus* Ferg.
16(15). Elytral granules smaller, less elongate, reddish......*S. Carteri*, n.sp.

Subgroup C.—Third and fifth elytral interstices costiform, second and fourth wanting.

Clothing dense, light.. ......*S. carinatus* Boisd.

Notes on the Table.—Distinctions of size and tuberculation can be regarded as correct only for typical specimens; intermediate forms have, perforce, been excluded.

S. Waterhousei includes *S. interioris* Macl.

S. Adelaidæ Macl., includes *S. nodulosus* Macl., and *S. divaricatus* Macl.

S. vittatus Macl., includes *S. Angasi* Macl., *S. rugicollis* Macl., *S. conspersus* Macl., and *S. fuscus* Macl.

S. vittatus Macl., var. ?, includes those forms wrongly identified by myself, in a previous paper, as *S. sordidus*.

S. tristis Boisd., includes *S. asper* Macl., and *S. Howitti* Macl.

S. sordidus Macl., includes *S. acuminatus* Macl.

S. obliteratus Macl., has been omitted from the Table, as I am not certain of the male.

S. Spencei Bohem., probably belongs to this Group; but, as I am uncertain of its identity, I have omitted it.

Sclerorinus Adelaidæ Macl.

Macleay, Trans. Ent. Soc. N. S. Wales, 1865, p.247; *S. divaricatus* Macl., *loc. cit.*, p.248; *S. nodulosus* Macl., *loc. cit.*, p.249; Lea, Trans. Roy. Soc. S. Aust., 1903, p.112.

The following description was drawn up from one of two female specimens standing under this name in the Macleay Museum. There is nothing to indicate which of the two is the actual specimen described by Macleay.

♀. Moderately large, relatively broad, elongate-ovate. Black; densely clothed with brownish pubescence, head with supra-orbital and median vittæ lighter, a dark brown patch on either side of median line, prothorax trivittate, elytra with a lighter tint along suture, and a short vitta at humeral angle; beneath, maculate in centre and at sides of each ventral segment.

Head and rostrum in the same plane above, forehead with three bare longitudinal carinæ, continuous with the rostral carina, gradually merging into head near the vertex. Rostrum broad, hardly excavate; external ridges prominent, subparallel; median carina long, prominent, slightly convex in profile, more raised than on the head; sublateral sulci shallow, deeper at the base. Prothorax (5 x 6·5 mm.) strongly transverse, widest in front of middle; apical margin feebly rounded above, with prominent ocular lobes; subapical impression moderately distinct, median line scarcely impressed; tubercles moderately large, and moderately closely set, elongate, round towards sides, small and obsolescent immediately in the centre; on the sides, tubercles becoming obsolete towards coxæ. Elytra (13 x 8 mm.) broad, apex moderately produced; base evenly and rather deeply emarginate, humeri prominent; seriate punctures small, obscured by the clothing, intrastrial granules small, little prominent; interstices tuberculate, sutural with a short costa on either side at base, followed by a row of fine granules; second with four or five widely separated tubercles, not reaching base, nor extending down the declivity; third with a subcontinuous row of thirteen from base practically to apex, rounded towards base, more conical towards apex; fourth without tubercles; fifth with a continuous row duplicated in places, slightly smaller than on third, about seventeen pairs or single tubercles; sixth with a continuous row of ten, about the same size as those on the third, hardly conical. Sides with depressed, rounded, often confluent, tubercles. Beneath, convex, slightly flattened in middle of each segment. *Dimensions :* ♀, 20 x 8 mm.

The male differs in being more subparallel, and less produced at apex; the elytral tubercles are similar, but are in single series on the fifth interstice; the fifth ventral segment has a rather narrow median channel, bordered on either side by a small tubercle, situated posterior to the middle; the intermediate tibiæ are slightly emarginate but not deeply notched above the apex;

the anterior tarsi are simple. *Dimensions:* ♂, 19 × 7; prothorax 5 × 6; elytra 10 × 7 mm.

Hab.—South Australia.

The species presents considerable variation in size, and in the number and position of the elytral tubercles. On the third interstice, the tubercles are sometimes fairly closely set, and sometimes rather widely separated and fewer in number; the two sides of the elytra sometimes differ in this respect. *S. nodulosus* and *S. divaricatus* have already been sunk as synonyms by Mr. Lea, and I can see nothing in the types to warrant their separation.

SCLERORINUS WATERHOUSEI Macl.

Macleay, *loc. cit.*, p.251; *S. interioris* Macl., *loc. cit.*, p.252; Lea, *loc. cit.*, p.112.

♂. Large, elongate, relatively broad, subparallel. Black; densely clothed with brownish subpubescence, the tubercles nitid, not clothed; ventral maculæ small.

Head and rostrum as in *S. Adelaidæ*. Prothorax (5 × 6·25mm.) widest in front of middle, much as in *S. Adelaidæ*, tubercles, if anything, slightly larger, less elongate, with larger ones along the subapical impression. Elytra (12 × 7 mm.) broad, apex not produced, base deeply emarginate, humeri prominent; seriate punctures small, open, intrastrial granules rather more prominent; tubercles larger, the apical and lateral ones more conical; second with four; third with a subcontinuous row of eleven from base almost to apex; fourth with none; fifth with a continuous row of sixteen, slightly smaller, closely placed, almost imbricate, conical tubercles; sixth with a continuous row of eleven, slightly larger than on the fifth, conical, outwardly directed. Apical ventral channel rather narrow, in type obscured by dirt. Intermediate tibiæ slightly emarginate; anterior tarsi simple.

♀. Larger, more ovate, the apex more produced. Prothorax (6 × 7 mm.) with tubercles larger than in *S. Adelaidæ*, elongate near middle, rounded towards the sides. Elytra (14 × 9 mm.) broad, apex moderately produced; tubercles noticeably larger than in *S. Adelaidæ*, tubercle-index 2-3, 9-12, 0, 17, 15. Apical ventral segment with a feeble linear impression. *Dimensions:* ♂ 19 × 7; ♀ 22 × 9 mm.

Hab.—South Australia. Type in Macleay Museum.

There are two specimens, sexes, under this label in the Macleay Museum, but the female appears to have been the actual type. Apart from the larger size in the female, and the larger, more conical, elytral tubercles, I can find nothing to separate this species from *S. Adelaidæ*. It is convenient, however, to retain this name for the larger form, though I much doubt if the species are really distinct. *S. interioris* is certainly conspecific, as has already been pointed out by Mr. Lea.

SCLERORINUS VITTATUS Macl.

Macleay, *loc. cit.*, p.249; *S. rugicollis* Macl., *loc. cit.*, p.250; *S. Angasi* Macl., *loc. cit.*, p.253; *S. conspersus* Macl., *loc. cit.*, p.250; *S. fuscus* Macl., *loc. cit.*, p.253; (?)*S. confusus* Macl., *loc. cit.*, p.251.

♂. Type, *S. vittatus* Macl.—Elongate subparallel, comparatively broad. Densely clothed with brown, trivittate and variegate with white, vittæ distinct on prothorax, on elytra forming a broad sublateral vitta, third interstice feebly maculate with white; setæ dark.

Head continuous with rostrum, external ridges subparallel, median carina distinct, extending up head, sublateral sulci shallow, foveiform at base. Prothorax (5 × 6 mm.) widest in front of middle, ocular lobes prominent; subapical constriction indefinite except at sides, median line marked by vitta hardly impressed; disc with tubercles distinct, somewhat depressed, elongate, irregular, at sides more rounded. Elytra (12 × 7 mm.) little dilatate, almost parallel-sided to before declivity, base arcuate, humeri marked. Disc with regular rows of small foveiform punctures, the intervening ridges setigerous, hardly granulate; tubercles small, subconical, larger nearer declivity, and more, though not greatly prominent, partially concealed by clothing; tubercular index 2, 14, 0, 23, 15; on third interstice, more or less continuous, becoming progressively larger posteriorly; on fifth and sixth, much smaller and with serrate appearance. Fifth segment with median channel, tubercles moderately close to apex.

Type ♀.—More robust than ♂, the prothorax (5 × 6·5 mm.) with tubercles rather larger and more conspicuous; elytra (12 × 8 mm.) with apex more produced, mucroniform, tubercles more separate on third interstice, tubercular index 5, 10, 0, 17, 15; beneath, convex, fifth segment feebly impressed longitudinally, and with a small, irregular, transverse fovea at apex. *Dimensions:* ♂ 18·5 × 7 ; ♀ 20 × 8 mm.

Hab. – S. Australia. Types in Macleay Museum.

The above description has been drawn up from the types, but many of the details of structure are liable to great variation; indeed it is hard to find two specimens agreeing in all particulars. I believe that Macleay was led into making too many species by not taking this variability sufficiently into account. I have examined the types of the other species I would refer to *S. vittatus*, and have noted same points of divergence from the types of this species.

S. rugicollis, type ♀.—Agrees in general appearance and structure with type ♀ of *S. vittatus*, but has the tubercles on the elytra rather more prominent, especially on the fifth and sixth interstices; tubercle-index 2, 8, 0, 17-14, 12. *Dimensions:* P., 5 × 6·5; E., 11 × 8·5; 20 × 8·5 mm.

S. Angasi Macl.—Two female specimens, evidently of one species, under the name-label in the Macleay Museum. Of the same form as *S. vittatus*, but with the tubercles rather less prominent and fewer in number, variable in shape and number in the two specimens.

Very close to *S. conspersus*, and possible females of that form, if it can be considered distinct from *S. vittatus*. Tubercle-index, A, 2, 8, 0, 13, 10; B, 4, 8, 0, 14, 10.

S. conspersus Macl., type ♂.—As there is some difference in general facies between the species and the type ♂ of *S. vittatus*, I have thought it wiser to give a fuller description of the type-specimen.

♂. Smaller than *S. vittatus*, type ♂, elongate-ovate, not subparallel on sides Clothing similar, the vittæ well marked, also the interrupted maculæ on the third interstice. Head and rostrum as in *S. vittatus*. Prothorax (4·5 × 5·5 mm.) widest before middle, ocular lobes prominent; subapical constriction fairly definite, median line hardly impressed; set with small, separate, distinct though slightly depressed tubercles, somewhat irregular in size and distribution. Elytra (10 x 6·5 mm.) gently and evenly widened from base to behind middle, thence more rapidly rounded off to apex; base, humeri, seriate punctures as in *S. vittatus*; interstices tuberculate, on second and third small, subconical, projecting backwards, degree of conicity increasing from before backwards, on second tubercles extending half-way down declivity, on third forming a row of separate tubercles from base to apex; fifth and sixth interstices each with a continuous row of smaller tubercles, having somewhat a serrate appearance; tubercle-index 3-4, 9-10, 0, 16, 11. Beneath, as in *S. vittatus*. *Dimensions:* ♂, 16·5 x 6·5 mm,

Apart from size, and variation in the number of the elytral tubercles, the main differences seem to be—(*a*) a slight difference in shape, (*b*) prothoracic tubercles more rounded than elongate, (*c*) slightly smaller elytral tubercles. None of these differences seem to me as of specific value.

The confusion one feels, when comparing the types, is not allayed but rather intensified by the examination of a series of specimens. Among a number of Amycterides sent for examination from the South Australian Museum, are several specimens I would refer to this species. Among them, I note the following forms.

1. Specimens agreeing with type of *S. vittatus*; males without exact locality-label.

2. Specimens labelled Grange, S. Aust., in shape and general appearance agreeing with *S. conspersus*, but with decidedly larger elytral tubercles, and less distinct prothoracic ones.

3. Specimens from Androssan, S. Aust. An extensive series of both sexes. The males are close to *S. vittatus* (typical) but smaller, with the tubercles on the third interstice more separate. The females are larger, and correspond to *S. vittatus* ♀, but show considerable variation, *inter se*, in the elytral tubercles. The colour of the setæ, though generally dark, is, in one or two specimens, light brown or yellow, showing an approach to *S. confusus*.

The two following species I would also refer to *S. vittatus*, though with somewhat more doubt.

S. fuscus Macl.—The type is a male, and is somewhat shorter than *S. vittatus*, and uniformly clothed with dingy brown; the tubercles are slightly smaller, round, not conical, forming a continuous row on the third interstice.

S. confusus Macl.—The type is a partially abraded female, with rather smaller tubercles than usual, set at intervals on the third interstice. The setæ are light-coloured.

SCLERORINUS IRREGULARIS Macl.

Macleay, *loc. cit.*, p.263.

♂. Elongate-ovate; moderately large. Black; without clothing, except a feeble macule in the centre of the third and fourth ventral segments; setæ yellowish.

Head convex, flattened in front, running on into rostrum; rostral ridges extending on to head. Rostrum wide; the external ridges slightly sinuate; median carina narrow, prominent; sublateral sulci broad, shallow, with a deeper fovea at base; a small puncture present in the middle line at junction of head and rostrum. Prothorax (4 × 5 mm.) moderately dilatate, with a well marked subapical impression; closely set with rather large tubercles, elongate near middle, more rounded towards sides; sides with granules obsolescent. Elytra (11 × 7 mm.) moderately broad, gradually widened posteriorly; base gently emarginate, humeral angle with a small rounded tubercle; seriate punctures evident, small, open, each subtended by a small granule; interstices tuberculate, tubercles small, rounded, conical posteriorly; second interstice with five tubercles, extending on to declivity; third with eight, at varying distances from base down on to declivity; fourth with three or four about the middle; fifth with a continuous row of seventeen to twenty, rather closely set, rounded, rather smaller than on third interstice; sixth with a continuous row of ten or eleven, outwardly and backwardly projecting. Apical ventral segment with a rather broad median channel, bordered on each side by a small tubercle, the channel somewhat transverse beyond the tubercles. *Dimensions:* ♂, 17 × 7 mm.

Hab.—South Australia. Type in Australian Museum.

Although I have described the type in some detail, I am by no means certain that it is a valid species. The specimen strongly suggests an abraded form of *S. vittatus*, with the tubercles on the third interstice situated at intervals. The lack of clothing is so complete, that it is hard to believe the specimen could have been artificially abraded. The light-coloured setæ are also a point of distinction. Unfortunately, I have not been able to compare *S. irregularis* with *S. confusus*, as the types are in different collections. From my recollections of *S. confusus*, the type of *S. irregularis* appeared a rougher insect, with more evident, intrastrial granules and somewhat larger tubercles.

Sclerorinus oblongatus, n.sp.

♂. Size moderate, elongate, suboblongate. Black; densely clothed with dark brown subpubescence; head and prothorax trivittate with greyish, the median vitta divided into two on the head and rostrum; elytra with a broad vitta along each side of disc, subdivided by the fifth interstice, and with whitish maculæ forming a row along each side internal to the third interstice; sides with scattered whitish subpubescence most marked along lower border; undersurface with similar clothing at sides of segments; legs with intermingled white and yellowish subpubescence along upper and outer surfaces; setæ dark.

Head and rostrum very gently convex above in profile; forehead with a median, lævigate, subcarinate line. Rostrum little excavate above; external ridges parallel; median carina prominent, narrow; sublateral sulci broad, shallow, with deeper basal foveæ. Prothorax (4·5 x 5 mm.) moderately rounded on the sides; apical margin gently sinuate above, with prominent ocular lobes; disc with a moderately definite subapical impression, and a longitudinal median impression; set with small, subobsolete, flattened granules, for the most part elongate, more rounded at the sides; sides with granules becoming obsolete towards the coxæ. Elytra (10 x 6 mm.) elongate, little widened posteriorly; apex strongly rounded; base trisinuate-emarginate, the humeral angles somewhat advanced, prominent, not tuberculiform; seriate punctures small, shallow, the intrastrial granules distinct, the whole confused and somewhat asperate; interstices with small, granuliform tubercles; second interstice with a few, small, isolated tubercles, little conspicuous, not extending to base, one or two present on the declivity; third interstice raised, in type, basal half costiform, with small, elongate, subobsolete granules, set in an irregular, double series, apical portion with more isolated, single tubercles; fourth with small, isolated, granuliform tubercles, hardly distinct from the intrastrial granules; fifth somewhat raised, with a single row of closely-set, rounded, granuliform tubercles; sixth with a similar row, not reaching base; sides with tubercles almost obliterated, separated by impressions, giving sides a rather feeble, vertically-rugulose appearance. Undersurface gently concave over metasternum and basal segment; fifth segment with a rather narrow, deep, median channel, leading into a transverse apical depression, the median channel bordered on either side by a small tubercle. Anterior femora not ridged beneath; tibiæ not notched; anterior tarsi symmetrical.

♀. More ovate, more produced at apex, each elytron separately mucronate; undersurface convex, fifth segment with apical margin not strongly bisinuate, with a median linear impression. *Dimensions:* ♂, 16 × 6 mm.; ♀, 15 × 6·5 mm.

Hab.—Victoria, Nelson (Blackburn). Type in South Australian Museum.

In general appearance, this species resembles more the *tristis*- than the *Adelaidæ*-portion of the group; to the latter, however, the simple tarsi will ally it. From most of its immediate allies, the small granuliform tubercles will separate it. The species doubtfully identified as *S. obliteratus*, from Mt. Buffalo, agrees with the present species in the small, granuliform tubercles; but there are numerous small differences, among others, the intrastrial granules are less distinct; the females also are very different.

In the type, the tubercles at the base of the third interstice are more or less coalescent, forming a costa; in other examples, however, the tubercles are more distinct, and this portion of the interstice could not be termed costiform.

The female is very similar in appearance to *S. acuminatus*, having a similar, apical, ventral segment; the elytra, however, are more granulose, and the males are certainly distinct, provided I am right in regarding *S. acuminatus* as the female of *S. sordidus*.

SCLERORINUS TRISTIS Boisd.

Amycterus tristis Boisd., Voy. de l'Astrolabe, ii., 1835, p.388, t.7, f.12; *S. tristis* Macl., *loc. cit.*, p.259; *S. Howitti* Macl., *loc. cit*, p.257; *S. asper* Macl., *loc. cit.*, p.254; Lea, Trans. Roy. Soc. S. Aust., 1903, p.112.

♂. Elongate, subparallel. Black; more or less densely clothed with brownish pubescence, prothorax more or less evidently trivittate with grey, ventral segments feebly maculate in middle.

Head and rostrum in the same plane above; lateral ridges traceable, but hardly raised, along head; median line lævigate, but not carinate. Rostrum little excavate; external ridges parallel; median carina narrow, strongly raised, separated from head by a punctiform depression; sublateral sulci shallow, deeper at base, moderately broad. Scape rather short, moderately strongly incrassate. Prothorax (4 x 5 mm.) rather widely dilatate, strongly rounded on the sides; apical margin sinuate above, ocular lobes strong; subapical transverse impression, and median impressed line moderately distinct; set with obsolescent, elongate granules, frequently confluent to form irregular ridges, setigerous, the setæ arising from the posterior end, granules most distinct towards the middle, almost completely obsolete laterally; sides with a few obsolete, rounded, granules above. Elytra (9·5 x 5 mm.) little widened on the sides; base gently emarginate, humeri not produced, subrectangular. Disc with sculpture much confused, the punctures moderately distinct, but irregularly arranged, the intervening ridges moderately prominent, often confluent across the interstices; interstices not raised, tuberculate; tubercles low, elongate towards the base, more raised, and more rounded, posteriorly, but hardly subconical, generally more or less separated, sometimes confluent at base of third or fifth interstices; fifth interstice generally with tubercles separated, sometimes forming a subcontinuous row; in other specimens, almost obsolete. Apical segment with the median channel rather shallow, bounded on either side, posteriorly, by a small tubercle. Anterior tarsi with the third, and to a less extent the second, joint asymmetrically dilatate internally, spongiose beneath.

♀. Elongate-ovate. Head, rostrum, and prothorax as in the male, except that the prothorax is slightly less dilatate. Elytra more strongly rounded on the sides, base moderately and gently emarginate; each elytron much produced at apex, and separately mucronate; sculpture much as described in the male. Undersurface convex; apical segment with a shallow median impression, deepened posteriorly, the borders here raised into a short tubercle; apical margin not bisinuate. *Dimensions:* ♂, 14 x 5; ♀, 15 x 6 mm.

Hab.—Tasmania; Victoria; South Australia.

After careful examination of many specimens, I have come to the conclusion that *S. Howitti* Macl., and *S. asper* Macl., cannot be separated from *S. tristis* Boisd. I am inclined to think that two species are included under *S. asper*, the male approaching closely to *S. sordidus*, while the female is certainly the same as *S. tristis*. The males of *S. tristis* and *S. sordidus* are very similar, but the two species are readily separable by the females. As the females are sometimes more easy to determine than the males, the following short table of the females of the allied species may be of service:—

A. Apical ventral segment tuberculate............................*S. tristis* Boisd.
AA. Apical segment not tuberculate.
  B. Apical margin not strongly bisinuate......................*S. sordidus* Macl.
  BB. Apical margin strongly bisinuate.....................*S. obliteratus* Macl.; *S. inornatus* Ferg.

Sclerorinus obliteratus Macl.

Macleay, *loc. cit.*, p.255.

♀. Elongate-ovate, rather strongly produced at apex. Black; clothed rather densely with dingy brown subpubescence; setæ dark.

Rostrum hardly excavate; the median carina narrow, raised, running on to head; lateral ridges subparallel; sublateral sulci broad, slightly depressed at base only. Head and rostrum in the same plane above. Prothorax (4 x 5·5 mm.) subtruncate above, with moderately prominent ocular lobes; disc with elongate, semi-obliterated granules, irregularly arranged in longitudinal lines, the setæ arising from the posterior end of each granule. Elytra (12 x 7·5 mm.) gently narrowed to apex, which is much produced and bimucronate; seriate punctures small, obscured by clothing, set in irregular wavy lines, subtended by small granules. Interstices with small tubercles or granules, elongate, narrow, forming rather obsolete costæ at base; beyond the middle, the tubercles small, rounded, isolated; fourth with one or two only, about middle; sixth with tubercles closer, giving interstice a serrate appearance. Beneath, gently convex; the apical segment somewhat flattened, with a faint, median, impresssd line, deeper at extreme apex, the apical margin, as viewed on edge, strongly bisinuate. *Dimensions:* ♀, 18 x 7·5 mm.

Hab.—Victoria.

The above description was drawn up from the type in the Macleay Museum. Though in general appearance close to *S. tristis*, I have no doubt that it is distinct on account of the difference in the ventral apical segment in the female. In *S. tristis*, this shows a small tubercle on either side of the median impression near the apex; in *S. obliteratus*, these are not present; moreover, in *S. tristis*, the apical margin is straight, not strongly bisinuate as in *S. obliteratus* Macl.

Unfortunately, I have never been able to obtain a pair, of which the female was absolutely identical with *S. obliteratus*. Two species approach it closely, however; one is *S. inornatus*, which has an even more obliterate sculpture; the other is from the Victorian Alps, and is more strongly sculptured, but is variable in this respect. Provisionally, I would regard this latter species as *S. obliteratus*. The male may be readily distinguished from *S. tristis*, *S. sordidus*, and *S. inornatus* by the anterior tarsal joints, not asymmetrically dilatate on the inner side.

SCLERORINUS SORDIDUS Macl.

Macleay, *loc. cit.*, p.254; *S. acuminatus* Macl., *loc. cit.*, p.255

♂. Size moderate; elongate, subparallel. Black; rather sparsely clothed with minute, depressed subpubescence; setæ black.

Head and rostrum much as in *S. tristis*; the antennal scape rather longer. Prothorax (4 × 5 mm.) widest in front of middle; subapical impression rather indefinite, median line not impressed; rather closely set with small granules elongate in the middle, rounded at the sides, little prominent, but less obliterated than in the female. Elytra (10 × 6 mm.) elongate, subparallel, base rather feebly emarginate, humeri subrectangular; seriate punctures small, in tortuous rows deflected by the tubercles; intrastrial ridges small, hardly granulate, setigerous; interstices tuberculate: sutural slightly raised, feebly granulate, more strongly granulate on declivity; second with two isolated tubercles; third with two or three conjoined, at base, and five isolated tubercles, the interstice very feebly raised between the tubercles; fourth with a single tubercle; fifth with ten or eleven, the basal eight small, subcontinuous, from humeral angle to about middle, followed by three larger tubercles, set farther apart; sixth with a continuous row of thirteen, small, slightly elongate tubercles, little prominent, not conical, nor outward projecting, their apices directed backwards. Sides with interstices obsoletely granulate. Apical ventral segment with a narrow median channel, a small tubercle on either side. Anterior tarsi with second and third joints asymmetrically dilatate on the inner side, the third the larger, and spongiose beneath.

♀. (*S. acuminatus*, type).—Head and rostrum similar; pro thorax (4 × 5 mm.) with granules almost obsolete, forming slightly raised ridges arranged in longitudinal wavy lines. Elytra (10 × 6·5 mm.) with apex rather less strongly produced than in *S. obliteratus*, bimucronate; punctures similar, tubercles small, slightly elongate, not costiform at base; fifth interstice with a row of small, almost minute, tubercles, moderately closely set. Apex of abdomen in type retracted and not visible. *Dimensions:* ♂, 17 × 6; ♀, 16 × 6·5 mm.

Hab.—South Australia. Types in the Macleay Museum.

This is not the species recorded by me as *S. sordidus* Macl., in the Trans. Roy. Soc. South Australia, 1914, p.18, but is the same as *S. acuminatus* Macl. My previous error was due to overlooking the tarsal structure, which at once separates *S. sordidus* from the previously identified species, which I tentatively regard as a variety of *S. vittatus*. The male is close to *S. tristis*, but has a less asperate structure; the female is distinguished by the non-tuberculate apical ventral segment, the apical margin of which is not bisinuate.

SCLERORINUS SPENCEI Bohem.

Bohemann, Schönh., Gen. Curc., vii.(1), 1843, p.64.

The description of this species shows clearly that it is a Sclerorinus, and also a member of Section i. It is evidently very closely allied to, if not identical with, *S. obliteratus* Macl. The apical abdominal segment is described in the following words—"segmento ultimo abdominis apice utrinque emarginato, supra foveola rotunda insculpto." The first part would fit *S. obliteratus*, *S. inornatus*, and *S. carinatus*; the latter part, however, is not an accurate description of any of these species. In *S. obliteratus* and *S. inornatus*, there is a longitudinal impression leading into a more or less rounded depression at the extreme apex. The following details of description fit *S. obliteratus* with more or less exactitude—"Thorax , . . . tuberculis et rugulis subremotis, parum elevatis obsitus . . . . Elytra . . . . apice dehiscentia, singulatim breviter mucronata, . . . obsolete striato-punctata, ... sutura interstitiisque 2, 4 et 6 magis elevatis, tuberculis parvis, remotis, subconicis, seriatim obsitis, ..."

The description of the eyes as "parvi, subrotundati," and of the rostrum as ". . . . supra utrinque profunde lateque longitudinaliter impressum . . . ," however, is hardly an accurate description of these structures in *S. obliteratus*. At the same time, the description, as a whole, fits *S. obliteratus* Macl., much more closely than any other species known to me.

Among some Amycterides sent to Mr. Lea, some years ago, for examination, from the British Museum, were two males of a species I identified at the time (and I believe correctly), as *S.*

irregularis Macl. One of the two specimens bore three names—*elongatus*, *lachrymosus*, and *Spencei*—and was also marked "compared with type", which type was not indicated. There was also a note, which I attributed to Pascoe (I do not now remember on what authority)—"Judging from notes, this should be the ♂ of insect named *Spencei* in Hope's Collection—my *lachrymosus* var." I have not now a female of *S. irregularis* available for comparison with the description of *S. Spencei*, but do not think it at all likely that the two species are identical. *S. elongatus* is certainly distinct from *S. Spencei* and *S. irregularis*, and belongs to Section ii.

Sclerorinus Mastersi Macl.

Macleay, *op. cit.*, 1866, p.323.

♀. Large, robust, elongate-ovate. Clothing moderately dense, yellow, variegate with white, prothorax trivittate, a triangular brown patch present on each side of middle of head; beneath, feebly maculate with cinereous at sides and in the centre of each segment, apical segment more uniformly clothed.

Head separated from rostrum by a moderately well defined transverse impression; centre of forehead subcarinate, lightly impressed on either side, external ridges not carinate on head. Rostrum as wide as head, external ridges subparallel; median carina conspicuous, rather broad, a small fovea present at junction with head; sublateral sulci rather deep at base, becoming shallower anteriorly. Eyes subovate. Prothorax (6 x 7·5mm.) widest in front of middle, not greatly ampliate; ocular lobes well defined; disc with feeble median and sublateral impressions; set with isolated, rather small, somewhat depressed, briefly elongate granules; sides with granules smaller and rounded, extending almost to coxæ. Elytra (15 x 10 mm.) subparallel on sides to beyond, thence rather strongly narrowed to apex, each elytron separately produced at apex, mucroniform, dehiscent; base evenly and gently marginate, humeri noduliform, not greatly produced. Disc with rows of small, rather shallow, but moderately well defined punctures, each subtended by a fine setigerous granule. Interstices feebly raised, with small elongate tubercles;

sutural thickened and out-turned, subgranulate at base; second with four; third with about ten, elongate tubercles from base to middle, more separate and feebly conical posteriorly to middle; fourth with one or two; fifth and sixth each with a row of small rounded tubercles, placed fairly close together, but not contiguous, about twenty in each row. Sides with tubercles hardly raised above general surface. Beneath gently convex; fifth segment with a shallow, median, linear impression from base to apex, widening out into a shallow, ill-defined depression at apex. *Dimensions:* ♀, 25 x 10 mm.

Hab.—South Australia.

Described from one of two female specimens in the Australian Museum. It is hard to be certain if either of these specimens is the type, and not the Macleay Museum specimens. There is a male in the Macleay Museum labelled *S. Mastersi*, and evidently conspecific; it has the intermediate tibiæ notched.

SCLERORINUS DIMIDIATUS Macl.

Macleay, *loc. cit.*, p.324.

♂. Elongate, subparallel. Black; clothing sparse, yellowish, head with two brownish patches separating the supraorbital and median vittæ, median vitta divided into two, and extending on to the sublateral rostral sulci; ventral segments with a median golden macule, and a lighter lateral one.

Rostrum rather narrow across the dorsum; median carina prominent, rather broad; sublateral sulci narrow, extending back, somewhat, on to head. Head not separated from rostrum above, with three lævigate lines continuous with the rostral carinæ, a small fovea present in middle line at junction with rostrum. Prothorax (4·5 x 5·5 mm.) with apical margin feebly rounded, almost truncate above, and with rather prominent ocular lobes; median line not impressed; moderately closely set with rounded, somewhat depressed, granules, somewhat variable in size. Sides sparingly granulate. Elytra (11·5 x 6·5 mm.) long, almost parallel-sided; base slightly emarginate, humeral angles not produced; with striæ of very shallow foveiform punctures; first interstice subcostate, little prominent, tending to split up into granules; second almost obsolete, with one or two small elongate tubercles; third prominent, subcostate to declivity, the costa consisting of a contiguous row of elongate tubercles, with two or three subconical tubercles on the declivity; fourth obsolete; fifth and sixth each with a continuous row of small tubercles placed close together, giving interstices a costiform appearance, less elongate and more conical posteriorly. Apical ventral segment with a shallow, median, longitudinal channel. Anterior femora with a feeble scar beneath; intermediate tibiæ notched at apex. *Dimensions:* ♂, 18 × 6·5 mm.

Hab.—South Australia, Flinders Range. Type in Australian Museum.

Though closely allied to *S. regularis* and *S. neglectus*, this species can be distinguished by its round, prothoracic granules, in conjunction with the costiform interstices, and deeper punctures.

SCLERORINUS CARTERI, n.sp.

♂. Size moderate; elongate, subparallel. Black, elytral tubercles reddish, legs piceous. Rather sparsely clothed with minute, light brown or greyish, subsquamosity; a narrow creamy vitta along the lower edge of elytra; undersurface almost without clothing, ventral segments feebly maculate in middle. Setæ black, rather long.

Head and rostrum in same plane above; head rather densely clothed except along three bare lines, these continuous with the rostral carinæ, but not definitely raised. Rostrum with external ridges setigero-punctate, slightly thickened at base; median carina prominent, as broad as the external ridges, not setigerous; sublateral sulci rather narrow, deep at base, becoming shallow anteriorly. Prothorax (4 × 5 mm.) moderately strongly rounded on sides, widest in front of middle; ocular lobes prominent; subapical impression moderately distinct, median impression well marked posteriorly; disc closely set with small setigerous granules, obsolescent and slightly confluent towards the centre, more distinct and rounded laterally; sides granulate. Elytra (10 × 5·5 mm.) elongate, narrow, little widened posteriorly; base gently emarginate, the humeral angles marked, not greatly produced; seriate punctures small, moderately deep, somewhat irregularly set, the intrastrial granules moderately distinct. Interstices with small reddish tubercles, the basal ones slightly elongate, the apical ones conical; sutural interstice slightly raised, not tuberculate; second interstice with about four, widely spaced, from middle to near apex; third with a row of eight to ten, widely spaced, rather closer together anteriorly, extending from base nearly to apex; fourth without tubercles; fifth with a more closely set row, extending from humeral angle down declivity, thirteen on one side, and sixteen on the other in the type; sixth with a similar row of about eleven. Sides with tubercles subobsolete. Moderately closely setigero-punctate beneath; basal segments flattened in the middle; fifth with a moderately deep median channel, not reaching apex, bordered, on either side, by a small tubercle, situated posteriorly to middle. Anterior femora not ridged beneath; intermediate tibiæ with a strong subapical notch. Anterior tarsi with third joint spongiose beneath, broader than first joint, the inner half broader than the outer; other tarsi not spongiose.

♀. More ovate, more produced at apex, each elytron separately, bluntly acuminate; undersurface convex, fifth segment feebly, longitudinally impressed; tibiæ much more feebly notched, tarsi simple. *Dimensions:* ♂, 16 × 5·5; ♀, 17 × 6·5 mm.

Hab.—Western Australia, Bridgetown (H. J. Carter). Type in Coll. Ferguson.

Closely allied to *S. neglectus*, this species may be distinguished by the smaller, more reddish elytral tubercles, and by the more distinct intrastrial granules. The asymmetry of the third anterior tarsal joint, though distinct, is less evident, in this subgroup, than in *S. tristis* and its allies. *S. Carteri* is the first species of Section i. to be described from the far west of the continent.

Other species belonging to Group i.

Under this and similar headings in each group, I propose to list those species recently described, of which recognisable descriptions are extant, and which are not separately noted elsewhere. The species are listed here in order to record their habitats; reference to the descriptions will be found in the introductory portion of this paper, under the describer's name.

S. neglectus Ferg.—South Australia, Port Lincoln.

S. regularis Ferg.—South Australia, Gawler Ranges.

S. carinatus Boisd.—New South Wales, Bombala. I think it probable that Boisduval's name will eventually be sunk as a synonym of *S. nigrospinosus* Don.

S. albovittatus Ferg.—Western Australia, Eucla. This species, though not included in the table of the Group, I regard, with some doubt, as a member of Section i. It might, perhaps, be better placed at the end of the genus, as an aberrant species.

ORDINARY MONTHLY MEETING.

November 24th, 1915.

Mr. A. G. Hamilton, President, in the Chair.

Candidates for Fellowships, 1916-17, were reminded that Tuesday, 30th inst., was the last day for receiving applications.

The Donations and Exchanges received since the previous Monthly Meeting (27th October, 1915), amounting to 5 Vols., 32 Parts or Nos., 4 Bulletins, 8 Reports, and 3 Pamphlets, received from 32 Societies, etc., and two private donors, were laid upon the table.

NOTES AND EXHIBITS.

Mr. Fred Turner exhibited, and offered observations on, a number of beautiful flowering West Australian plants collected by Mrs. Alice E. Stephens, who forwarded them to him for botanical identification. Mrs. Stephens, who now resides in the western State, is a daughter of the late Honorable Dr. James Norton, M.L.C., who was for many years connected with this Society as Honorary Treasurer and President. Like her late father, Mrs. Stephens is a great lover of the indigenous flora, and her paintings of native and exotic plants, and other subjects, have often been exhibited in Sydney, and have been most favourably commented upon by connoisseurs and in the public press. The botanical names of the plants exhibited were:—*Actinotus leucocephalus* Benth.; *Calythrix gracilis* Benth.; *Cyanostegia angustifolia* Turcz.; *Dampiera eriocephala* De Vr., (Mrs. Stephens has found an albino of this species); *Dampiera eriocephala* De Vr., var. *concolor*; *Dampiera lavandulacea* Lindl.; *Pityrodia bartlingii* Benth.; *Pityrodia racemosa* Benth.: *Verticordia monadelpha* Turcz.; *Verticordia picta* Endl.

Mr. Froggatt showed—A collection of insects secured by Mr. Surveyor S. R. Dobbie on Womberal beach, a sample of large quantities to be found along high water-mark, after the recent high off-shore winds, which carried great numbers of insects out to sea.—A fine series illustrating the life-history of a longicorn-beetle (*Phoracantha recurva*), together with parasites (four species of Braconid wasps, one Chalcid, and one Clerid) which prey on the larvæ, obtained from the bark of fallen logs of Peppermint Gums at Uralla, N.S.W., 1914-15.—Examples of a small *Cordyceps* on a little lamellicorn-beetle, found under logs at Uralla.

Mr. A. A. Hamilton exhibited specimens from the National Herbarium including—*Rosa* Hort.var., (E. W. Mitchell; Wagga; August, 1915), showing, in various stages, petalody, phyllody, and prolification. First stage: the calyx and carpels are frondescent, the latter being represented by elongated, plumose leaves. Second stage: the carpellary frondescent leaves have become more attenuated, the petals exhibit a degree of virescence, and the stamens are adherent to them. Third stage: four of the calyx-lobes are frondescent, the fifth showing petalody; axial elongation has occurred, and the flower shows prolification, several partially coherent buds, consisting chiefly of leaves, being present. Fourth stage: the axis of the shoot is further prolonged, and shows bundled fasciation; three distinct, coherent stems, each surmounted by a bud, the buds also coherent, and two buds on separate peduncles, arise from the centre of the primary flower; the ovary of the latter is undeveloped, and two flowers, represented by slightly petaloid calyces, are adherent to its axis. —*Lycopersicum esculentum* Mill., a cultivated "Tomato," var. "Earliana" (W. A. Birmingham; October, 1915), showing chloranthy. A series of calyces form an almost symmetrical involucre (similar to that of a Composite), ruptured only in a small portion where the calyx-lobes have intruded, and disturbed the axillary arrangement of the frondescent floral organs; the latter are all narrowed, elongated, and have developed a degree of curvature. A number of united pistils are to be noted, the styles dilated upwards, and the unity continued. [Mr. Birmingham notes this as the first flower formed; the succeeding ones did not exhibit any abnormality. The plants were grown in an open, sunny situation, and artificial fertiliser only was used as a stimulant]. The general appearance of the inflorescence points to insect-attack.—*Epacris crassifolia* R.Br., showing variation in habit and leaf-characters, due to environmental conditions. Bentham (Fl. Aust., iv., p.237) mentions two forms of this species; one from Port Jackson, near the sea (with large leaves and flowers), and the other from the Blue Mountains (with small leaves and flowers). Examples of both these forms were exhibited, the mountain-form from Wentworth Falls (W. Forsyth; October, 1897), growing in the crevices of dripping rocks, and the other form (near the sea) from Cowan Bay (A. A. Hamilton; November, 1896). In each case, the character of (comparatively) large or small leaves is maintained. Examples were also shown of a form growing on the more or less dry cliffs at Newnes Junction (November, 1914), and Bell (A. A. Hamilton; January, 1915), which have become coarse and twiggy, and are gradually assuming an erect habit; and a further stage is reached by plants growing in the ground at the base of the cliffs (A. A. Hamilton; Eskbank; January, 1915), which have become upright shrubs of 1-1½ feet. The examples from Bell and Eskbank approach forms of *E. obtusifolia* Sm., from the Blue Mountains, which have also had their habit and foliage altered by external conditions. *E. obtusifolia* Sm., is, normally, a swamp-dweller, where it is an erect shrub of 1 foot, to (in the Botany Swamps) 3 feet high; but in this case, one of the examples (A. A. Hamilton; Lawson; January, 1915) was growing in the crevices of rocks in a shady railway-cutting; and the other (A. A. Hamilton; Wentworth Falls; January, 1915) on the dry fringe of the swamp. The variations in habit and foliage shown in *E. crassifolia* are similar to those in *E. reclinata* A. Cunn., (noted in These Proceedings, 1914, p.453), brought about by similar environmental conditions. —*Kennedya rubicunda* Vent., (A. A. Hamilton; Cook's River; November, 1913), showing leaf-variation. The leaflets range from rotundate to oblong-lanceolate, with apices from acute to rotundate, the base of some of the narrower forms abruptly broadened, the petiole of the upper leaflet varying from ¼ to 1 inch long.—*Cassinia longifolia* R.Br., three forms from Blue Mountain localities (Coll. A. A. Hamilton). An example from Woodford has leaves 1½ inches long; others, from Lawson, range to above 3 inches long, and are narrow linear, ½ to 1 line broad; and a Mount Victoria specimen has leaves 4 inches long, and 3 lines broad.

Mr. E. Cheel exhibited a fine series of specimens, including seedlings and living plants, of seven species or varieties of *Hardenbergia*.—*H. monophylla* Benth., Burwood (September, 1914). This is the most common form in the Port Jackson district. The figure in Bot. Mag., 263, under the name *Glycine bimaculata*, which is said to have been drawn from plants raised from seeds collected in Botany Bay by Banks and Solander, agrees with this form.—*H. monophylla* Benth., var. *longiracemosa* (*Kennedia longiracemosa*, Lodd., Bot. Cab., t.1940; *Kennedya monophylla* var. *longiracemosa*, Bot. Reg., t.1336), Penshurst (September, 1910). This has longer racemes, with flowers of a pale pink colour.—*H. monophylla* Benth., var. *alba*, Unkya, viâ Macleay (S. G. F. Smith; August, 1896: Heathcote; J. L. Boorman; August, 1904). Similar in habit to the above, but with the flowers pure white.—*H. ovata* Benth., Pl. Hügel, p.40 (*Kennedya ovata* Sims, Bot. Mag., 2169). The specimens exhibited were from cultivated plants, which are of an upright habit, with flowers of a rosy-pinkish colour. Seedlings show the same upright habit, and colour of flowers as the parent-plants. There are specimens in the National Herbarium collection from Tenterfield (E. Betche; October, 1886); and Mount Lofty Range, S.A. (Max Koch; September, 1902); which seem to belong to this species.—*H. alba* R. T. Baker, Proc. Linn. Soc. N. S. Wales, 1900, p.659; and 1907, p.711. The specimens exhibited were from Hay (August, 1915); and from cultivated plants. Seedlings show the same upright habit, and white flowers, as the parent-plants. There are specimens in the National Herbarium collection from Bendigo (G. Knight; 1891); and Mount William, Victoria (J. Staer; April, 1911). This is very similar in habit of growth to *H. ovata*, the only apparent difference being in the pure white flowers.—*H.* sp., (probably undescribed). George's River (J. Staer; November, 1910); Macquarie Fields (J. L. Boorman; August, 1914). This is an upright, rigid bush, with purplish flowers similar to those of the trailing *H. monophylla*. Seedlings grown at Hill Top show the same upright habit of the parent-plants, so that it would appear that the characters are constant, and the plants worthy of a name, and *H. erecta* is proposed. —*H. cordata* Lindl., Bot. Reg., t.944. This is included, as a synonym, under *H. monophylla*, by Bentham; but it would appear that the species is distinct, and the name may be restored. It is quite common in the neighbourhood of Hill Top, the specimens agreeing in every way with the description and figure given by Lindley. In the National Herbarium, there are specimens from Tumut, Towrang, Cooma, Bumbery, and Bowan Park, near Cudal, in this State; as well as some from Tasmania and South Australia, which belong to this species, and are easily distinguished from the Port Jackson plants of *H. monophylla.*

Mr. G. A. Waterhouse exhibited a series of butterflies caught recently at Cape Hellas, Gallipoli, by Mr. G. M. Goldfinch, a member of the Society, at present with the First Field Artillery Brigade, Australian Imperial Forces.

CONTRIBUTIONS TO OUR KNOWLEDGE OF SOIL FERTILITY.

No. xiv. The Stimulative Action of Chloroform retained by the Soil.

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

It appears to be a general rule, that substances which act as protoplasmic poisons also behave as stimulants in minute doses. This is the case with animals and man, with higher plants, and even with single cells such as bacteria. Fred (Centrlb. f. Bakt. 2te Abt. xxxi., 185) showed that bacteria growing in dilute bouillon were favourably influenced by the presence of poisonous chemicals such as copper sulphate, ether, carbon bisulphide, potassium bichromate or salvarsan, when in dilutions of from 1-100,000 to 1-1,000,000, according to the kind of microbe.

When a soil is treated with a volatile poison, such as chloroform, and then exposed to the air, the disinfectant is soon dissipated. The effect of the temporary action of the chloroform is shown in an alteration of the soil-constituents, whereby the fertility is increased. Several reasons have been suggested for the change, all depending upon the action of the volatile disinfectant. Some groups of bacteria are destroyed wholly or in part, while others persist, and, under suitable conditions of moisture and temperature, multiply with considerable rapidity. The ammonia-producers are included among the persistent forms. But the soil is altered in some way, for it is able to support a greater bacterial population than formerly.

The hypotheses, that have been advanced to explain the alteration, include that of Russell and the Rothamsted school, who believe that it is brought about by the destruction of the protozoa which normally prey upon the bacteria. Unfortunately for the hypothesis, the addition of the so-called pure cultures of protozoa to soil do not bring about a diminution of the bacteria. I have suggested that the bacteria in raw soils limit themselves by the toxic action of their own products of decomposition. Fred thinks the alteration in treated soils is caused by a stimulation of the bacteria by the disinfectant. That the nature of the surviving bacteria may partly explain the rise in bacterial numbers, was shown by an experiment of Russell and Hutchinson, who found that a soil capable of supporting a definite number of bacteria, could accommodate a further number of foreign bacteria.

One of the undoubted effects of the treatment by volatile disinfectants is, that the soil becomes more nutritive. Russell and others have shown that there is an instantaneous production of a small quantity of ammonia. I have suggested that the nutrients are made more available by the translocation of the agricere or fatty substances of the soil, and have shown that the portions of soil, where the agricere gathers, are less nutritive than the other portions. Buddin noted that a disinfectant, such as pyridine, can be attacked and utilised by bacteria. Hutchinson and MacLennan ascribed the growth of bacteria in soils partially sterilised by lime to the chemical action of the lime upon the organic matter of the soil. A number of writers, Störmer, Heinze, Loew and Aso, consider that the treatment brings about a change in the availability of the nitrogen of the soil.

The action of a volatile disinfectant appears to be similar to the simple drying of the soil, although the effect of the disinfectant is more exaggerated. Buddin writes—"It is possible to trace a certain relationship between the action of all the substances used. The intensity of the effects shades off gradually from that of the powerful non-volatile antiseptics through cresol and formaldehyde to the more and less potent volatile antiseptics respectively, till finally the action of merely spreading out the soil in a thin layer is reached."

While the effect of air-drying rapidly wears off, that of the disinfectant persists for some time. The effect of the increased soil-activity, which is intimately associated with the growth of micro-organisms, does not appear to be due to an alteration of the physical structure, according to Rahn, but to the nutrients going more easily into solution.

The stimulating effect of a volatile disinfectant, such as chloroform, is not only evident in soil, but also on presumably microbe-free, vegetable tissue. For example, the recent work of the Armstrongs shows that many chemicals, including toluene, chloroform, ether, and carbon bisulphide, can bring about an interaction between enzyme and glucoside which does not occur in their absence. The effect is probably caused by an increased permeability of the cell-walls of the tissue by the action of the disinfectant, and the consequent easier migration of the enzyme.

If this applies to a collection of cells, it may also apply to a single cell, such as a microbe, and the action becomes stimulative, as suggested by Fred, and not only may it be stimulative for one bacterial enzyme but for many. Any stimulative action will, however, be restricted to one bacterial cell, and will not influence the progeny of that cell, so that, under the conditions that prevail when a soil is moistened after the removal of the disinfectant, the stimulative action should rapidly disappear. One can imagine an initial but not a prolonged stimulation, such as obtains in treated soils.

It is assumed that all the volatile disinfectant is dissipated when no odour is observable after spreading out the soil to the air, and that none remains in the soil. An appeal to the senses certainly shows that a disinfectant, such as chloroform, has all evaporated. But are we justified in concluding that such is the case? May not some be fixed by the soil-constituents? This question appears to be at the root of the stimulative action of volatile disinfectants, such as chloroform, upon soil, and certain experiments were made to test the validity of the contention.

In testing the persistence of carbon disulphide in treated soil, Moritz and Scherpe* found traces of the decomposition-product, sulphuric acid, up to five months after treatment; while Heinze† found it qualitatively, as carbon disulphide, at the end of a month.

* Centrlbl. f. Bakt., 2te Abt. 12, p. 573. † *Ibid.*, 18, p. 62.

The method of estimating the chloroform, by decomposing it with alcoholic soda and titrating the chloride with silver nitrate, was employed. After a few trials, the following method was adopted. One hundred grams of soil were put into a 300 c.c. flask, and 100 c.c. of methylated spirit containing 5 c.c. of a 10% alcoholic solution of tartaric acid were added. A Young 12-pear, still-head was attached, and the mixture was distilled. Eighty c.c. were generally obtained in from an hour to an hour and a half. The distillate was treated with 5 c.c. of 15% soda (one stick of caustic soda, pure by alcohol, to 100 c.c. of water) and 20 c.c. of water, and boiled under an inverted condenser for 10 minutes. Three or four drops of phenolphthalein were then added, and the alkali neutralised with nitric acid (10% by volume). After cooling, 1 c.c. of 3% chromate of potash was added, and the solution was titrated with silver nitrate, 8·535 grams to 1,000 c.c. (1 c.c. = 2 milligrams of chloroform).

In the trial-tests, 11·9 milligrams of chloroform were decomposed with soda, and titrated with 5·95 c.c. of silver nitrate = 11·9 milligrams of chloroform. One hundred grams of soil, with no chloroform, required at this time 0·1 c.c. of silver nitrate. One hundred grams of soil distilled with alcohol containing 11·9 milligrams of chloroform required 5·9 c.c. silver nitrate = 11·8 milligrams of chloroform. The method is, therefore, fairly accurate.

Experiment i.—A soil containing 8·8% of moisture was treated overnight with 1·5% of chloroform, and, in the morning, the soil was spread out on paper. In an hour, all odour of the disinfectant had disappeared. One hundred grams of soil at this stage gave, upon distillation, 13·9 milligrams of chloroform. After a twenty-four hours' exposure to the air, the moisture fell to 1·6%, and 5·4 milligrams of chloroform were recovered from 100 grams of the soil. After a further 24 hours' exposure to the air, 100 grams of the soil yielded 4·2 milligrams of chloroform.

It is apparent that the bulk of the disinfectant is rapidly volatilised upon exposure to the air, and that a small quantity is held persistently.

Experiment ii.—Six kilograms of soil containing 10·8% of moisture were sifted, and treated with 60 c.c. of chloroform for 24 hours. The soil was aired for 24 hours, and divided into two parts, one of which was put into a jar with a loose cover; the other was put into an open jar, and the moisture brought up to 10%.

The chloroform was estimated from time to time, due allowance being made for the experimental error by testing an untreated soil in the same manner. The error, using different samples of the same, untreated soil, was equivalent to 0·25 c.c. of silver nitrate, and this has been deducted from the results.

	Chloroform detected in milligrams per 100 grams of air-dried soil.	
	Dry soil.	Moist soil.
When stored	2·4	—
Two days after	2·0	1·8
Five days	1·6	1·6
Seven days	1·0	0·8
Fifteen days	0·7	0·7
Twenty-six days	0·6	0·6
Thirty-five days	—	0·6
One hundred and eighty days ..	—	0·6

Another sample of air-dried soil was treated with 2% of chloroform, and after treatment for a day, the disinfectant was aired off for twenty hours. The soil was then stored in a jar with a loose lid, and tested from time to time. As in the previous experiment, due allowance was made for the experimental error.

	Chloroform detected in milligrams per 100 grams of air-dry soil.
One day after storing	6·9
Four days	4·5
Twenty-one days	1·9
Twenty-nine days	1·9

It is clear that there is an appreciable quantity of chloroform retained by the soil. In the case of the damp sample containing

8·8% of moisture, the chloroform was present to the extent of one part in 15,000 of the soil-moisture after a storage-period of 180 days.

Attempts were made to see if there might be any considerable fixation or alteration of the chloroform by the soil. The procedure consisted in chloroforming the soil in a stoppered separating funnel, and, after a lapse of twenty-four hours, in aspirating the free chloroform through alcohol contained in washing-towers. All apparent leakage was guarded against, but, in spite of all precautions, there was a loss of from 20% to 30% of the chloroform, not only from soil, but also from sand or cotton-wool, when these were substituted for the soil. The elucidation of the question, therefore, was temporarily abandoned.

Passage of the aspirated air through water did not yield any hydrochloric acid, from which it was concluded that the disinfectant was not altered into carbonyl chloride.

The chlorine-content of the soil is not increased by chloroforming, as was shown by the chloride removable by water being the same, whether the soil had been treated with 1% or with 2%, or had not been treated.

In a final experiment, a kilogram of garden soil was air-dried, and treated with 2% of chloroform for four days, aired-off for 24 hours, and the moisture brought up to 10%. It was then stored in a fruit-jar with a loose lid. The chloroform was determined from time to time.

	Chloroform in milligrams per 100 grams of moist soil.
One day after storing	4·9 milligrams.
Six days	2·5 ,,
Twenty days	1·5 ,,
Forty-seven days	0·9 ,,
One hundred and sixty-nine days ..	0·4 ,,

Since traces of chloroform are retained by the soil for some time, these may cause a stimulation of enzymic action and of bacterial growth. Fred showed that such a stimulation was exercised upon certain cultures of pure bacteria when grown in dilute bouillon in the presence of several disinfectants. A similar stimulation may also be exercised upon the bacteria that survive the partial sterilisation of soils. As there are so many reasons to account for the increase in soils, it was believed that, if the disinfectant did act as a stimulant, the action could be more clearly shown in porcelain-filtered extracts of soil, treated directly with the disinfectant, and seeded with soil-bacteria.

Extracts of soil were accordingly prepared by shaking a quantity of soil with an equal weight of water, and filtering the extract through water and then porcelain. A volume of the sterile filtrate was treated with one-fifth volume of chloroform-water of two strengths, and seeded with a suspension of *Bac. prodigiosus* or of soil-bacteria. After an incubation of 22° for 20 hours, the bacteria were counted by the plate-method.

EXPERIMENTS i. and ii.

Soil-extract containing chloroform in parts per million.	Growth of *Bac. prodigiosus*.
None	100
13	184
130	382
None	100
17	109
170	164

EXPERIMENTS iii. and iv.

Soil-extract containing chloroform in parts per million.	Growth of *Bac. prodigiosus*.	
	a	*b*
None	100	100
22	172	148
220	215	195

"*a*" was ordinary soil-extract; "*b*" was the extract of the residue from "*a*".

The experiments show that traces of chloroform, varying from 13 to 220 parts per million of soil-extract, stimulate the growth of *Bac. prodigiosus*.

Chloroform rapidly deteriorates in aqueous solution, as is well known, but although a portion would disappear during 24 hours' incubation, enough has been left to exert a stimulative action.

The rate of disappearing was determined in one instance, in which 0·122 gram was shaken up with 100 c.c. of water.

Chloroform taken by weight	0·122 gram.
Chloroform determined at once	0·114 gram.
Chloroform determined after 20 hours ...	0 072 gram.

The growth of soil-bacteria in chloroformed extracts of soil was then examined. The extracts, after treatment with chloroform-water, were sown with a suspension of bacteria from a soil which had been previously chloroformed and stored in a fairly dry condition (moisture = 4·5 %).

Experiment v.

Soil-extract containing chloroform in parts per million.	Growth of mixed soil-bacteria.
None	100
41	144
414	79

A stimulation of the growth of the soil-bacteria has occurred in the presence of 41 parts of chloroform per million, while 414 parts have evidently been too much, as they have acted as a toxin.

Experiment vi.

Soil-extract containing chloroform in parts per million.	Growth of	
	mixed soil-bacteria.	*Bac. prodigiosus* and *Micr. candidus.*
None	100	100
18	192	1,200
180	123	1,850

This agrees generally with the previous experiments, although the stimulating effect of the larger quantity is not so pronounced as the smaller with the soil-bacteria. *Micr. candidus* had, in some accidental manner, got into the suspension of *Bac. prodigiosus*.

The extracts in Experiments i. to vi. had always been nutritive, as was shown by the bacteria, that grew in the unchloroformed extract, being always greater in number than in the water-control tests made at the same time. In the next experiment, we have a different condition.

EXPERIMENT vii.

Soil-extract containing chloroform in parts per million.	Growth of	
	bacteria from a raw soil.	*Bac. prodigiosus.*
None	100	100
16	106	191
165	5	170

This extract was anomalous, inasmuch as it was toxic to the soil-bacteria, and nutritive to *Bac. prodigiosus.* The great reduction of the bacteria, in the test with 165 parts of chloroform per million, suggests that the toxins of the extract may behave like chloroform, and be stimulative in small doses, and toxic in large doses. In this experiment, the soil-bacteria were obtained from a raw soil, while, in all the other experiments, they were got from a soil which had previously been chloroformed.

EXPERIMENT viii.

Soil-extract containing chloroform in parts per million.	Growth of *Bac. prodigiosus.*
None	100
17	100
170	137

The extract was slightly toxic.

EXPERIMENT ix.

Soil-extract containing chloroform in parts per million.	Growth of mixed soil-bacteria.
None	100
8	58
84	3

This soil was strongly toxic, and was again used a week later in the following.

Experiment x.

Soil-extract containing chloroform in parts per million.	Growth of	
	mixed soil-bacteria.	*Bac. prodigiosus.*
None	100	100
10	77	82
101	57	52

After the week's storage in the laboratory, the soil did not give so strongly toxic an extract. After still another week, the toxicity had disappeared, and the extract was nutritive.

Experiment xi.

Soil-extract containing chloroform in parts per million.	Growth of	
	soil-bacteria.	yeasts.
None	100	100
7	127	261
74	342	203

In the experiment, the yeasts grew upon the same plates with soil-bacteria, and were distinguished by the small size of their colonies. They were very numerous, being in the ratio of about 250 : 1 of the soil-bacteria.

The results of the foregoing experiments show that the chloroform does act as a stimulant in soil-extracts, and we are justified in concluding that it will also act in this manner in soil-moisture Its persistence in the soil after treatment, combined with its action in soil-extracts, argues in favour of the stimulation-theory that the great increase in the bacterial numbers, following treatment of a soil with chloroform, is due in part to the stimulation of the bacteria by small doses of the disinfectant retained by the soil.

STUDIES IN AUSTRALIAN *NEUROPTERA*.

No. i. The Wing-Venation of the Myrmeleonidæ.

By R. J. Tillyard, M.A., B.Sc., F.E.S., Linnean Macleay Fellow of the Society in Zoology.

(Plate lviii., and ten Text-figs.)

Introduction.

In entering upon the study of Australian Neuroptera, my intention is eventually to attempt to work out the little-known life-histories of these insects, and to contribute something towards the study of the morphology of their larvæ and pupæ. However, we know as yet so little about the Australian forms, that it is clearly of the first importance that their systematic classification should be placed upon a secure foundation, before any other work can be satisfactorily proceeded with. With the aid of collections sent by Mr. W. W. Froggatt, F.L.S., Government Entomologist of New South Wales, and by myself, Mr. Esben Petersen, of Silkeborg, Denmark, has lately been enabled to unravel a great deal of the tangle surrounding the isolated and often incomplete descriptions of Australian forms published during the past hundred years or more. Two of his papers* have been published quite recently in these Proceedings. Mr. Petersen had previously undertaken a tour of the principal Museums of Europe, and had carried with him a number of specimens from Australia, for comparison with the old types. He also secured photographs of nearly all of these latter. Thus he has been able to give us, not only a number of excellent descriptions of new species, but also some valuable observations on the synonymy of many of the better known forms. It may be truthfully said, that Mr.

* Esben Petersen, Australian Neuroptera, Part i., These Proceedings, 1914, xxxix., pp.635-645, Plates lxxii.-lxxv.; Part ii., *l.c.*, 1915, xl., pp. 56-74, Plates vi.-xiii.

Petersen's two papers form a basis, without which it would have been inadvisable for any Australian entomologist to undertake the study of this Order; and that Australian scientists, as a whole, must be deeply indebted to him for his excellent and painstaking work.

Before Mr. Petersen's papers were published, I had already studied a considerable number of rare Neuropterous insects in my own Collection. Many of these were sent to him for his opinion, and I now desire to thank him for his valuable advice and help in this direction. In many cases, it was quite impossible to determine a species as definitely new, until it had been compared with some old type, owing to the often glaring inadequacy of some of the older published descriptions. In order to do justice to the excellent work of McLachlan and others, it is only fair to state that the principal obstacle in this respect has always been Walker,* whose work is here strongly recommended to any Australian entomologist as a model of how descriptions of insects should *not* be written. Fortunately, Mr. Petersen has seen Walker's types, and we may now hope that the fog caused by that painstaking "manufacturer" of new species has been permanently lifted.

The species described as new from my own Collection, together with a number sent to me for study from other parts of Australia, will be published in No.2 of this series of papers. Meanwhile, as the whole scheme of classification hinges chiefly on the wing-venation, it was found necessary to deal with this matter first of all. In No.1 of this series, therefore, I offer the results of my study of the pupal wing-tracheation of the *Myrmeleonidæ*, together with some remarks on certain special structures in the imaginal venation which are of value to the systematist.

The species selected for study was *Myrmeleon uniseriatus* Gerst. Its larva is perhaps the commonest and most easily noticed of the Ant-lions of the Sydney district. This species

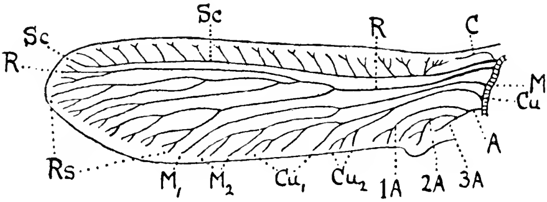
* Catalogue of Neuropterous Insects in the Collections of the British Museum, 1853.

makes a number of pits in my garden every year, and has thus provided both easily accessible and sufficiently abundant material for all purposes.

About a dozen larvæ were collected in October, 1914. These were placed on a smooth layer of sand in a large flat tin about three inches deep. They at once burrowed, and very soon had completed their characteristic conical pits. Each pit was regularly supplied with an ant once or twice a day, and a careful watch kept for any instance of refusal to eat on the part of the larva. For some weeks, the ant-lions fed regularly on all that was offered them. Then, one day, it was seen that one of the larvæ had refused an ant. At next feeding-time, the sand was carefully put through a sieve, and, as expected, a freshly-formed spherical cocoon of sand-grains was recovered. The other larvæ re-formed their pits and went on feeding. A few days later, another fresh cocoon was obtained, and, soon afterwards, the majority of the larvæ had spun their neat little homes in the sand.

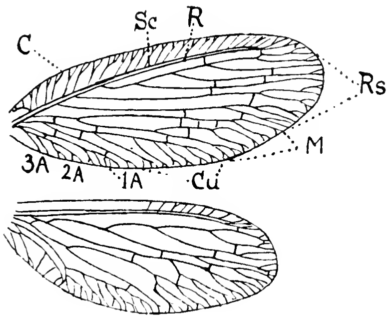
These cocoons were all placed on sand in a tray covered with a cage of mosquito-netting. The first cocoon was cut open six days after its recovery from the sand. It was found that the enclosed larva had not yet pupated. The next was opened after seven days, with the same result. A third, eight days old, contained an evidently freshly formed pupa. Finally, the pupa selected for dissection was one taken from a cocoon thirteen days old, in which the wing-sheaths appeared to be eminently suitable for the object in view. This pupa was very active, and was killed with chloroform. The wing-sheaths were then quickly dissected off under water, and floated on to a slide. A light cover-slip was then let down gently upon them, and they were transferred at once to Reichert's photomicrographic apparatus, where three satisfactory photographs were obtained. These are reproduced in Plate lviii., and are made the basis of a comparative study with the imaginal venation.

It will be seen that the obtaining of suitable material in the right condition is not an easy matter. Comstock and Needham, in their famous work on the Wing-Venation of Insects,* did not deal with the *Myrmeleonidæ*, but they succeeded in photographing the tracheation of the pupal wing of one of the *Hemerobiidæ*.



Text-fig. 1.—Wing-tracheation from the forewing-sheath of a pupa of an Hemerobiid, much enlarged. Adapted from Comstock and Needham.

They happened to hit upon a form, therefore, in which the venation is remarkably easy to determine, since it agrees in almost every detail with the pupal tracheation preceding it. This can be seen from figs. 1-2. All the main veins of the imaginal wing follow the curves of their corresponding tracheæ, except for a certain amount of secondary fusion at their bases; (the tracheæ are, of course, quite separate at their bases, owing to the greater breadth of the wing-sheath). It is thus possible, in the case of *Hemerobius*, to indicate, without any shadow of doubt, the number and limits of the radial sectors (Rs), the position of the two-branched media (M), of the two-branched cubitus (Cu), and of the three-branched analis (1A, 2A, 3A). Such a complete agreement between tracheation and venation indicates, of course, a great lack of specialisation in the latter, and suggests

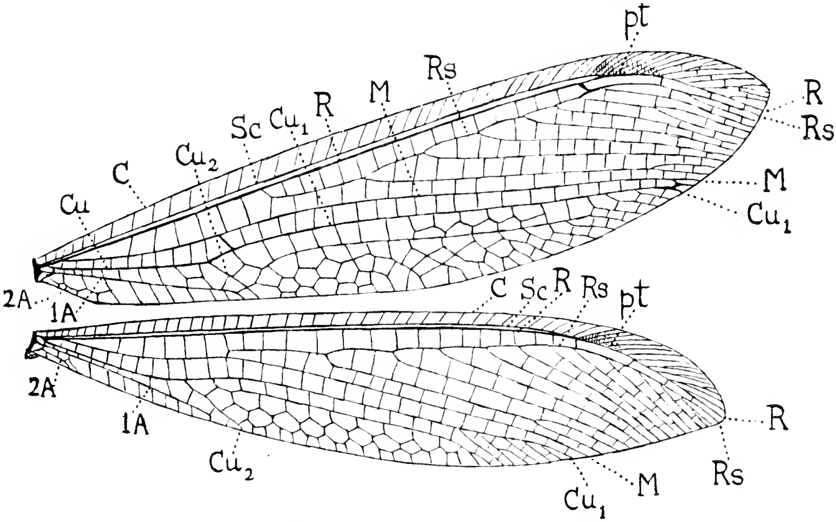


Text-fig. 2.
Wings of *Hemerobius nitidulus* (×8).
Adapted from Handlirsch.

* "The Wings of Insects," American Naturalist, 1898, xxxii, seven parts.

that the *Hemerobiidæ* have preserved, with very little alteration, an original archaic wing-plan.

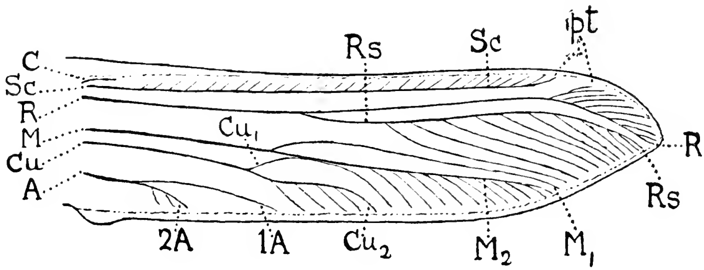
An examination of the wing-venation of a Myrmeleonid (Text-fig.3) suggests that there could be nothing rash in at once naming off all the principal veins and branches without reference to the pupal tracheation. Three obvious differences from the Hemerobiid plan are at once recognisable, viz., the presence of only a single radial sector, Rs, the unbranched condition of the media, M, and the presence of only two branches of the analis (1A, 2A).



Text-fig.3.—Wings of *Myrmeleon uniseriatus* (× 3), to show the usually accepted venational nomenclature. (Original).

All students of the *Myrmeleonidæ* have applied the Comstock-Needham notation to this venation in the manner shown in Text-fig.3, and it seemed that there was no more to be said on the subject.

Now the *Myrmeleonidæ* are admittedly, by their specialised life-history, and by the success of their evolutionary effort, in comparison with that of the other groups of Neuroptera, the most advanced family in the group (except perhaps the *Chrysopidæ*). It seemed to me very strange, therefore, that we should all accept tacitly the suggestion that they had such an unspecialised system of wing-venation, without any confirmation from the pupal tracheation. The suspicion that all was not right led me to study the venation in several well-known genera more carefully. But I obtained no light on this subject for a long time, until one day I noted the *persistent obliquity* of a certain cross-vein just above, and distad from the cubital fork in the forewing of the genus *Acanthaclisis*. Recalling the importance of a similar occurrence in the wings of Odonata, I at once sought for this oblique cross-vein in other genera, and was rewarded by finding it clearly present in the forewings of almost every specimen of *Myrmeleonidæ* in my collection. I could not, however, detect any sign of it in the hindwing in any case. As the venatious of the two wings appear otherwise to be exceedingly similar, I determined to study the pupal tracheation, and it was with this end in view that the pupæ of *Myrmeleon uniseriatus* were obtained.

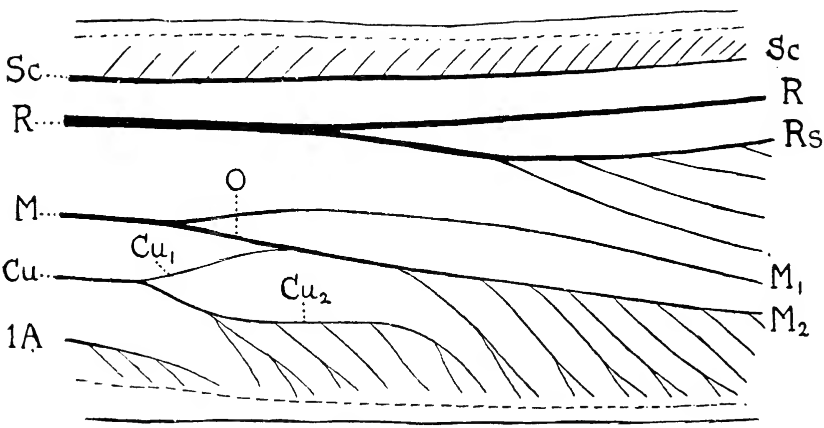


Text-fig.4.—Wing-tracheation from the right forewing-sheath of a pupa of *M. uniseriatus* (× 19), to show correct naming of tracheæ. Compare Plate lviii., fig.1. (Original).

As soon as the photomicrographs of the pupal wing-sheath were studied, the reason for the persistent obliquity of the cross-vein above-mentioned was made clear. Text-fig.4 shows the pupal tracheation of the forewing, while Text-fig.5 shows the most important portion of it enlarged. In Text-fig.6, I have reproduced the imaginal venation of the forewing for comparison, together with the alterations in notation that will now be necessary. The results may be stated as follows.

(1). The course and limits of the subcosta (Sc), radius (R), radial sector (Rs), and analis (1A, 2A) are the same as in the generally accepted scheme (Text-fig.3), and need no further consideration.

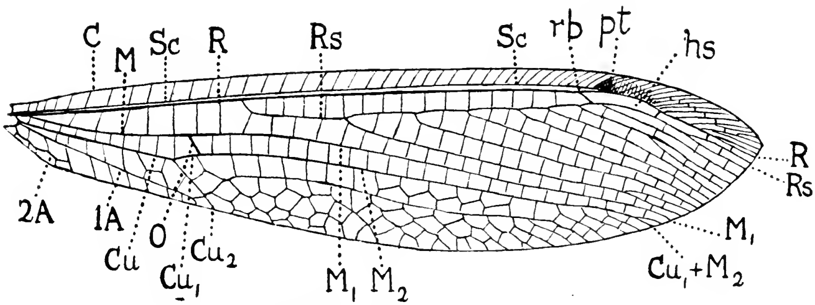
(2). The supposedly simple median vein is really *two-branched*, as in most *Hemerobiidæ*, *Osmylidæ*, and *Nymphidæ*. In the tracheation, the thicker and straighter of the two branches is the lower one, M_2, from which the weaker M_1 arches weakly upwards, to run above and nearly parallel to M_2. The upper branch of the cubitus (Cu_1), which forks at a level slightly proximal to that at which M forks, is also weak, and arches similarly upwards, *to meet* M_2 *just distally from the fork, and there unite with it.*



Text-fig.5.—Portion of Text-fig.4 enlarged (×50), to show the formation of the oblique vein O, and the cubito-median, $Cu_1 + M_2$. Compare Plate lviii., fig.2. (Original).

Now, in the imaginal venation, a peculiar transformation occurs. The strong, straight, lower branch of the media, M_2, becomes sharply bent downwards at the fork, thus forming the oblique vein O, whose persistence had so puzzled me before. This lower branch M_2 consequently unites with the much weaker Cu_1 at the lower end of O. At that point it bends away distad again, *exactly continuing the line of* Cu_1 *itself.* No wonder, then, that the resulting vein has been labelled Cu_1 without any hesitation, for the deception is almost as complete as Nature could possibly have made it, and the oblique vein is the only clue left to the discovery of this remarkable venational freak.

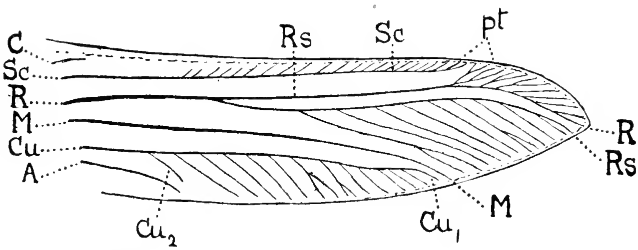
We see, therefore, that in the *forewing* of *Myrmeleonidæ*, the media is really two-branched, and that the vein usually called the "upper branch of the cubitus" and labelled Cu_1, is really a composite vein, formed proximally—for the short distance from the cubital fork to the foot of the oblique vein—by Cu_1, and thence distad by M_2. I propose, therefore, to name it the *cubito-median vein*, with the notation $Cu_1 + M_2$. As far as I know, there is no exact homologue to this vein in any other group of insects.



Text-fig. 6.—Forewing of *M. uniseriatus* (× 3), to show the correct naming of veins. (Original).

(3). Some alteration of our ideas as to the extent of the cubitus is necessary. In the tracheation, the main stem of Cu is continued on, with only a slight downward bend, by Cu_2 as a fairly stout trachea giving off four or five descending branches. By contrast, Cu_1 is a very weak trachea running obliquely upwards to fuse with the much stouter M_2. It is possible that the first of the branches descending from M_2 may be the cut-off end of Cu_1. But, as this cannot be definitely shown to be the case in our photographs (though perhaps it might be seen in figures from a larger species), we must, for the present, limit Cu_1 to the short piece between the cubital fork and the foot of the oblique vein.

We must also remark that the excessively short lower branch of Cu in the venation, usually labelled Cu_2, does not really represent the full limits of that vein, but is formed basally from the stem of Cu_2, and distally from the first branch descending from it. The rest of Cu_2 is represented by the irregular series of crossveins up to five or six cells' width distad from Cu_2. In *Protoplectron*, we can see a more normal arrangement, Cu_2 running along under, and parallel to Cu_1 for a considerable distance. In this respect, therefore, we must count *Protoplectron* and allies as amongst the most archaic of *Myrmeleonidæ*. In *Myrmeleon uniseriatus*, the supplementary vein running under and parallel to $Cu_1 + M_2$ is a purely venational development, quite unrepresented in the tracheation. It is clearly formed by alignment of the first series of crossveins below $Cu_1 + M_2$, and may be called the *cubito-median supplement*.



Text-fig.7.—Wing-tracheation from the right hind wing-sheath of a pupa of *M. uniseriatus* (× 19), to show correct naming of tracheæ. Compare the hindwing in Text-fig.3, and Pl. lviii., fig.3. (Original).

The venation of the hindwing in *Myrmeleonidæ* presents no difficulties at all, as may be seen by comparing Text-figs.3 and 7. Both M and Cu are unbranched, and run straight through the wing. The waviness of M in the venation, and the very weak fork of Cu, are slight venational specialisations which appear to indicate a weak attempt at convergence towards the form of the forewing venation, by a different route. The weak Cu_2 which, in the hindwing, joins 1A distally, is indicated in the tracheation only as a weak branch of Cu of a calibre barely equal to that of the numerous branches following it distally along Cu. Thus, in the hindwing, Cu_1 is the *analogue* in form and position of $Cu_1 + M_2$ in the forewing.

We may summarise our results as follows:—

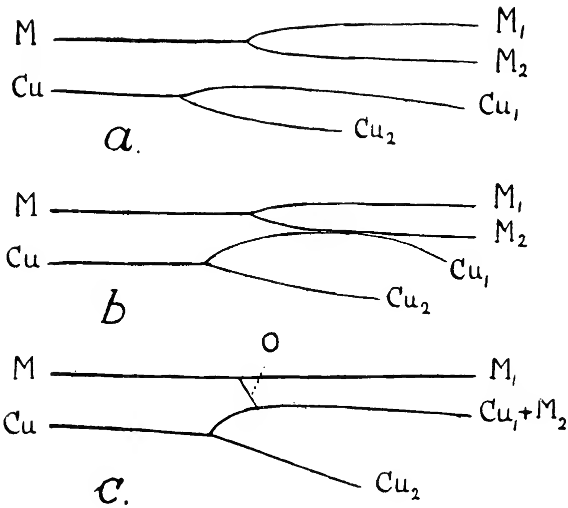
TABLE OF MYRMELEONID VENATION.

Vein.		Usual Notation.	Correct Notation.	
—		—	Forewing.	Hindwing.
Costa		C	C	C
Subcosta		Sc	Sc	Sc
Radius	Main Stem ...	R	R	R
	Radial Sector ..	Rs	Rs	Rs
Media	Upper Branch...	M	M_1	absent
	Lower Branch...	Cu_1(distal part)	M_2 } $= Cu_1 + M_2$	M
Cubitus	Upper Branch .	Cu_1(proximal part)	Cu_1 }	Cu_1
	Lower Branch...	Cu_2	Cu_2	Cu_2(weak)
Analis	First anal (Post-cubitus)...	1A	1A	1A
	Second anal (Axillary)...	2A	2A	2A
	Third anal (Basilar) ..	(3A)	absent or vestigial	absent or vestigial

PHYLOGENETIC CONCLUSIONS.

The phylogenetic results deducible from this new discovery are of considerable interest and importance. So far, it has not been possible to indicate with any certainty the origin of the dominant group, *Myrmeleonidæ*. There has been a general agreement in looking upon the *Nymphidæ*, a small family confined to Australia, as representing the probable type from which the *Myrmeleonidæ* have been developed. But this agreement is not, so far as I can ascertain, based on any definite evidence, but merely on a general impression of the Myrmeleonid-like appearance of the well-known *Nymphes myrmeleonides* Leach. We now have definite venational evidence to go upon, and we may say at once that it fully establishes the claim of the *Nymphidæ* to be regarded as the remains of the ancestral group from which the *Myrmeleonidæ* have sprung.

In the *Nymphidæ* (except in the case of the aberrant reduced genus *Austronymphes*) *the median vein is forked in the forewing,* *but simple in the hindwing.* Also, the cubitus is strongly forked in the forewing, *at a level somewhat proximad to the forking of* M, while in the hindwing it is only very weakly formed. Further, it is remarkable that, in the *Nymphidæ*, Cu_1 in the forewing is not strong enough to reach the distal border of the wing. It is, in fact, *dynamically* useless already, and its fusion with M_2 may be regarded as the obvious result of further weakening. If, in the venation of the forewing of *Nymphes myrmeleonides* (Text-fig. 8, *a*), we bring Cu_1 into apposition with M_2 (fig. 8*b*), we get a



Text-fig. 8.—Phylogeny of the cubito-median vein in the forewing of *Myrmeleonidæ*. *a*, Nymphid (archaic) stage; *b*, Intermediate stage (apposition of Cu_1 to M_2); *c*, Myrmeleonid stage, with oblique vein O, and cubito-median vein completed ($Cu_1 + M_2$).

condition almost exactly represented in the pupal tracheation of *Myrmeleon*. By the fixation of the oblique vein O and the alignment of Cu_1 with the rest of M_2, we finally get the imaginal venation of *Myrmeleon* (fig. 8, *c*).

Another point in which the *Nymphidæ* differ from the *Myrmeleonidæ* is that, in the former, Rs arises from R quite close to the base of the wing, whereas, in the latter, it is always more or less removed from the base. The change has clearly been brought about by a gradual shifting of the point of origin of Rs distad along R. Evidence of this is furnished by *Glenoleon* and allies, in which Rs still arises, in the hindwing, so close to the wing-base that only one crossvein is interposed in the radial space before the origin of Rs. N. Banks has, indeed, divided the *Myrmeleonidæ* into two subfamilies on this very character; the *Myrmeleoninæ* having several crossveins before Rs in the radial space in the hindwing, the *Dendroleoninæ* only one (rarely two). On phylogenetic grounds, this subdivision is now seen to be clearly justified. Moreover, as might be expected from their zoogeographical distribution, we can say definitely that the *Dendroleoninæ* is the more archaic subfamily of the two.

We may conclude, then, that the *Myrmeleonidæ* are a specialised and highly successful offshoot from Nymphid-like ancestors, the course of evolution being marked by the following changes:

(1). In the venation, attachment of Cu_1, in the forewing, to M_2, to form a single strong vein, the *cubitomedian*; progressive movement distad of the origin of Rs; gradual reduction in length and distinctness of Cu_2; also gradual reduction in the general density of venation and in the size and prominence of the pterostigma.

(2). In the antennæ, a gradual reduction from a moderately thickened and fairly long filiform antenna of numerous joints, as in *Nymphidæ* (itself probably a specialisation from the longer and slender Osmylid-form), to a shorter and stouter form with a gradual tendency to the formation of a club at the tip.

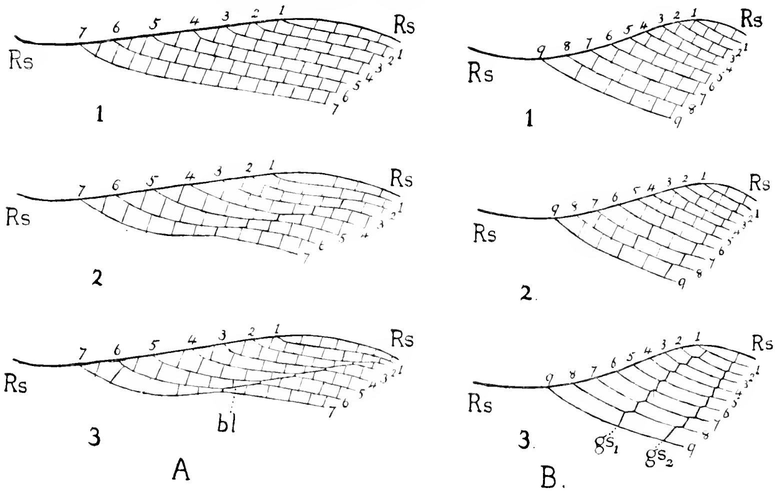
(3). In the larval life-history, a change from a wandering (probably nocturnal), carnivorous larva, with an oval abdomen and omnivorous tastes, to a sedentary, pit-dwelling, ant-feeding form with a more rounded and specialised abdomen.

True *Myrmeleonidæ* being unknown from even the latest of the Mesozoic strata, we shall probably be right in regarding this family as being of early Tertiary origin.

Some additional Notes on the Venation of Myrmeleonidæ.

We shall conclude this paper with a few remarks on certain structures of systematic importance in the venation, which have not come definitely within the range of study covered by the pupal tracheation.

(*a*) *The Banksian Line.* (Text-fig. 9).



Text-fig. 9.—Phylogenies of the Banksian Line (Series A) and the Gradate Series (Series B) compared. In A, the radial sector is shown with seven branches, numbered from above downwards, or from the apex inwards; Stage 1, archaic unspecialised arrangement (*Nymphes*, *Myrmeleon*, etc.); Stage 2, intermediate stage; Stage 3, Banksian line (bl) completed; note that the proximal half of branch 6 is now practically continued by the distal half of branch 7, and so on. In B, the radial sector is shown with nine branches, numbered as before; Stage 1, archaic unspecialised arrangement (*Osmylidæ*); Stage 2, intermediate stage, with two series of gradate veins foreshadowed; Stage 3, the Gradate Series completed (*Chrysopidæ*), and the other crossveins suppressed; gs_1 proximal, and gs_2 distal Gradate Series. Diagrammatic. (Original).

In some genera (e.g., *Acanthaclisis*, *Glenoleon*), the branches of the radial sector are bent in a peculiar manner, so that, with the aid of a series of reduced crossveins between them, an apparently continuous, or nearly continuous, straight line is formed, running through the middle of the apical third of the wing. This line is used as a generic character. As the description of the formation of this line usually occupies two or three lines of print, and is unwieldy for use in dichotomous tables, generic definitions, and so forth, it seems advisable to give it a definite name. I therefore propose here the name *Banksian Line* for it, in honour of Mr. Nathan Banks, who has done so much to advance the study of Neuroptera, and has described an immense number of new species from all parts of the world.

The *Banksian Line* should be contrasted phylogenetically with the development of crossveins known as the *Gradate Series* in *Chrysopidæ* and other families of Neuroptera. Both formations are derived from the typical archaic arrangement of the branches of the radial sector seen in *Nymphidæ*, and still preserved for us in *Myrmeleon* and other genera. In Text-fig.9, the series A shows the formation of the Banksian Line, the Series B the formation of two Gradate Series.

Those genera in which the Banksian Line is well-developed must be considered, at any rate in this respect, as the highest developments in their respective subfamilies. Thus, *Acanthaclisis* is evolutionarily at the head of the *Myrmeleoninæ*, *Glenoleon* at the head of the *Dendroleoninæ*.

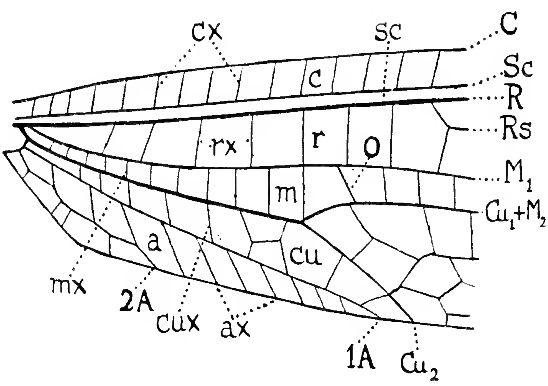
(*b*) *The Hypostigmatic Space.* (Text-fig.6, hs).

Below the pterostigma in *Myrmeleonidæ*, there is a narrow elongate cell devoid of crossveins, and enclosed by R above and Rs below. This space I here designate as the *Hypostigmatic Space* (Text-fig.6, hs). Proximally, it is bounded by a more or less slanting crossvein which may be termed the *radial brace* (Text-fig.6, rb), distally by an isolated crossvein of unspecialised form. The hypostigmatic space is present in *Nymphidæ*, and is very constant in all *Myrmeleonidæ*. It may, however, be used as a convenient basis of reference for stating the position of spots and colouring on and around the pterostigma, the latter organ being merely an assemblage of crowded crossveins, with ill-defined limits. Besides this, for any given species, the number of branches of Rs may conveniently be stated up to the limit of rb, and the position of rb itself, whether standing directly over one of these branches, or between two of them, may be of some value in specific diagnosis.

(c) *The Cubital Fork.*

The term "fork" is usually applied, in venation, to *the point of bifurcation* of a vein, and not to one of the resulting branches. It is unfortunate, therefore, that Cu_2 has been termed the "cubital fork" in *Myrmeleonidæ*, especially as the term "lower branch of cubitus" takes priority, and is free from objection. I propose to restrict the term "fork" to its more legitimate meaning; so that, in future, by "cubital fork" the point of bifurcation of Cu will be indicated, while by "median fork" (in the forewing only), we shall understand the point at which the oblique vein O leaves M_1. The abbreviations cuf and mf may be employed for these two points respectively.

(d) *The Basal Spaces.* (Text-fig. 10).



Text-fig. 10.—Basal spaces and crossveins in forewing of a Myrmeleonid. For nomenclature, see text. (Original).

The spaces into which the main veins divide the wing at the base, are named from the vein bounding them *anteriorly*, as follows.

(i.) *Costal space* (c) between C and Sc, from base to pterostigma. This has been called the "subcostal space" by some authors. The crossveins in it should be called "costal crossveins" (cx), not subcostals.

(ii.) *Subcostal space* (sc), the very narrow space between Sc and R, from base to pterostigma. It has no cross-veins in *Myrmeleonidæ.*

(iii.) *Radial space* (r), between R and M, from base to origin of Rs. The crossveins in it should be termed "radial crossveins" (rx); there is only one of these in the hindwing of the *Dendroleoninæ.*

(iv.) *Median space* (m), between M and Cu, from base to oblique vein. The crossveins in it are the "median crossveins" (mx).

(v.) *Cubital space* (cu), between Cu and 1A, from base to Cu_2. The crossveins in it are the "cubital crossveins" (cux). The shape of this area, and the number of rows of crossveins in it, are of considerable systematic importance.

(vi.) *Anal space* (a), between 1A and the posterior border of the wing. It may also be termed the "anal field," since it includes 2A, and the remnant of 3A if present. Its form and extent are of considerable systematic importance, as are also the number and length of the "anal crossveins" (ax) running from 1A to the posterior border.

NOTE ON THE GENDER OF GENERIC NAMES IN MYRMELEONIDÆ.

It might seem superfluous now-a-days to quote the rule given in Art. 14 of the International Rules for Zoological Nomenclature, that specific names, when adjectives, must "agree grammatically with the generic name." However, it is necessary to do so, since numerous authors seem to imagine that any generic name ending in "*on*" must necessarily be neuter. Thus we have recently had the whole of the specific names in *Glenoleon* written in the neuter by authors, though Rambur, in an age before Greek was despised or disregarded by scientists, described the type-species of this genus as *Myrmeleon pulchellus.* In a recent paper, I find, on the same page, two new species, *Protoplectron costatus* and *P. pallidum* described! Other examples are *Pseudoformicaleo nubecula, Callistoleon erythrocephalum*, etc. As the terminations in use for generic names in *Myrmeleonidæ* are very few, it may be as well to give their derivations and genders for the guidance of future workers:—

-leon (Greek λέων, a lion, *masculine*) e.g., *Myrmeleon*, *Callistoleon*, *Glenoleon*, *Dendroleon*, and many others. These must all take *masculine* specific names.

-plectron (Greek πλῆκτρον, a spur, *neuter*), e.g., *Protoplectron*.

-clisis (Greek κλίσις, a bending, *feminine*), e.g., *Acanthaclisis*.

-ourus (correctly *-ura*, from Greek οὐρά, a tail, *feminine*), e.g., *Glenurus*, *Macronemurus*. As these have a *masculine* form, they take masculine specific names.

-leo (Latin leo, a lion, *masculine*), e.g., *Formicaleo*, *Pseudoformicaleo*.

It should also be noted that the *correct* family-name for the Ant-lions is not *Myrmeleonidæ* but *Myrmeleontidæ*. By the International Rules, Art.4, "the name of a family is formed by adding the ending *idæ* to the root of the name of its type-genus." The root of λέων is λεόντ-; hence *Myrmeleontidæ*. Similarly we should have the subfamilies *Dendroleontinæ* and *Myrmeleontinæ*.

EXPLANATION OF PLATE LVIII.

Fig. 1.—Tracheation of forewing-sheath of *Myrmeleon uniseriatus* Gerst., (×19). [Compare Text-fig.4].

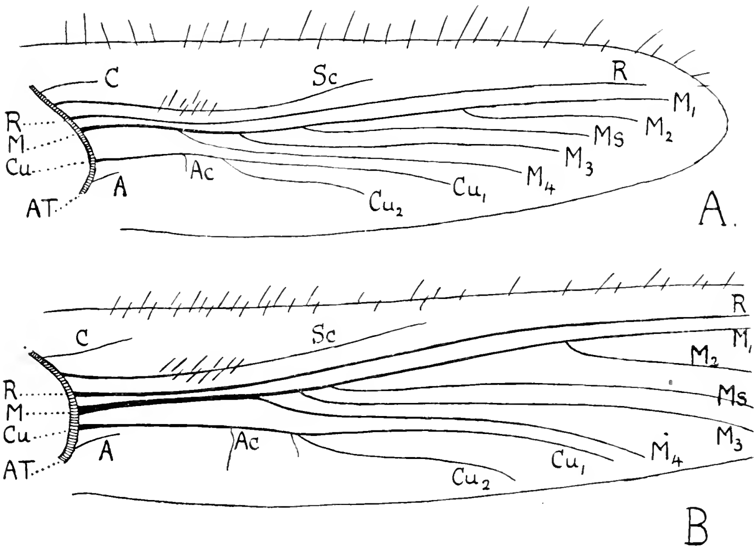
Fig. 2.—Ditto, a portion much enlarged, (×50). [Compare Text-fig.5].

Fig. 3.—Ditto, hind wing-sheath, (×19). [Compare Text-fig.7].

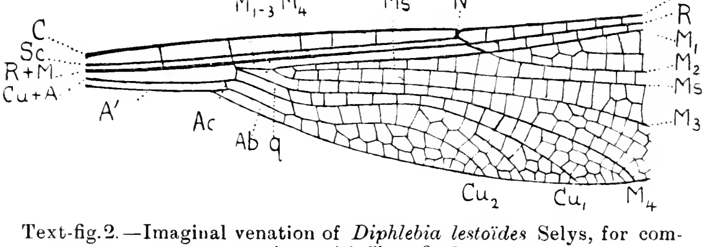
(Postscript: *added December 27th, 1915*).—Since the above was written, Mr. Esben Petersen has drawn my attention to the fact that Navás has employed the term *linea plicata* for what, in this paper, is designated the *Banksian line*. Mr. Petersen is of opinion that the term *linea plicata* is objectionable, and is unwilling to accept it. I must here express my agreement with Mr. Petersen on this point on the ground that the term "plicata" in no way describes either the complex formation of this structure, nor its final result, which, in its most highly developed form, is a "linea recta." It is because I am strongly of opinion that no single word or phrase can be coined, which will indicate the peculiar structure of the Banksian line, that I have fallen back upon a practice that is very generally observed in these difficult cases in Biology, and named this line after one of our foremost contemporary workers on the Neuroptera.

Appendix.

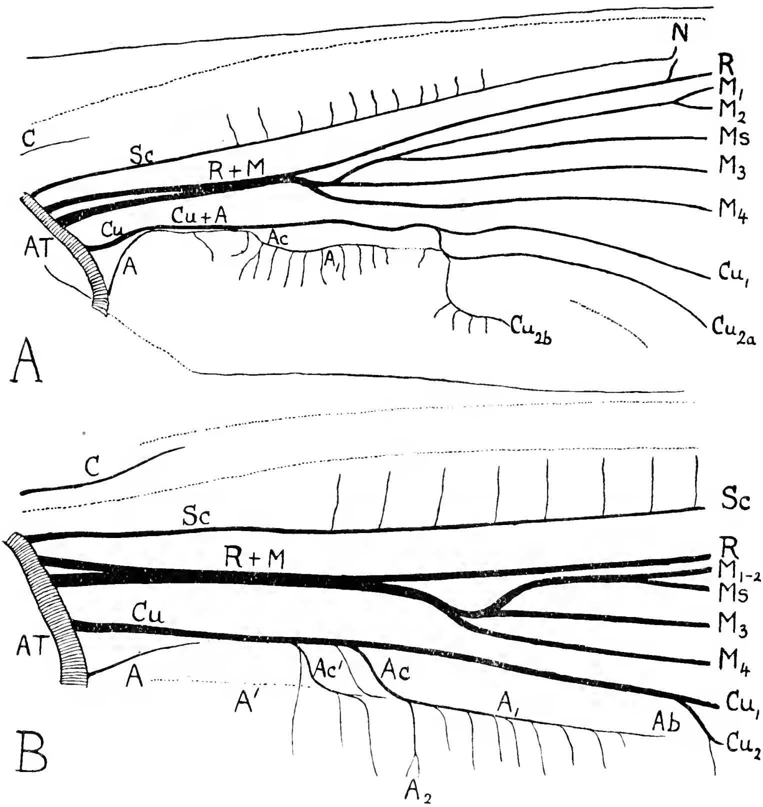
The text-blocks above the legends of Text-fig.1 and Text-fig.3 on pp.215 and 217 of Mr. Tillyard's paper "On the Development of the Wing-venation in Zygopterous Dragonflies, &c.," (*antea*, p.212), were inadvertently transposed. The figures are now reprinted as they should have appeared in the original paper. [Ed.]



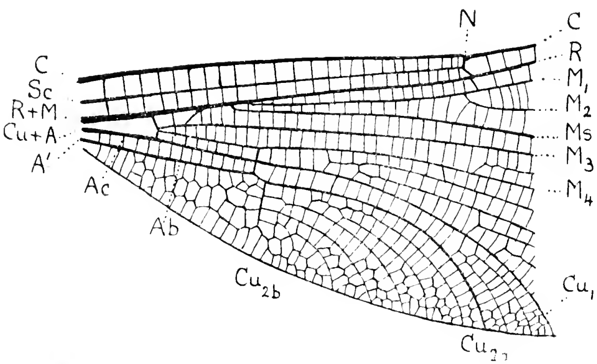
Text-fig. 1.—Tracheation of larval wing of *Diphlebia lestoïdes* Selys. A. Antepenultimate instar. B. Penultimate instar. Compare Pl. xxxii., figs 1-3, Pl. xxxiii., fig. 1.



Text-fig. 2.—Imaginal venation of *Diphlebia lestoïdes* Selys, for comparison with Text-fig. 1.



Text.fig.3.—Tracheation of larval wing of *Calopteryx splendens* Harris. A. Penultimate instar. B. Last instar. Compare Pl xxxiv., figs. 2-3.



Text-fig. 4.—Imaginal venation of *Calopteryx splendens* Harris, for comparison with Text-fig. 3.

OBSERVATIONS ON THE POLLINATION OF *DARWINIA FASCICULARIS* Rudge. [N.O. MYRTACEÆ].

By Agnes A. Brewster.

(Plate lix.)

The late Mr. E. Haviland, in a paper published in the Proceedings of this Society, for 1884, Vol. ix., p. 67, dealt with the general structure, and the life-history of this plant; and my paper is intended to add some additional notes to his observations. The low shrubs flourish in sandstone-country, in exposed, sunny situations. The narrow, crowded leaves are well fitted for such conditions, for a cross-section of the leaf examined under the microscope shows that it has a thick layer of cuticle, which gives the stomates a sunken position. The palisade-tissue extends all round the leaf, and thus, with the aid of the cuticle, too rapid transpiration is prevented. There are two vascular strands in the centre of the leaf, embedded in colourless parenchyma.

Mr. Haviland described the flower-clusters, and the general structure of the flower. In the red clusters, the corollas of the flowers are white, except the lobes at the apex, which are red. There are ten stamens, with globular anthers, which dehisce by two pores. These alternate with ten staminodes.

I have noted, on microscopic examination of the corolla, that there are oil-glands dotted over the free lobes; and it is probably the evaporation of the volatile oils in these glands which gives the strong, peculiar perfume given out by the flowers in the sunshine. On crushing the foliage-leaves in the hand, there is a strong odour of rather oily eau-de-cologne.

Mr. Haviland says that, of a hundred of its flowers, ninety-five never open. I have noticed that every flower opens in the early stage of the flower, some remaining open for a longer period than others, but all the flowers close again in the later and longer stage of their existence. As they do so, the lobes of the corolla fit round the lower part of the style, and may give some measure of support to this upstanding part of the flower.

The stamens are protandrous, ripening before the style begins to elongate, and just before the flower opens. They are in two whorls, each of the upper ones being placed in the middle of the corolla-lobes, the lower stamens occurring each at the junction of two of the lobes. The anthers are bent forward towards the centre of the tube; the benefit of this arrangement of the stamens will be pointed out later. If young anthers are placed on the micro-slide and mounted in water, and the cover-slip gently pressed, the pollen-sacs, four, may be plainly seen; in more mature anthers, there are only two loculi of the normal anther. The fibrous layer is beautifully shown, as is also the tapetal layer, which is disappearing.

Mr. Bentham (Fl. Austr., iii., 6), from the examination of herbarium-specimens, includes among the generic characters of *Darwinia*: "Style exserted, usually long, and more or less bearded towards the end." By the late Mr. E. Haviland, the bearded portion was thus described: "Immediately below the stigma is a ring of stiff hair-like glands, which secrete an adhesive fluid copiously"; and he suggested that these hairs secreted nectar, which was seen as a globule round the tuft of hairs, and which was carried up by the elongating style. I had found, on examining many buds, that these hairs extended across the flower so as to reach the anthers; and that just before the flower opens, the anthers give out a viscous mass in which the pollen-grains are embedded; and that it is this mass which adheres to the substigmatic tuft of hairs which extends between the two whorls of anthers, and is carried up by the elongating style. By this means, the pollen is placed in a very conspicuous position; and this fact, together with the colour of the flower-clusters, suggested bird-visitors, as the agents which caused cross-pollination. On examining the stigmas of young flowers under the microscope, I found that there were numerous, transparent, rounded protuberances over their surfaces. On examining mature stigmas, I found that there was a general enlargement of the stigmatic surface, with the development of about a dozen of the protuberances into elongate, inverted, flask-shaped hairs, which contained a red fluid, and stood out above the colourless, rounded projections. These coloured outgrowths are probably the secretory hairs of the stigma.

The flower-clusters in most cases become red-tipped as they mature; even if they are not quite red, the style will be seen to become pink, and the corolla-lobes will have a pink streak here and there. I have seen many of these red clusters, in the latest period of their development, wet and shining with the overflowing nectar secreted by the surface of the ovary. Another interesting feature is, that the flower-clusters show a marked, initial zygomorphy of the inflorescence. Mr. John McLean Thompson, M.A., B.Sc., in a paper published in the Transactions of the Royal Society of Edinburgh (Vol. xlix., 6, 691), entitled, "Studies in Floral Zygomorphy," states that: "When any member of a cycle of floral parts shows a definite tendency to reach a developmental stage in advance of the remaining members, or to have the attainment of a developmental stage delayed, zygomorphy is initiated. The zygomorphy may be only temporary, in which case morphological actinomorphy may be restored."

The individual flowers of *D. fascicularis* exhibit initial, pistillate zygomorphy, and there is a marked initial zygomorphy of the inflorescence; for, in almost every cluster, there is a distinct zone of mature, or almost mature flowers, representing roughly one-half of each cluster, while the other half is in bud, or in various stages of early development. An examination of over ninety flower-clusters, on plants in various districts, showed that the flowers develop one after another, but that, about half-way in the development of the cluster, there is a distinct zone of almost mature, closed flowers; while, in the other half, the flowers are young or in bud. At this stage in the growth of the cluster, the flowers are usually all white, or the zone of maturer development is becoming pink. The individual flower, at its maturity, establishes morphological actinomorphy; and, later, the morphological actinomorphy of the inflorescence is attained.

This initial zygomorphy of flower and inflorescence is a distinct gain to the plant, for each cluster, at one period of its existence, will have flowers with elongated styles, carrying the mature stigmas ready to receive pollen; and other flowers, with shorter styles, with large pollen-masses ready for the visitor to carry them away; so that every visit to such clusters means an opportunity of both giving and receiving pollen at the one visit. The clusters are very often grouped closely, so that general cross-pollination is more easily effected. The introduced hive-bees are constant visitors to these flowers during the winter months. But they are useless guests, for they rarely touch the stigmas of the flowers; and only occasionally did I see them brush off the pollen with their wings. They approach the clusters from the side, usually, and walk between the groups of styles without touching the stigmas. They seem to visit the more mature clusters with closed flowers, and it was amusing to watch their efforts to get open the corolla-lobes in order to reach the nectar. Sometimes, in their efforts to force open the flowers, they seem to stand on their heads; and I have seen them force apart the mouth-parts in their endeavours to push the sucking-mouth through to the nectar.

In June and July, 1915, I observed, several times, honey-eaters of two species on these bushes. One species of honey-eater was very shy, and I could not identify it; but I saw the birds fly from flower to flower, and from one Darwinia bush to another. On another occasion, I observed a pair of the Spinebill Honeyeater (*Acanthorhynchus tenuirostris*) on one of the plants; and I was able to get within six feet of them, and watch, at leisure, their feasting on the flower-clusters. They approached mostly from the side, and sent their long bills into the flower-groups, their heads rubbing against the styles. They visited the white-coloured clusters, as well as the red ones. After a time, I stood up, but the birds just looked up, flew to another cluster, and went on feeding. It was only when I moved towards them that they flew off. Unfortunately I had not a camera. On that occasion, Miss Le Plastrier was with me, but she was observing another patch of Darwinia thirty yards away; she, too, saw birds of both species alight, and visit the flower-clusters of *D. fascicularis.* The visitations of these birds, then, make the cross-pollination of Darwinia very simple, for the pollen-masses held by the substigmatic hairs, and carried up by the elongating style, are carried off by the bird as its head brushes the flowers. At the same time, pollen is placed on the stigmas of mature flowers, either of the same cluster or of adjacent ones. The closing of the corolla-lobes is a means of keeping out small creeping insects which would be useless to the flowers, because they might steal the nectar, without touching the stigma or the pollen below it.

These plants, when once established in a district, are plentiful, and must fruit freely.

I examined dozens of mature flower-clusters to see if there was any sign of the stigmas being brought down to meet the remains of the pollen-masses on the substigmatic hairs, and so causing self-pollination, should cross-pollination have failed to take place; but there was not one style which had so bent in order to bring the stigma in contact with the hairs.

I also noticed that it was only in comparatively few flower-clusters that there was an excessive supply of nectar so as to run over the edges of the flowers of such clusters; and I wondered whether, in these inflorescences, visitors had not come, and the excessive nectar was given off to make a special attraction (for such flowers glitter in the sun), or whether it was the result of the accumulation of unused nectar.

The pollen-grains of *D. fascicularis* are typical of the Natural Order Myrtaceæ, being formed of two curved, solid triangles, base to base, with clear triangular outlines, when viewed under the microscope. At each of the truncate angles of the pollen-grain, there is a button-like, transparent protuberance, which marks the spot where the pollen-tube may issue. I put some of the grains in a weak sugar-solution over night, and tubes had developed in the morning.

I submerged flowers in water, and found, after two days, dozens of pollen-grains with well-advanced germ-tubes developed. One interesting example was seen of a mass of pollen on the substigmatic hairs with germ-tubes developed; and nearly all the tubes were stretched out towards the stigma, which was turned slightly downward, owing to the style having been fractured just below the stigma. These grains germinate very readily. After trying them half a dozen times, more than half the grains developed in one night, that is within twenty-four hours.

EXPLANATION OF PLATE LIX.

Pollination of *Darwinia fascicularis*.

Fig. 1.—Inflorescence with actinomorphy restored.
Figs. 2-3.—Young flowers, showing the viscous pollen-mass.
Fig. 4.—Mature closed flower.
Fig. 5.—Flower viewed from above, with the viscous pollen-mass.
Fig. 6.—Stamen showing four pollen-sacs.
Fig. 7.—Mature stamen.
Fig. 8.—Pollen-grains, *b* and *c* with germ-tubes.
Fig. 9.—Stigma, and substigmatic hairs with pollen.
Fig. 10.—Mature stigma.
Fig. 11.—Fruits.

(All figures much enlarged.)

REVISION OF THE AMYCTERIDES.

Part iv. *Sclerorinus* [Section ii.]. [Coleoptera].

By Eustace W. Ferguson, M.B., Ch.M.

(*Continued from p.718.*)

Section ii.

Ventral segments with a strong, hirsute, median vitta in the male; less marked in the female.

Group ii.—Fifth interstice strongly, generally closely, tuberculate; third interstices approximated on the declivity; intermediate tibiæ simple. Type of group, *S. sabulosus* Macl.

This group includes a number of the finest species in the genus. The headquarters of the group are in South Australia, whence it spreads into the Mallee-districts in the north-west of Victoria, and to the Murchison District, in West Australia. The group is represented in Central Australia by a number of species closely related, *inter se*, and constituting a distinct Subgroup, of which *S. convexus* Sloane, is the type.

The species are large, and of an elongate, subparallel form, the prothorax being strongly ampliate. The elytra are tuberculate, but the tubercles vary in size and form, from mere subobsolete elevations along the interstices, to small but definite, or large and conical, tubercles. As a rule, the arrangement is regular, the third, fifth, and sixth interstices being generally more or less closely tuberculate; in *S. Elderi* and one or two others, however, the tubercles are large and separate, even on the fifth interstice. The approximation of the third elytral interstices on the declivity is characteristic, though not confined to the group; it is more pronounced in the female. The structure of the ventral surface is also characteristic of the group. The median vitta projects strongly beyond the plane of the segments, which are concave or subconcave on either side of the vitta, and marked by more or less constant depressions, more particularly on the apical segments.

Many of the species approach each other closely and are difficult to separate. At the same time, I think that, with the exception of *S. arenosus*, which is a synonym of *S. sabulosus*, and possibly of *S. Goudiei*, which, perhaps, is only entitled to be regarded as a variety of *S. sabulosus*, all the described species are distinct. It is possible that I may have allowed too much for variation in the cases of *S. molestus* and *S. Elderi*, both of which have distinct "forms."

The elytral sculpture of *S. convexus* and its allies is at variance with that of the other species of the group. The striæ are more or less strongly foveate, and the interstices subcostiform and broken up into nodulose elevations, having little of the tuberculate character of the other species, excepting about the declivity.

Table of Species, Group ii.

Subgroup A. Elytral tubercles rounded or conical.

1(20). Anterior femora with median ridge beneath.

2(15). Fifth interstice closely tuberculate throughout, tubercles small.

3(8). Tubercles black.

4(5). Sides of prothorax with granules obsolete below protuberance of disc.......... ....*S. sabulosus* Macl.

5(4). Sides of prothorax granulate to coxæ.

6(7). Elytral tubercles very small, granuliform.......... ......*S. Dixoni* Ferg.

7(6). Elytral tubercles noticeably larger and more conical...*S. Goudiei* Ferg.

8(3). Tubercles reddish.

9(10). Clothing dense, ferruginous...... .. . .*S. molestus* Pasc.

10(9). Clothing less dense.

11(12). Tubercles of second interstice not noticeably larger than those of third interstice.

12(11). Tubercles of second interstice closely placed.........*S. occidentalis* Sl.

13(14). Tubercles of second interstice fewer and more distantly placed . ...*S. angustipennis* Sl.

14(13). Tubercles of second interstice distinctly larger than those of third interstice........................... ....*S. Browni*, n.sp.

15(2). Fifth interstice with strong, but separate, tubercles.

16(17). Tubercles black....................*S. laticollis* Macl.; *S. molossus* Pasc.

17(16). Tubercles reddish.

18(19). Prothoracic granules large......................... .... *S. Elderi* Sl.

19(18). Prothoracic granules smaller, form narrower......*S. angustior*, n.sp.

20(1). Anterior femora not ridged beneath..... ....*S. amycteroides* Ferg.

Subgroup B. Elytral sculpture consisting of irregular foveæ and subcostiform interstices, divided into elongate, flattened elevations.

21(22). Outline of elytra in the female much narrowed to apex .. *S. noctis* Sl.
22(21). Not as in *S. noctis*.
23(26). Elytra convex.
24(25). Elevations on the second and fourth interstices not much fewer than on the other interstices .... *S. convexus* Sl.
25(24). Elevations on the second and fourth noticeably fewer than on the other interstices .... *S. Spenceri* Ferg., var.
26(23). Elytra depressed along the middle. ... . *S. insignis* Sl.

Sclerorinus sabulosus Macl.

Macleay, *loc. cit.*, p.322; *S. arenosus* Macl., *loc. cit.*, p.322.

♂. Large, elongate, subparallel. Black; densely clothed with brownish, and with light yellow setæ; ventral vitta light yellow.

Head convex. Rostrum broad, dorsal surface broad; external ridges prominent, thick, not extending up head; median carina appearing as a narrow lævigate line, widening out in front, feebly raised. Eyes ovate. Prothorax (7 × 8 mm.) rather strongly dilatate in front of middle; apex gently rounded above, with definite but rather small ocular lobes; granules depressed, especially in the centre. Sides with granules obsolete except above, and obsolescent in front. Elytra (16 × 9·5 mm.) robust, base emarginate, humeri noduliform; punctures shallow, in regular rows, subtended by small granules; interstices tuberculate; second with one or two; third and fourth each with a continuous row of small tubercles, rounded at base, rather larger and conical on or about declivity, about twenty-five in each row, third interstices approximated on declivity; fourth without tubercles; sixth with a continuous row of thirteen, similar to row on fifth interstice. Beneath, rather rugosely punctured; apical ventral segment grooved in the middle, with the oblique impressions rather indefinite. Anterior femora ridged beneath.

♀. Shorter than ♂, with the prothorax less dilatate, and more rounded; elytra shorter, with the row of tubercles broken in the middle, presenting the appearance of a badly set fracture. Tubercle-index: 1, 22, 0, 21, 12.

Dimensions: ♂, 26 × 9·5 mm.; ♀, 21·5 × 9 mm.

Hab.—South Australia. Type in Australian Museum.

I cannot separate *S. arenosus* from this species; under the name-label of *S. arenosus* in the Australian Museum, are two females, certainly conspecific, one of which has dark setæ, and the other light. In all respects, these agree with the type-female of *S. sabulosus*.

S. Dixoni Ferg., and *S. Goudiei* Ferg., are very closely allied, but I think worthy of separate names. The points of distinction between them were fully discussed when they were described.

SCLERORINUS MOLESTUS Pasc.

Pascoe, Journ. Linn. Soc., xii., 1873, p.9.

♂. Elongate, subparallel, large. Black, elytral tubercles diluted with red; densely clothed with silaceous squames, except on tubercles; median ventral vitta reddish-brown.

Head convex, continued on into rostrum, sometimes a slight transverse impression at junction; external rostral ridges continued on up the head. Rostrum shallowly excavate; external ridges prominent, thick, parallel; median carina narrow, little raised, not continued up forehead; sublateral sulci rather narrow, with a deeper depression at base. Eyes subovate. Prothorax (8 × 8·5 mm.) widely dilatate; apical margin rounded above, with moderately distinct ocular lobes; subapical transverse impression moderately strongly marked; median and sublateral impressions feeble or absent; closely set with small, round, slightly depressed granules, rather smaller in the centre. Sides with very small, distant granules, absent on posterior portion. Elytra (16 × 8·5 mm.) elongate, subparallel, very little widened posteriorly; base widely emarginate, humeri noduliform; punctures shallow, obscured by clothing, the intrastrial granules small, inconspicuous; sutural interstice with a row of fine granules, thickened towards the base, hardly traceable apically; second with a few small, slightly depressed, granuliform tubercles, not reaching base nor extending down declivity; third interstices approximated on declivity, each with a continuous row of small tubercles, closely set, rounded and slightly depressed towards base, slightly more prominent and subconical on declivity; fourth with a few tubercles, similar to those on second, or without tubercles; fifth and sixth interstices each with a continuous row similar to third. Sides with vertical, little prominent rugæ. Beneath, with a median ridge clothed by the median vitta, fifth segment deeply longitudinally grooved on either side of vitta; apical segments with fine, somewhat asperate, setigerous granules. Anterior femora ridged beneath.

♀. Similar to ♂; prothorax less dilatate; convex beneath, with feebler vitta.

Dimensions: ♂, 26 × 8·5 mm.; ♀, 25 × 8 mm. Another ♂ measures 21 × 6·5 mm.

Hab.—South Australia: Eucla, Nullabor Plains, Eyre's Sandpatch.

The above description was drawn up from two specimens which were compared, for me, with the type, in the British Museum, by Mr. K. G. Blair. In his letter, Mr. Blair writes, "type has more swollen thorax of 5, but granules of elytra like those of 6." In a long series of this species which I have examined, great differences were noticeable in the number of the elytral tubercles; there was also some difference in the size of the tubercles; and, in one or two, the elytra were not subparallel, but narrowed towards the apex.

The following tabulation will indicate the great differences in the number of the tubercles.

Specimen.	Number of tubercles on interstices.				
	2.	3.	4.	5.	6.
♂. Eyre's Sandpatch ...	7-9	21-20	4-7	20	15
♂. No locality	6	17-18	3-5	14	14-12
♂. Nullabor Plains ...	2	21-20	0	19	13-12
♂. Eyre's Sandpatch ...	6	23-25	0	23-24	10
♂. Nullabor Plains ...	5	18-16	0	16-18	12-13
♀. Eyre's Sandpatch ...	4	17	2	18-19	12
♀. Eucla	7-8	23-22	0	23-20	14
♀. Eucla(?)	3-5	21	0	19-22	9*

* Tubercles only traceable in apical half.

In cases where the number of tubercles on the two sides varies, the number on the right side is given first.

SCLERORINUS BROWNI, n.sp.

♂. Large, robust, elongate, subparallel. Black, elytral tubercles feebly diluted with red; moderately densely clothed with minute, dingy-brown subsquamosity; median vitta tawny-brown; setæ dark.

Head convex, almost in same plane above as rostrum, feebly depressed in front at bases of the rostral foveæ. Eyes suboval. Rostrum little excavate, the external ridges very feebly convex in profile, subparallel, continued up head for a short distance, somewhat thickened internally about middle, sparsely setigero-punctate; median carina distinct, narrower than the external ridges, impunctate, separated from head by a punctiform depression, thence continued as a narrow, non-carinate, lævigate line; sublateral sulci shallow, with deeper basal foveæ. Prothorax (6 × 7 mm.) moderately widely dilated on the sides; apical margin rounded, very feebly produced above, ocular lobes large; disc convex from side to side, with a rather indistinct, subapical impression, and a feeble impression at the latero-basal angle, median impression hardly traceable; closely set with small, discrete, somewhat depressed granules, smaller in the centre, and fewer along the position of the sublateral vittæ; sides with granules obsolescent, except above. Elytra (15 × 8 mm.) robust, gently rounded on the sides; base feebly emarginate, humeral angles slightly noduliform; seriate punctures small, shallow, slightly transverse, traceable with difficulty, the intrastrial granules small, subobsolete; interstices tuberculate, sutural with small granules, larger and distinct at base, becoming obsolete towards apex; second interstice with four, moderately large, slightly elongate, somewhat depressed tubercles, about middle; third interstices approximated on the declivity, with a continuous row of about twenty-five, small, granuliform tubercles, never becoming conical, extending from base to apex, smaller than those on second interstice; fourth without tubercles; fifth with a row of twenty-five, similar to third; sixth with a row of ten, slightly larger, and more separated, than those of third and fifth, but smaller than those of second, not extending to base. Sides with tubercles somewhat depressed, sometimes confluent vertically. Ventral segments longitudinally impressed on either side of median vitta, impressions indistinct on third and fourth segments, deep on apical segment. Anterior femora with a distinct ridge on the undersurface, in the outer half. Legs simple.

♀. Broader, more robust than male; elytral tubercles more distinctly red. Head more convex, with deeper, frontal depressions; rostral ridges broader, sulci and foveæ deeper. Prothorax less dilatate. Elytra broader, with more pronounced humeral angles, and more evident intrastrial granules; the tubercles on the third and fifth interstices transverse or else duplicated (except on declivity). The undersurface convex, with a feeble, interrupted vitta on the last three segments; longitudinal impressions feeble. *Dimensions*: ♂, 22 × 8; ♀, 24 × 10 mm.

Hab.—Western Australia: Yalgoo (H. W. Brown). Type in Coll. Ferguson.

Though closely related to *S. occidentalis* Sloane, this species can be readily distinguished by the distinctly larger tubercles on the second interstice. In both *S. occidentalis* Sl., and *S. angustipennis* Sl., the tubercles on the second are not noticeably larger than those on the other interstices.

The clothing is only distinguishable under the lens; to the naked eyes, the species appears destitute of clothing.

Sclerorinus laticollis Macl.

Macleay, *loc. cit.*, p. 326.

♂. Elongate, suboblongate, large. Black, subnitid; without clothing above; median ventral vitta black.

Head convex, bi-impressed in front. Rostrum short, thick, external ridges subparallel, thick, continued back on to head; median carina distinct, moderately broad, not continued up head, a narrow linear puncture at point of junction. Eyes small, ovate. Prothorax (5·5 × 7 mm.) very widely dilatate, widest in front of middle; disc closely set with moderately large, rounded granules, largest around central granules, which are slightly smaller, and along subapical impression. Sides granulate. Elytra (11·5 × 6·5 mm.), elongate, subparallel, base feebly emarginate, humeral tubercle moderately prominent, out-turned; seriate punctures shallow, hard to define, interrupted by tubercles, intrastrial granules distinctly prominent. Interstices tuberculate, tubercles moderately large, rounded, somewhat elongate at base, conical towards apex; second with four to six tubercles, separate, not extending to base nor down declivity; third interstices approximated on declivity, with a continuous row of fourteen or fifteen tubercles, from base to apex; fourth with four or five, non-contiguous tubercles; fifth with ten from humeral angle down declivity, sub-contiguous, the line interrupted in places; sixth with seven to nine, close together, more outwardly directed. Sides with interstices tuberculate, the tubercles close together, rounded, little prominent. Beneath, sparsely setigero-punctate; an oblique impression on each side of median vitta, extending over the two basal segments; other segments with more indefinite; middle of abdomen raised along vitta. Anterior femora ridged beneath. 0| *Dimensions:* ♂, 19 × 6·5 mm.

♀. Differs in the somewhat less dilatate prothorax, and in the convex abdomen, the apical segment of which bears a subquadrate impression at the apex.

Hab.—Western Australia. Type in Australian Museum.

A thoroughly distinct species, most nearly related to *S. Elderi* Sl., and *S. molossus* Pasc., the former of which has reddish tubercles, and is otherwise different.

Sclerorinus molossus Pasc.

Talaurinus id. Pascoe, Journ. Linn. Soc. xii., 1873. p.13.

♀. Elongate-ovate, convex, robust. Black, subnitid; without sign of clothing; setæ very small, black.

Head strongly rounded, separately so from rostrum, sparingly setigero-punctate. Rostrum wide, shallowly excavate; external ridges rounded, feebly convex, sparingly setigero-punctate, not continued on to head; median carina present, obsolescent in front, a small, punctiform depression at junction with head; basal foveæ rather indefinite. Eyes rotundate. Prothorax (6 × 7 mm.) subrotundate, disc rather strongly convex; disc closely and evenly covered with hemispherical granules; sides granulate. Elytra (13·5 × 9 mm.) ovate; apex rather strongly rounded; base emarginate, humeral angles produced, tuberculiform; suture with fine granules, thickened at base; second interstice with seven tubercles; third with fourteen; fourth with five; fifth with twelve; sixth with nine; tubercles flattened basally, becoming conical posteriorly. Sides rugosely granulate. Ventral segments feebly maculate with brownish; fifth segment with a feeble, apical impression. *Dimensions*: ♀, 20 × 9 mm.

Hab.—Western Australia.

The above description was drawn up, some time ago, from a specimen compared with the type, which was kindly sent for examination by the British Museum authorities. I now regret not having noted several features which might have proved useful in differentiating this species from its allies. The black colour of the tubercles would associate *S. molossus* with *S. laticollis* Macl., but my recollection is that it was more closely allied to *S. Elderi*. I have a specimen, which, at the time, I identified as a variety of *S. molossus*, and which has the tubercles distinctly reddish. This specimen is readily separated from *S. Elderi* by the sides of the prothorax, which are granulate down to the coxæ. Compared with *S. laticollis*, this specimen has a more convex prothorax, and a broader rostrum; as, however, my specimens are of different sexes, they are hardly comparable.

S. molossus, though described as a Talaurinus, is certainly a Sclerorinus.

Sclerorinus angustior, n.sp.

♂. Closely allied to *S. Elderi* Sl., but narrower. Black, the elytral tubercles diluted with red; moderately densely clothed with minute, obscure, brownish squames; median vitta a rich dark brown.

Head convex, feebly bi-impressed in front, hardly carinate. Rostrum about as wide as head, little excavate above; external ridges very feebly convergent towards base; median carina rather broad, not greatly raised; sublateral sulci moderately broad, shallow, slighter deeper at base. Prothorax (5·5 x 6·5 mm.) moderately dilatate on sides, subangulate slightly in front of middle; ocular lobes rather feeble; subapical constriction present, not deeply impressed; disc convex, closely set with small, unisetigerous, somewhat depressed granules; sides with granules obsolete, except above. Elytra (13 x 7 mm.) very feebly rounded on the sides; base gently emarginate, the humeral angles noduliform; seriate punctures small, shallow, indefinite, intrastrial granules small, hardly traceable, except by setæ; interstices rather strongly tuberculate, sutural with small granules not traceable beyond middle; second interstice with three to five, moderately large tubercles, separate, slightly elongate, not reaching base, nor extending down declivity; third with a row of eleven or twelve separate tubercles, extending from base almost to apex, strongly rounded towards base, the last four or five more prominent and conical; fourth with two near the middle; fifth with a row of nine or ten, separate tubercles, the last two or three conical; sixth with a row of nine, more closely set. Sides with tubercles moderately large, somewhat depressed, sometimes confluent vertically. Ventral segments longitudinally impressed on each side, the impressions deeper on the fifth segment. Anterior femora ridged beneath; legs simple. *Dimensions*: ♂, 22 x 7 mm.

Hab.—Western Australia. Type in Coll. Ferguson.

Three specimens are under examination, labelled "Whitlock, C. French." I am uncertain whether Whitlock is the name of a place, or of the collector from whom Mr. French received them.

The species is closely allied to *S. Elderi* Sl., of which it might be more properly considered a subspecies. It may be distinguished by its smaller, narrower form; and by the smaller, more depressed, prothoracic granules.

As in other species of this group, the number of tubercles on each interstice is variable, even on the two sides of the same specimen. The numbers given in the description are those of the type, the relative numbers in the three specimens are shown below:—

	Interstices.					
	2.	3.	4.	5.	6.	
(1). Type ...	3-5	11-12	2	9-10	9	
(2). ...	6	10	5-6	8-10	10	Tubercles slightly smaller; intra-strial granules more evident.
(3). ...	4-5	9-10	2-3	9-10	8	Tubercles somewhat larger.

Other species belonging to Group ii.

S. Dixoni Ferg.—Victoria: Ouyen, Kow Plains.

S. Goudiei Ferg.—Victoria: Birchip.

S. occidentalis Sl.—W.A.: Upper Murchison (type), Kellerberrin.

S. angustipennis Sl.—W.A.: Frazer Range (type): South-West Australia. Two specimens, in my collection, labelled S.W. Australia, are larger than the types and more elongate; I do not think they are specifically distinct.

S. Elderi Sl.—The range of this variable species is from South Australia to the Murchison in Western Australia. I have records of the following localities: Everard Range (type), Fowler's Bay, Streaky Bay, Ouldea, Gawler Ranges, Overland Railway (20 miles E. of Kychering Soak), Cue (Murchison District).

S. amycteroides Ferg.—Victoria: Portland.

S. noctis Sl.—Central Australia: Barrow Range.

S. convexus Sl.—Central Australia: McDonnell Ranges.

S. convexus Sl., var. *Spenceri* Ferg.—Central Australia: Ouldea to Talarinna, Deering Creek, Hermannsburg.

S. insignis Sl.—Central Australia (Elder Expedition).

Group iii.

Fifth interstice continuously tuberculate; third interstices not approximated on the declivity; middle tibiæ simple.

This group has been formed for the reception of a few species which occur along the highlands of Queensland and New South Wales. Two other species have been included—*S. bubalus* from Tasmania, Victoria, and South Australia; and *S. dilaticollis* from Victoria—which present the above characters, but which differ in other respects from the other members of the group. *S. horridus* also possesses the main characters of this group, but is so different in many respects, that I have not included it, but treated it as an anomalous species.

I have seen a large number of specimens from different localities in New South Wales, which belong to this group, but which were mostly represented by single specimens. They showed considerable variation, *inter se,* and from any of the described species. I have not had sufficient material, however, to determine the range of variation, and have, therefore, described only the most outstanding forms. I think, however, that the group will be found to be a much larger one, when the mountain-ranges, particularly in the southern portions of New South Wales, have been properly worked.

A species, that occurs commonly on the Blue Mountains, has been identified by Macleay as *S. elongatus* Bohem.

Table of species, Group iii.

1(4). Prothorax finely granulate.
2(3). Elytral tubercles little larger than the prothoracic granules.... ....*S. bubalus* Oliv.
3(2). Elytral tubercles much larger than the prothoracic granules.... .... *S. dilaticollis* Macl.
4(1). Prothorax more coarsely granulate.
5(12). Elytral tubercles in continuous series on most of the interstices.
6(7). Tubercles transversely conjoined on the fifth and sixth interstices; elytra separately mucronate......................*S. apicalis* Macl.
7(6). Tubercles not as in *S. apicalis.*
8(9). Ventral vitta yellowish-brown............. ... .*S. Stutchburyi* Macl.
9(8). Ventral vitta black.
10(11). Elytral striæ evident, at least the two inner ones...*S. aterrimus,* n.sp.
11(12). Elytral striæ hardly, if at all, traceable.... . *S. elongatus* Bohem.(?).
12(5). Elytral tubercles well developed, but separate, on all the interstices...*S. verrucosus* Macl.

Sclerorinus bubalus Oliv.

Olivier, Ent. v., 83, p. 399, t. 25, f. 354; *Amycterus morosus* Boisd., Voyage Astrolabe, ii., 1835, p. 386; Ferguson, Proc. Linn. Soc. N.S. Wales, 1911, p. 152.

As I have recently fully described the type of *A. morosus* Boisd., a further description is unnecessary here.

Specimens in my collection from Victoria(?), differ somewhat from Tasmanian specimens; and may, perhaps, belong to a distinct species. I hesitate to describe them as distinct, as Tasmanian species appear to vary somewhat. They differ principally in the almost obliterate sculpture; in one male, the prothoracic granules are almost obsolete; in another, they are more distinct; in both, the elytral tubercles are small and almost obsolete, and the punctures are hardly traceable. The specimens of a Tasmanian series before me(5) show some variation in the size of the tubercles, and one male has them almost as small as in the supposed Victorian specimens; a female is also hardly separable from a Victorian(?) female. These specimens, I attribute to Victoria principally because they were received from Mr. C. French, of Melbourne. I have, however, seen undoubted Victorian and South Australia specimens which I attributed to *S. bubalus*.

Sclerorinus dilaticollis Macl.

Macleay, *loc. cit.,* 1865, p. 258.

♂. Elongate-ovate, of medium size. Black; clothing reduced to minute muddy-coloured squames in depressions, ventral vitta black.

Head convex, slightly impressed in front, on each side of median line. Rostrum short, external ridges parallel, not continued along head; median carina prominent, about as wide as external ridges; sublateral sulci rather deep. Prothorax (3·5 × 4·25 mm.) widely dilatate, subangulate on sides, rather strongly narrowed before base, postero-lateral angles subrectangular; ocular lobes distinct; subapical impression well marked, median line moderately distinctly impressed posteriorly; closely set with small, rounded granules. Sides not granulate. Elytra (8 × 4·5 mm.) elongate, little widened posteriorly; base gently emarginate, humeral angles out-turned, tuberculiform; seriate punctures small, shallow, rather indistinct, intrastrial ridges slightly raised, granuliform, but not prominent; interstices two and four not raised, and without tubercles; sutural interstice strongly raised, and costiform at base;

third interstice with large, prominent tubercles, about ten in number, but variable in both number and position, extending from base down declivity, or ending before declivity; fifth with a continuous row of closely-set tubercles, smaller than on third, rounded at base, conical posteriorly; sixth with a similar row, commencing rather far from base. Sides vertically rugose, tubercles obsolete. Beneath, with a deep, oblique impression on either side of base of median vitta, and fainter impressions on other segments. Anterior femora with a moderately distinct ridge beneath; intermediate tibiæ simple.

♀. More ovate; undersurface convex, fifth segment very feebly depressed at apex.

Dimensions: ♂, 14 × 4·5; ♀, 15 × 6 mm.

Hab.—Victoria, Melbourne. Type in Macleay Museum.

Redescribed from specimens in my own collection. This species is very variable in size, and in the degree of tuberculation of the elytra. Some of the specimens I have seen, were hardly larger than *S. bubalus*, to which the species is most closely allied, but the elytral tubercles are always larger than in that species.

Two specimens from Caulfield (Melbourne) in the National Museum, Melbourne, differ in having tubercles on the second and fourth interstices; they may belong to a new species; at present, I regard them as a variety.

Sclerorinus apicalis Macl.

Macleay, *loc. cit.*, p. 260.

♀. Elongate-ovate. Size moderate. Black; rather densely clothed in depressions with brownish squames; median ventral vitta yellowish.

Head convex, forehead very feebly bi-impressed in front. Rostrum rather strongly excavate in front; the external ridges strongly developed, slightly sinuate, the median carina conspicuous, rather broader than the external ridges; sublateral sulci rather narrow, deep. Eyes subrotundate. Prothorax (4·5 × 5 mm.) evenly rounded on sides; subapical and median impressions indefinite; closely set with small, rounded granules, rather larger than in

S. dilaticollis, the granules becoming obsolescent on the sides, towards the coxæ. Elytra (10 × 6 mm.) moderately produced to apex, each elytron with a strong, sharp mucro at apex; base gently emarginate, humeral angle with a strong, rounded tubercle; punctures shallow, towards sides confluent laterally, and arranged in a series of transverse grooves, suture raised, costiform at base, elsewhere with a row of small granules; second interstice with two or three moderately large, isolated tubercles; third with five similar ones from base to above declivity; fourth with no tubercles; fifth and sixth, and lateral interstices with tubercles small, and joined across by the intrastrial ridges to form a series of parallel, transverse rugæ separated by deep sulci; this transverse arrangement also faintly traceable across the declivity. Undersurface of type obscured by gum. *Dimensions*: ♀, 16 × 6 mm.

Hab.—New South Wales(?). Type in Macleay Museum.

The only specimen I have ever seen of this interesting and distinct species, is the type. Probably the mucronation is a sexual character; but, apart from this, the transverse rugæ render the species easy of identification.

Sclerorinus Stutchburyi Macl.

Macleay, *loc. cit.*, p. 264.

♀. Elongate-ovate. Black; with scanty, minute, brown squames in depressions.

Head strongly convex, front feebly bi-impressed. Rostrum wide, dorsal surface much narrower than total width; external ridges prominent, thick, slightly convergent basally, and running on to head for a short distance; median carina evident, but slightly less prominent, not extending on to head. Eyes small, rotundate. Prothorax (4 × 4·75 mm.) widest in front of middle, not greatly ampliate, rather strongly transversely convex; subapical impression rather indefinite; moderately closely set with rather large, non-contiguous, rounded tubercles, obsolete on the sides. Elytra (9·5 × 6 mm.) not greatly widened posteriorly; base moderately emarginate, humeri noduliform, out-turned; punctures shallow, not definite towards the sides, tending to be confluent laterally, this tendency more marked on the sides; intrastrial granules distinct. Interstices tuberculate; sutural costiform at base, elsewhere with fine granules; second with seven, rather large tubercles, elongate towards base, more raised and conical posteriorly, extending from near base down declivity; third with a similar row of eight, from base down on to declivity; fourth with no tubercles; fifth with a continuous row of smaller tubercles, somewhat transverse, and about thirteen in number; sixth with eleven, similar tubercles. Sides with vertical rugæ separated by depressions, not so marked as in *S. apicalis*. *Dimensions*: ♀, 15 × 6 mm.

Hab.—Queensland. Type in Australian Museum.

This species may be readily distinguished from the other members of the group by the colour of the median, ventral vitta. The tubercles on the fifth interstice are somewhat irregular; in a specimen, in my own collection, they are almost absent on one elytron.

I believe the type came from Queensland, but do not know from what locality. There is a specimen, which I refer to this species, in my own collection, from Tamworth, N.S.W.

SCLERORINUS ATERRIMUS, sp.n.

♂. Elongate, subparallel. Black, subnitid, legs diluted with red; clothing practically absent; median, ventral vitta black; setæ black.

Head separated from rostrum above by a slight constriction; external rostral ridges continued back into forehead; median line rather feebly subcarinate. Rostrum with external ridges slightly convex in profile, somewhat sinuate as viewed from above; median carina strong, narrow, separated from head by a deep puncture; sublateral sulci broad and deep, especially at base. Eyes ovate. Prothorax (4 × 4·5 mm.) widest anteriorly to middle, subangulate at sides; ocular lobes not very prominent; disc with rather large, rounded granules, variable in size, moderately closely set; sides with granules obsolete. Elytra (10 × 5 mm.) elongate, subparallel; base emarginate, humeri noduliform; with rows of small punctures, each subtended by a small, setigerous granule, the inner two rows regular, the outer rows confused and broken by the tubercles; interstices with strong, conical tubercles, suture with a few obsolete granules at base; second interstices with two or three isolated tubercles; third with a more continuous row of ten, more closely set, extending almost to apex; fourth with one or none; fifth with a continuous row of ten closely placed tubercles; sixth with nine, not reaching to base; the tubercles of the fifth and sixth interstices conical, slightly smaller than those of third, and not transverse. Sides with punctures more regular, the interstices with subobsolete tubercles. Beneath, with scattered, setigerous punctures; apical segment concave, not excavate, the posterior and lateral borders raised. Anterior femora with a well developed ridge beneath; tibiæ simple. *Dimensions*: ♂, 17 × 5 mm.

Hab.—New South Wales, Mt. Kosciusko (Dr. A. Jefferis Turner). Type in Coll. Ferguson.

Close to the species identified by Macleay as *S. elongatus* Germ., but narrower, with much more evident elytral punctures. Possibly an extended series, from intermediate localities, would link the two species up, but, at present, I do not think it can be regarded as conspecific with the Blue Mountain species.

Sclerorinus elongatus Bohem.

Bohemann, Schönh., Gen. Curc., vii.(1), 1843, p. 58.

This species has been referred, and I believe correctly so, to Sclerorinus, by Macleay, who, moreover, identified it with an insect which occurs on the Blue Mountains, N.S.W.

An examination of the description enables me to assign the species with tolerable certainty to Group iii. The description of the abdomen, ". . . medio longitudinaliter dense atro-pubescens" would apply only to *S. inconstans, S. alpicola,* one or two members of Group i., and Group iii. The species not belonging to Group iii., can all, I think, be excluded. Of the species contained in Group iii., *S. bubalus, S. dilaticollis,* and *S. Stutchburyi* can confidently be excluded; and I do not think that it is likely to prove to be *S. apicalis* or *S. verrucosus.*

Until the type can be examined, I think it wisest to accept Macleay's identification as being correct, particularly as this insect agrees fairly closely with Bohemann's description. It is closely allied to *S. aterrimus* Ferg., but differs principally in the elytra wanting the regular, striate punctures, these punctures being almost obsolete in the Blue Mountain species. As Bohemann describes the elytra as "vix striato-punctata," I do not think that *S. aterrimus* can be identical with *S. elongatus*, though it may prove merely a variety.

Some time ago, Mr. K. G. Blair, of the British Museum, sent me, for examination, a specimen of *S. verrucosus* bearing the following label—"agrees with specimen in British Museum named *elongatus* Germar; compared with Hope's specimen referred to by Schönherr. I have not found this specimen, the only *elongatus* in Hope's Collection being an Acantholophus, "*elongatus* mihi" in Hope's writing."

Bohemann states that he received his specimens from Germar and Hope.

Germar, in his Insects of Adelaide (Linn. Ent. iii., p. 217), shortly redescribes *S. elongatus*, and states—"Specimen a Schönherro e museo nostro descriptum, squamis detritis, tuberculisque paullo crassioribus ob hoc nunc allato recedit. Striga villosa pectoris abdominisque atra, quam signum maris credam, pariter colore ferrugineo differt." This leaves a suspicion that, either Germar, or more probably Bohemann, had mixed up two species; or that possibly Bohemann's description was based on Hope's specimen. Certainly, among many species, I have never found a South Australian species agreeing with Bohemann's description.

Sclerorinus verrucosus Macl.

Macleay, *loc. cit.*, p. 262.

♀. Elongate-ovate. Black; sparsely clothed with minute, dingy-brown squamosity in depressions; median vitta yellow.

Head strongly convex, separately so from rostrum; forehead feebly bi-impressed, the median line lævigate, not raised, with a small puncture at junction with rostrum, and one above. Rostrum broad, little excavate; dorsal surface considerably narrower than total width of rostrum; external ridges subparallel, not continued upon head, median carina strong, about as broad as external ridges; sublateral sulci rather shallow, deeper at base. Prothorax (4 x 5 mm.) subangulate on sides, widest in front of middle; subapical impression rather indefinite; moderately closely set with large, rounded, slightly depressed tubercles, varying slightly in size, and irregularly placed; sides not granulate. Elytra (10 x 6 mm.) not greatly widened posteriorly; base rather strongly emarginate; humeri with a rather large, projecting tubercle; punctures not traceable; interstices with strong, conical or subconical tubercles; sutural with a row of fine, distant granules; second with a row of eight tubercles, set at even distances, less than the length of a tubercle, extending from near base down on to declivity; third with a similar row of ten from base down on to declivity; fourth with six, not reaching base, nor extending down declivity; fifth with twelve, slightly smaller, subconical, out-turned; sixth with thirteen, slightly smaller and less conical. Sides with strong, vertical ridges, separated by deep furrows, the ridges running up on to, and including the tubercles of the sixth interstice. Beneath, convex; ventral segments with irregular impressions on each side; fifth with a shallow, transverse impression near apex. *Dimensions*: ♀, 16 x 6 mm.

Hab.—New South Wales. Type in Macleay Museum.

Though closely allied to *S. elongatus* Bohem.(?), this species may be readily identified by the tubercles on each interstice being well separated from one another. I have a male, which was taken, I believe, at Blackheath, on the Blue Mountains, and which I refer, with slight doubt, to this species. It has the ventral vitta black. Probably this species has a wider range inland, as I once took, at Wellington, the remains of a Sclerorinus, which appeared to be *S. verrucosus*.

Group iv.

Fifth elytral interstice tuberculate throughout; intermediate tibiæ with a strong, subapical emargination.

Though but few in number, the species of this Group are very homogeneous in their general type of structure The Group is, I think, more closely related to the *Stutchburyi*-group than to the following one, though the notched tibiæ are present in such species as *S. tuberculosus* and *S. Germari.*

In many of the species, the elytral interstices are costiform in character, the costæ, however, often resolving into their component tubercles. The Group corresponds, therefore, to Group 4 in Macleay's subdivision of the genus.

The species are distributed over the southern tablelands in New South Wales, extending from the Murray, to at least as far north as Mudgee.

In addition to the species described by Macleay, three of the early described species appear to belong to this group. *Amycterus Kirbyi* Guérin is almost certainly founded on *S. subcostatus* Macl. I regard Guérin's name, however, as preoccupied by *Phalidura Kirbyi* W. S. Macleay, the two genera being then, as indeed they really are, considered to be synonymous, notwithstanding that the two species are now placed in different genera. The description of *Amycterus dolens* Boisd., would apply to a number of species of this group; and *S. subsequens* Macl., has been sent to me from the British Museum as *S. dolens* Boisd. Until the type can be located, and authoritatively examined, I think it best to treat Boisduval's species as non-existent. *S. Hopei* Bohem., is quite possibly a grey-clothed species, widely distributed on the western slopes of the tableland, from Koorawatha to Mulwala on the Murray. Specimens have been sent to Stockholm for comparison with Bohemann's type; in the meantime, I have redescribed the species as *S. Hopei* Bohem.(?).

S. vermiculatus Macl., I regard as a synonym of *S. subcostatus* Macl.; and *S. interruptus* Macl., as a synonym of *S. subsequens* Macl.

I have added one new species, *S. subcarinatus*, to the Group.

Table of Species, Group iv.

1(8). Clothing scanty, except on sides.

2(5). Prothoracic granules obsolete or subobsolete in middle, often confluent.

3(4). Elytral interstices strongly raised, generally costiform (excepting sometimes the second and fourth)........... ..*S. subcostatus* Macl.

4(3). Elytral interstices less strongly raised, less costiform, the component tubercles smaller, granuliform..............*S. squalidus* Macl.
5(2). Prothoracic granules distinct, rounded.
6(7). Elytral interstices with the tubercles, as a rule, distinctly separate. ....*S. subsequens* Macl.
7(6). Elytral interstices continuous, crenulate.......... *S. subcarinatus*, n.sp.
8(1). Clothing dense, light greyish-brown ....*S. Hopei* Bohem.(?).

SCLERORINUS SUBCOSTATUS Macl.

Macleay, *loc. cit.*, p. 258; *S. vermiculatus* Macl., *l.c.*, p. 261; (?)*Amycterus Kirbyi* Guérin, Voy. Coquille, ii.(2), 1830, p. 121.

♂. Size moderately large, elongate, robust. Black; practically without clothing above; with yellow pubescence clothing the sides of the prothorax, the basal portion of the sides of the elytra, and the sternal segments; median vitta ochreous-yellow; legs sparsely clothed with yellow; setæ black.

Head convex. Rostrum little excavate; external ridges subparallel; median carina moderately prominent, a deep puncture present at junction with head; sublateral sulci shallow, with a deep basal fovea. Prothorax (5·5 x 6·5 mm.) subangulate, dilatate on sides, widest in front of middle; ocular lobes moderately large; subapical impression moderately strongly marked, median line shallowly impressed; set with low, semiconfluent granules, almost or completely obsolete in centre, more rounded and distinct at lateral angles; sides non-granulate. Elytra (11 x 7 mm.) not greatly widened posteriorly; base gently emarginate, humeral angles rather strongly marked, out-turned; with regular rows of moderately large, open, foveiform impressions, the intrastrial granules feeble; interstices costiform, the first, third, fifth, and sixth strongly raised; the second and fourth less strongly or not at all raised; third interstice the most strongly raised, somewhat crenulate on upper surface, showing a tendency to split up into elongated tubercles posteriorly; fifth crenulate-costate, sometimes split into its component tubercles; sixth composed of elongate, closely set tubercles; lateral interstices with tubercles obsolete. Undersurface with basal, ventral segments flattened or feebly depressed in middle, the other segments gently convex from side to side.

Anterior femora not ridged beneath; intermediate tibiæ with a strong subapical emargination; posterior tibiæ with a feebler emargination.

♀. More ovate than the male; convex beneath, without median vitta, the ventral segments feebly maculate with yellow, the fifth segment with a feeble transverse impression at extreme apex; intermediate and posterior tibiæ feebly emarginate.

Dimensions : ♂, 18 × 7; ♀, 16 × 6·5 mm.

Hab.—New South Wales: Goulburn, Taralga, Lockyersleigh, Bathurst, Molong, Wingelo, Braidwood. Type in Macleay Museum.

This species has probably a wide range over the southern tablelands. It is very variable in regard to the elytral sculpture, particularly in the costiform character of the interstices. The above description was drawn up from specimens in my own collection, as access could not be had to the types in the Macleay Museum. I have, however, examined these on several occasions, and can find no valid reason for separating *S. vermiculatus* from *S. subcostatus.* This species is almost certainly the *Amycterus Kirbyi* of Guérin, but, for reasons mentioned elsewhere, I regard this name as preoccupied.

The specimens from Molong should, possibly, be regarded as a new species; but they are so closely allied to *S. subcostatus*, that I do not care to separate them.

SCLERORINUS SQUALIDUS Macl.

Macleay, *loc. cit.*, p.261.

♂. Elongate-ovate, relatively broad. Black; without clothing above, metasternum and sides of ventral segments with small patches of fulvous; median, ventral vitta fulvous. Setæ light golden-brown.

Head running into rostrum without interruption, forehead feebly flattened, feebly bi-impressed in front; median line lævigate. Rostrum wide, dorsal surface wide; median carina narrow, rather feebly raised; sulci broad, shallow, with a deeper, subtriangular fovea at base. Prothorax (4·5 × 5·5 mm.) transverse, subdilatate, widest in front of middle; apical margin feebly sinuate in the middle above, with prominent, ocular lobes; median line feebly impressed; granules rugose, irregularly arranged, often confluent, obliterate in the centre, more distinct and rounded towards the sides; sides without granules. Elytra (11 × 7 mm.) rather broad, gradually widened posteriorly; base gently emarginate, humeri prominent, not projecting; seriate punctures open, shallow, each subtended by a distinct setigerous granule. Sutural interstice with a continuous row of granules; second interstice with about eight, narrow, small, elongate tubercles, hardly larger than the intrastrial granules, each bearing a seta at extremity; third with a continuous row of seventeen, similar, elongate tubercles, joined together to make the interstice subcostiform; fourth with six, similar to second; fifth with a row of about eighteen, similar to third, but more rounded; sixth with a similar row of sixteen. Sides with interstices with small, flattened, granuliform tubercles. Beneath, flattened over ventral segments, without notable impressions, fifth segment very shallowly depressed in middle, the depression obscured by the vitta. Intermediate tibiæ emarginate on the inner side subapically. Anterior femora not ridged.

♀. Differs in having the intrastrial granules smaller, and the third and fifth more definitely costiform. It differs also in being convex beneath, and in having simple legs.

Dimensions: ♂, 17 × 7; ♀, 16 × 6·5 mm.

Hab.—New South Wales: Lambing Flat (Young), Harden. Type in Macleay Museum.

The specimens from Harden differ slightly from the type in the elytral interstices; but the species is somewhat variable in this respect, no two specimens, that I have seen, being quite alike. The setæ are also of a darker colour. I think that this is probably also a variable character.

Sclerorinus subsequens Macl.

Macleay, *loc. cit.*, p.263; (?)*S. interruptus* Macl., *loc. cit.*, p.263.

Type ♀. Elongate-ovate. Black; devoid of clothing; setæ light brown.

Head convex, bi-impressed in front. Rostrum little excavate; external ridges conspicuous, running back on to head, with a slight constriction at point of junction; median carina narrow, slightly less prominent, and much narrower than the external ridges, not extending on to head; sublateral sulci shallow, with a deeper, foveiform depression at base. Prothorax (4·25 × 5·25 mm.) widest a little in front of middle, ocular lobes moderately prominent; closely set with moderately large granules (or tubercles), slightly confluent, or subconfluent, near centre, rounded, and separate towards sides, median line with few granules. Sides with a few obsolete granules above and in front. Elytra (10·5 × 7 mm.) ovate, gradually widened posteriorly; base feebly emarginate, humeral angles nodulose, out-turned; seriate punctures small, intrastrial ridges setigerous, hardly definitely granulate. Interstices tuberculate: sutural narrow, somewhat raised and costiform; second with six, narrow, elongate tubercles, the basal four connected and costiform; third costiform, composed of elongate, narrow tubercles, connected together, and becoming separate and feebly conical on the declivity; fourth with one or two, small, elongate tubercles; fifth with a continuous row of sixteen, small, rounded tubercles, closely set but not costiform; sixth with a similar row of twelve. Beneath, convex. Intermediate tibiæ with a shallow, subapical emargination. *Dimensions:* ♀, 16 × 7 mm.

Hab.—New South Wales: Mudgee. Type in Australian Museum.

The above description was drawn up from the type in the Australian Museum. The type of *S. interruptus* Macl., also a female, in the same collection, was examined on the same occasion, and the following notes made:

♀. Smaller than *S. subsequens*; head and rostrum similar; prothorax (3·5 × 4·5 mm.) with granules slightly less prominent, rounded. Elytra (9 × 6 mm.) with punctures shallower; second interstice with four or five, isolated tubercles, shorter and more raised, not at all costiform; third with about nine tubercles, the basal five connected, forming an irregular costa; fourth without tubercles; fifth with twelve tubercles, more elongate than in *S.*

subsequens, connected together, costiform; sixth with a similar row of eleven. Beneath, as in *S. subsequens*. *Dimensions:* ♀, 14 × 6 mm.

Hab.—Mudgee.

Despite the apparent difference in the elytral tubercles, I am inclined to regard the two specimens as belonging to but one species. There are, in the Australian Museum, and in my own collection, specimens which are intermediate between the two types in their elytral sculpture. There are specimens in my own collection from Tarana, which I attribute, with some slight doubt, to *S. subsequens*; the females are much alike, but a male is much more coarsely tuberculate than any Mudgee specimens, especially when compared with a male from Mudgee, which seems to be the same as *S. interruptus*. There is also some doubt as to whether the Australian Museum specimen of *S. interruptus* is actually the type. Macleay gives the measurements as 8 × 3¼ lines, but the Australian Museum specimen measures only 7 × 3 lines, though agreeing in other respects with the description. Tentatively, I propose to sink *S. interruptus* under *S. subsequens*, retaining the latter name, although the former is described before the latter on the same page.

Sclerorinus dolens Boisd.

Boisduval, Voy. Astrolabe, ii., 1835, p.376; Macleay, *loc. cit.*, p.264.

The description of the elytra leaves no doubt that this species is a member of Group iv. As the prothorax is described as "confertim granulato," the species is evidently different from *S. subcostatus* Macl., or *S. squalidus* Macl. The description of the elytral interstices may well be quoted:—"On voit sur chacune d'elles sept côles élevées, interrompues, comme rongées, moins distinctes sur les flancs qu'en dessus. Les intervalles sont ponctués irrégulièrement et occupés par des points élevés, confluents parfois et disposés sans ordre." This description would apply almost equally well to *S. subequens* and *S. subcarinatus*. A specimen sent out from the British Museum, for examination, under the name of "*dolens*, Boisd.(?)," proved to be a specimen of *S. subsequens*.

While I think it likely that this synonymy will prove correct, I do not think it advisable, at present, to sink Macleay's name for Boisduval's.

Sclerorinus subcarinatus, n.sp.

♂. Elongate, ovate; of median size. Black, opaque; without clothing above, save for a few minute scales in depressions; with conspicuous patches of golden-yellow pubescence on the sides of the prothorax, the metasternum, and first abdominal segment; with a bright golden-brown median vitta, and a few, long, black setæ intermingled. Setæ black.

Head continuous with rostrum above; the external, rostral ridges continued back on to head, but not carinate, with a narrow, median line free from setæ, but not raised, elsewhere strongly nigrosetose. Rostrum little excavate, external ridges subparallel; median carina raised, not very prominent, separated from head by a small fovea; sublateral sulci rather shallow, deeper, foveiform at base. Prothorax (5 x 5·5 mm.) moderately strongly rounded at sides; apical margin lightly sinuate above, with prominent, ocular lobes; disc closely set with small, rather depressed granules, frequently subconfluent, but nowhere obsolete, except immediately along anterior margin; sides only granulate above. Elytra (10·5 x 6·5 mm.) rather strongly rounded on sides; base moderately deeply emarginate, humeri prominent, noduliform; disc rather deeply striate, with small, open punctures in striæ, each subtended by a seta; interstices raised, costiform, narrower than the striæ, edge very obsoletely serrate, serrations more definitely granuliform on the more lateral interstices, and on the declivity, each with a long, decumbent seta. Sides with closely set, rounded, depressed granules on the interstices, the latter not costate. Beneath, flattened. Anterior femora not ridged; middle and posterior tibiæ with a deep, subapical emargination.

♀. Similar to ♂, more ovate; sculpture similar, but elytral, intrastrial granules distinct; beneath, convex, the median vitta much feebler, not hirsute, tibiæ with much feebler emarginations.

Dimensions: ♂, 17 × 6·5 ; ♀, 17 × 7·5 mm.

Hab.—N.S.W.: Grenfell (T. G. Sloane and E. W. Ferguson). Type in Coll. Ferguson.

I do not think that this species can be confused with any previously described one. *S. subsequens* is its nearest ally, but differs in the rather larger, prothoracic granules, and in the elytral sculpture, to some extent. It is, of course, possible that *S. dolens* Boisd., may prove to be this species.

Group v.

Fifth interstice typically tuberculate only at the base, or more feebly tuberculate than on the other interstices.

The species constituting this Group may be further subdivided into four Subgroups.

Subgroup A contains the more typical species of the Group, and comprises a number of closely allied species often difficult to separate, in many cases, leading into one another. *S. longus*, *S. vestitus*, and *S. Stewarti* are undoubtedly closely allied, but I have regarded them as distinct; *S. tæniatus* Pasc., is a synonym of *S. Stewarti* Macl. *S. pilularius* Macl., is closely allied to *S. sublineatus* Macl., and *S. alpicola* Ferg., to *S. inconstans* Lea.

Subgroup B contains but a single, named species, *S. exilis*. I have specimens of it from Widgiewa and Condobolin; but the specimens from the latter place differ in some respects, and might be regarded as distinct, or, at least, as a variety.

The Subgroup has the tubercles on the elytra all separated, and they are present at intervals all along the fifth interstice. On this account, it might be thought advisable to remove this species from the Group, but it is, in other respects, so closely allied to the other members, that I have not thought it necessary.

In Subgroup C, the tubercles are closely set on the third and sixth interstices, and few or absent on the others. The third interstices are also approximated on the declivity. So far, only two species fall into this Subgroup, *S. biordinatus* Macl., and *S. Blackburni* Ferg., found on opposite sides of Spencer's Gulf.

Subgroup D contains those species of Group v., which have the intermediate tibiæ with a strong, subapical notch. *S. tuberculosus* Macl., from Victoria, and *S. Queenslandicus*, sp.n., from Queensland, are larger than the others. Of these latter, *S. Germari* appears to form a centre around, and from which, several variations occur. I have, however, not considered these as specifically distinct, except in the case of *S. parvulus* and *S. mucronipennis*.

S. mucronatus Macl., and *S. meliceps* Pasc., should probably also come into Group v., the former being probably a synonym of *S. tuberculosus*.

The Group, while on the whole a natural one, tends to lead, on the one hand, through *S. inconstans* to the *Stutchburyi*-group; and, on the other, through *S. tuberculosus* and *S. Queenslandicus* to the *subcostatus*-group.

The majority of the species are inhabitants of South Australia, though several extend into Victoria. *S. inconstans*, *S. exilis*, and *S. Stewarti* occur in New South Wales; while *S. Queenslandicus* is from Southern Queensland. *S. meliceps* Pasc., is from Central Queensland.

Table of Species. Group v.

Subgroup A. —Without the special features found in the other subgroups.
1(10). Median vitta reddish-yellow or brown.
2(7). Tubercles conspicuous, not obscured by clothing.
3(4). Clothing uniform, grey.. *S. longus* Macl.
4(3). Clothing darker, with three, obscure vittæ on each elytron.
5(6). Tubercles comparatively large.................................. *S. vestitus* Macl.
6(5). Tubercles small.. *S. Stewarti* Macl.
7(2). Elytral tubercles more or less obscured by clothing.
8(9). Form narrow, subparallel; rostral clothing white..................
.... *S. sublineatus* Germ.
9(8). Form more ovate, robust; rostral clothing yellow... *S. pilularius* Macl.
10(1). Median, ventral vitta black.................................. *S. inconstans* Lea.
Elytral tubercles fewer and smaller than in *S. inconstans*.
.... *S. alpicola* Ferg.

Subgroup B.—Tubercles separate, at intervals along all the interstices, excepting sutural .... *S. exilis* Macl.

Subgroup C.—Third and sixth interstices alone strongly and closely tuberculate; third interstices approximated on the declivity.

11(12). Elytra with conspicuous, white vittæ..............*S. biordinatus* Macl.
12(11). Elytral clothing darker; tubercles larger.........*S. Blackburni* Ferg.

Subgroup D.—Intermediate tibiæ with deep, subapical emargination.

13(16). Tubercles large, conspicuous.
14(15). Intrastrial granules conspicuous...................*S. tuberculosus* Macl.
15(14). Intrastrial granules obsolete ....*S. Queenslandicus*, n.sp.
16(13). Tubercles small, granuliform.
17(20). Elytra not mucronate in the female.
18(19). Prothoracic granules elongate, subobsolete..........*S. Germari* Macl.
19(18). Prothoracic granules discrete, rounded...............*S parvulus* Macl.
20(17). Elytra separately mucronate at apex in the female.............
...........*S. mucronipennis* Ferg.

Sclerorinus longus Macl.

Macleay, *loc. cit.*, p.258.

♂. Elongate-elliptical; size large. Black; densely clothed with light grey subsquamosity; beneath, with greyish-yellow clothing at sides, and with a light golden-brown, median vitta.

Head not quite in the same plane with rostrum above; the external, rostral ridges continued back to above eyes; median line bare in front, hardly carinate. Rostrum short, rather narrow across the external ridges, these parallel; median carina distinct; sublateral sulci shallow, deeper at base. Eyes rotundate, Prothorax (5·5 × 6·5 mm.) subdilatate on sides, widest in front of middle; apical margin rounded above, with moderately prominent, ocular lobes. Disc with a moderately distinct, subapical impression; with median and sublateral lines free from granules, hardly impressed: granules variable in size, small, with a few larger ones about subapical impression, and a few near the base, the granules rather distantly placed. Sides sparsely granulate above, and in front. Elytra (12·5 × 7·5 mm.) subelliptical, gently rounded on sides; base feebly emarginate. Seriate punctures small, in somewhat flexuous lines, distorted by the tubercles; intrastrial granules small, not at all conspicuous; interstices tuberculate, sutural with a few, small, rounded tubercles at base, rapidly deteriorating into widely separated granules, not traceable much beyond the middle; second interstice with four, widely separated, subconical tubercles, not reaching base, nor apex; third with a row of nine, from base to half-way down declivity, tubercles separate, smaller near base, otherwise as on second interstice; fourth with one or two near middle; fifth with a moderately large, humeral tubercle, followed by a few, small granules, becoming obsolete and not traceable; sixth with a row of about seven, moderately distantly placed, smaller than on other interstices (except the fifth), not reaching base. Sides with three rows of small, rounded granules, the uppermost reaching to base, the middle to a level with the basal end of the sixth interstice, and the lowest much finer, only traceable posteriorly. Apical, ventral segment concave on either side of median vitta. Legs simple. *Dimensions:* ♂, 20 × 7·5 mm.

Hab.—South Australia [exact locality uncertain]. Type in Macleay Museum.

SCLERORINUS VESTITUS Macl.

Macleay, *op. cit.*, 1866, p.323.

Close to *S. longus*, narrower, more elongate. Black; clothing dense, brownish; prothorax with traces of a median vitta; elytra with an interrupted, greyish vitta internal to third interstice, and a broader, interrupted, sublateral one; sides with light, almost white, clothing, extending over the whole side of prothorax, and along the lower half of the side of the elytra; clothing beneath greyish, punctate with black spots; median vitta golden-brown.

Head and rostrum much as in *S. longus.* Prothorax (5 × 6 mm.) subdilatate, with subapical constriction less distinct; granules larger than in *S. longus*, varying in size, with larger ones in front of, and behind centre of disc. Elytra (12 × 6·5mm.) more elongate; seriate punctures as in *S. longus*; tubercles variable in size in different specimens; sutural interstice with semiconfluent, rounded tubercles at base, hardly traceable beyond middle; second with about six, rounded at base, conical nearer apex; third with ten or eleven, similar to those of second, extending down declivity; fourth with three or four about centre; fifth with a small humeral tubercle, followed by a row of others, variable in number and position, generally obsolete after the shoulder, in type(?) eight in number, nearly reaching declivity; sixth with about ten, small, conical tubercles, more closely placed than in *S. longus.* Otherwise as in that species.

♀. More ovate than ♂; convex beneath, with the median vitta less marked.

Dimensions: ♂, 19 × 6·5; ♀, 20 × 8 mm.

Hab.—South Australia: Flinders Range, Gawler Ranges—Victoria: Birchip, Sea Lake, Murray River.

Described from a pair in the Macleay Museum, which agree with Macleay's description, and are probably his types. The male, however, has the fifth interstice more tuberculate than in any other specimen I have seen. The size of the tubercles varies; in some specimens they are larger than in *S. longus*, in others they are smaller. The number of tubercles on each interstice also varies considerably.

The specimen standing over the label *S. mucronatus* Macl., in the Macleay Museum, belongs to this species, but does not agree with the description of *S. mucronatus.*

Sclerorinus Stewarti Macl.

Macleay, *op. cit.*, 1865, p.252; *S. tæniatus* Pasc., Journ. Linn. Soc., 1873, p.8.

♀. Elongate, elliptical-ovate. Black; densely clothed with brown squamosity; prothorax indistinctly trivittate; each elytron trivittate, an incomplete vitta along each side of suture at the base, a vitta internal to third interstice, and a broader vitta along each side of disc; sides of prothorax and lower portion of sides of elytra also with lighter clothing; below, densely clothed with light grey, and with a reddish-brown, median vitta.

Head and rostrum as in *S. longus.* Prothorax (5 × 6 mm.) subangulate, dilatate; subapical impression well marked; moderately closely granulate, granules small, slightly larger about constriction, and in the middle near the base, absent or fewer and smaller along vittæ. Elytra (13×8 mm.) with the interstices slightly raised, tuberculate; tubercles small, much smaller than in *S. longus* or *S. vestitus*, slightly elongate, subconical posteriorly; second with six from about middle down declivity; third with a subcontinuous row of about eleven; fourth with four, spaced-out over middle portion; fifth with humeral tubercle followed by three small tubercles, and a row of granules barely traceable through the clothing; sixth with a row of fourteen, very small tubercles, rather closely placed, subconical. Sides with interstices granulate. Beneath, convex. *Dimensions:* ♀, 20×8 mm.

Hab.—"Stewart's Land, Central Australia." Type in Macleay Museum.—South Australia: Blinman—New South Wales: Darling River (Coll. Lea).

The last three species are all closely related, so that it is somewhat questionable whether they are more than subspecies; I think it well, however, to retain the three names. All the species vary much in size, and also in the number and size of the tubercles, particularly those on the elytra; in some specimens of *S. longus*, the tubercles are larger than in some specimens of *S. vestitus*, but the reverse is common; and I have seen larger tubercles in *S. vestitus* than in the other two species. The colour of the clothing is dependable, except in the case of abraded specimens; *S. longus* has uniform light clothing, *S. vestitus* and *S. Stewarti* are more darkly clothed, and have each elytron trivittate, apart from the colour. *S. longus* may be distinguished by the prothoracic tubercles more widely separated, and also by the fewer and more widely separated tubercles on the sixth, elytral interstice. *S. Stewarti* has the elytral tubercles much smaller than in the other two, and has more numerous, and more closely placed tubercles on the sixth interstice.

S. longus occurs in South Australia, but I am ignorant of its exact habitat. *S. vestitus* occurs in the Flinders Ranges, South Australia, and in the Mallee-districts of Victoria. There appear to be slight differences between the eastern and western specimens, but not definable ones. *S. Stewarti* occurs inland in South

Australia; probably its habitat will be found to extend from the Lake Eyre Basin to, at least, the Darling River. I have a specimen from Condobolin, which I cannot separate from *S. Stewarti*, and there is another in the Australian Museum from Mossgiel. *S. tæniatus* Pasc., is certainly synonymous with *S. Stewarti*. I have a specimen which was compared with Pascoe's type by Mr. Blair, who writes that it is smaller than the type; but the specimen is a small one, as compared with the type of *S. Stewarti*.

SCLERORINUS SUBLINEATUS Germar.

Germar, Linn. Entom., iii., p.217; *S. marginatus* Pasc., *loc. cit.*, p.9.

♂. Moderately large, elongate, subparallel, relatively narrow. Black; densely clothed with ochreous-brown squamosity; head trivittate with white, the median vitta bifurcate on the rostrum; prothorax trivittate; elytra with a broad vitta along each side of disc, and an obscure vitta, more marked posteriorly, along suture; sides of rostrum, prothorax, and elytra vittate with white, on prothorax clothing almost the whole side, on elytra extending along lower border; sternal and abdominal segments maculate with white laterally, median vitta reddish-brown, the space between the median vitta and the lateral maculæ bare; legs with moderately dense, white clothing, with small, black spots. Setæ dark.

Profile of head and rostrum slightly undulate at junction; external, rostral ridges continued back along head for some distance; median carina present as a narrow, lævigate line, extending for a short distance on to head, not greatly raised. Prothorax (4 × 5 mm.) moderately dilatate, widest in front of middle; subapical impression moderately distinct, median and sublateral vittæ free from granules, but not definitely depressed; elsewhere set with small granules, widely separated, obscured by clothing in the middle, slightly larger along the subapical impression and basally. Sides with a few, scattered, subobsolete granules. Elytra (12 × 5·5 mm.) elongate; base feebly emarginate; seriate punctures small, indefinite, the granules little evident, obscured by clothing; sutural interstice with fine granules, the other interstices tuberculate; second somewhat raised, with a few, small, isolated tubercles, subconical and more prominent posteriorly, not reaching base, but extending almost to apex; third with a row of widely separated tubercles from base to edge of declivity; fourth with a few not reaching base, nor extending down declivity; fifth with a humeral tubercle and one or two small ones behind it, thence represented by a row of small granules, sixth with a more continuous row, subconical, larger posteriorly. Sides with small, regular, granuliform tubercles on the upper two interstices only. Undersurface deeply longitudinally furrowed on either side of base of median vitta. Anterior femora not ridged beneath; third joint of anterior tarsi somewhat asymmetrical.

♀. Differs from the male in its more ovate form, and convex, ventral surface.

Dimensions: ♂, 17·5 × 5·5: ♀, 17·5 × 7 mm.

Hab.—South Australia: Adelaide, Moonta, Peterborough, Blanchetown, Balaklava—Victoria: Sea Lake, Melbourne.

In ascribing the name *sublineatus* to the above species, I am following Macleay's identification, I think, however, it is correct, as it agrees with Germar's description, and is, moreover, one of the commonest species of *Sclerorinus* in South Australia.

Of *S. marginatus* Pasc., I have seen a cotype, sent out from the British Museum for examination.

The species, besides being one of the commonest, is one of the most variable, in size, relative width, and clothing.

Sclerorinus pilularius Macl.

Macleay, *op cit.*, 1866, p.324.

♂. Elongate-ovate. Black; clothing dense, varying in colour from cinereous to ochreous and dark brown; head with narrow, supraorbital vitta, and a broad, median vitta, extending on to rostrum, of a yellowish-brown; prothorax very feebly trivittate; elytra with an interrupted vitta along third interstice, and a broad vitta along lateral margin, of a whitish colour or lighter than the predominant colour of the clothing; sides of prothorax and elytra with greyish-white along lower border; sides of sternal and abdominal segments clothed with greyish-white; median vitta reddish-brown.

Head and rostrum in same plane above; external, rostral ridges subparallel, extending on to head; median carina narrow, little raised, showing as a fine, lævigate line through clothing; sublateral sulci moderately broad, basal foveæ concealed by clothing. Prothorax (4 x 5 mm.) subdilatate on sides; ocular lobes moderately prominent; subapical impression rather indefinite, median line slightly impressed; granules small, slightly larger than in *S. sublineatus*, and rather more closely set, but not contiguous; sides with smaller granules. Elytra (12 x 7 mm.) broader and more rounded on the sides than in *S. sublineatus*; base gently emarginate, humeral angles noduliform; seriate punctures shallow, indefinite, intrastrial granules moderately prominent, but concealed by clothing: interstices tuberculate, tubercles small, about the same in size and arrangement as in *S. sublineatus*; second with a few isolated tubercles; third with a continuous row of about fifteen, becoming more spaced-out posteriorly, and extending down declivity; fourth with a few isolated tubercles; fifth with humeral tubercle followed by three or four smaller ones, and then by a row of granules; sixth with a moderately closely-set row of tubercles, not reaching base. Sides with interstices set with depressed, granuliform tubercles. Undersurface as in *S. sublineatus*. Anterior femora feebly ridged beneath; tibiæ not notched. *Dimensions:* ♂, 18 x 7 mm.

♀. Differs in being more ovate, with the ventral surface more convex.

Hab.—S.A.: Flinders Range, Tarcoola, Ouldea, Wilgena, Musgrave Range.

Described from specimens in my own collection. Though closely allied to *S. sublineatus*, I think the present species is undoubtedly distinct. It is a broader, more ovate species, and, apart from other differences, this will always separate the males, the females being less easily distinguished. The clothing is different, but, in this respect, both species show considerable variation. The clothing on the rostrum, however, appears to be constant; in *S. pilularius* it is yellow, contrasting with the almost snowy-white clothing of *S. sublineatus*. *S. pilularius* appears to replace *S. sublineatus* in the western portions of South Australia. I am uncertain whether the types are in the Australian or in the Macleay Museum.

Sclerorinus exilis Macleay.

Macleay, *loc. cit.*, p.245; *S. angustatus* Macl., *l.c.*, p.246.

Elongate, elliptical. Black, tubercles reddish; densely clothed with dark brown; head, prothorax, and elytra conspicuously trivittate with white, the median vitta bifurcated on the rostrum; sides of prothorax and elytra vittate with white along lower border; undersurface with scattered, yellow pubescence, and with a strong, median, golden, hirsute vitta.

Head convex, forehead very slightly depressed in front, not carinate. Rostrum moderately short; external ridges subparallel, somewhat out-turned at base; median carina narrow, little elevated; sublateral sulci broad, shallow, deeper at base. Prothorax (5 x 6 mm.) moderately strongly rounded on the sides, apical margin gently rounded above, with moderately prominent, ocular lobes; subapical impression distinct; median line not impressed; set with small, but rather conspicuous, distinctly separated granules; sides not granulate, except above. Elytra (14 x 7 mm.) subelliptical; base gently emarginate, humeral angles distinct, set with a small tubercle; seriate punctures moderately distinct, each subtended by a small, setigerous granule; interstices with isolated tubercles, rounded near base, becoming conical posteriorly; suture with a row of fine granules, larger at base; second with a comparatively few, isolated tubercles, from near base to edge of declivity; third with more numerous tubercles, extending from base to apex; fourth with a few tubercles near middle; fifth with isolated tubercles extending from humeral angle to edge of declivity, sixth with tubercles more closely set with outwardly-projecting, conical tubercles, not reaching to base. Sides with tubercles depressed, granuliform. Undersurface with a somewhat ill-defined but deep furrow on either side of median vitta at base; fifth segment with an oblique, longitudinal depression on either side, extending on to fourth segment. Anterior femora not ridged beneath; tibiæ simple; anterior tarsi with third joint, and, to a less extent, the second, asymmetrical, the inner portion broader and more expanded than the outer.

♀. Differs in its more robust form, convex undersurface, the fifth segment with a shallow, transverse, apical impression, less hirsute vitta, and in the simple tarsi.

Dimensions: ♂, 22 x 7; ♀, 21 x 7·5 mm.

Hab.—N.S.W.: Lower Murrumbidgee (Macleay), Widgiewa (T. G. Sloane). Type in Macleay Museum.

Described from specimens in my own collection. I have included this species in Group v., although the tubercles are present at intervals along the whole length of the fifth interstice. In general appearance, however, it is more closely related to the species of this Group than to any other. It will be noted that, in almost all the Groups, there are species presenting this peculiarity; and Macleay placed them together in his third aggregate. In all cases, however, the general appearance and other details of sculpture show the true affinities. I refer specimens from Condobolin, with some doubt, to this species; they differ somewhat in the colour of the clothing, in the more sparsely granulate prothorax, and, to a slight extent, in the elytral sculpture. The species is variable in size, and *S. angustatus* seems to me only a small male, although the setæ on the prothorax are of a paler colour.

SCLERORINUS BIORDINATUS Macl.

Macleay, *op. cit.*, 1866, p.326.

♂. Large, elongate, subparallel. Black; densely clothed with ochreous-brown squames; head trivittate with lighter golden-brown, median vitta bifurcate on front and rostrum; prothorax trivittate with greyish-white; elytra quadrivittate with greyish-white, a narrow vitta internal to third interstice, a broader vitta along lateral margin; sides broadly vittate along lower edge with white; median ventral vitta golden-brown.

Head with a rather broad ridge on either side of upper surface, continuous with external, rostral ridges; median line of forehead lævigate, hardly carinate. Rostrum short, little excavate, the external ridges subparallel; median carina narrow, but prominent; sublateral sulci broad, shallow, with a deeper fovea at base. Prothorax (5·5 x 6·5 mm.) widely dilatate, subangulate on sides, roughly hexagonal in shape, widest slightly in front of middle; ocular lobes not prominent; disc with a distinct, subapical impression, most evident near sides, mesial line not impressed; set with rather small, round, discrete granules, absent along vittæ; sides without granules, except above. Elytra (14 × 7 mm.) elongate, little widened posteriorly; base evenly emarginate, humeral angles tuberculiform; seriate punctures small, shallow, attendant granules small and inconspicuous; interstices three and six with a continuous row of closely-set, conical tubercles extending from base (in sixth, not quite reaching base) to half-way down declivity, the third interstices slightly approximated on declivity; second interstice with one or two isolated tubercles, or without any; fourth with none; fifth with two conjoined tubercles at base, forming the humeral tubercle. Sides with upper interstice nodulose, the other interstices without tubercles or granules. Undersurface with a longitudinal furrow on either side of median vitta at base; fifth segment slightly rugulose on either side of ventral vitta. Anterior femora with a ridge on outer half of undersurface; tibiæ not notched.

♀. Differs from the male in its ovate form, and in its strongly convex, ventral surface, with feebler, ventral vitta; the fifth segment bears a shallow, median impression at apex.

Dimensions: ♂, 20 × 7; ♀, 19 × 7 mm.

Hab.—S.A.: Yorke Peninsula. Type in Macleay Museum.

Described from specimens in my own collection. With the exception of *S. Blackburni*, which has larger prothoracic and elytral tubercles, I know of no species with which the present one could be confused. Though Macleay placed this species among those having the fourth (*i.e*, the fifth) interstice continuously tuberculate, he was certainly in error, as this interstice is only tuberculate at the humeral angle. The contrast of the black tubercles against the brown clothing relieved by the white vittæ, renders this species one of the most beautiful in the genus.

SCLERORINUS GERMARI Macl.

Macleay, *op. cit.*, 1866, p.325.

♂. Small, elongate, subparallel. Black; densely clothed with brownish subpubescence, vittate with grey; head trivittate, median vitta bifurcate on rostrum; prothorax trivittate; elytra with an interrupted vitta along side of disc, and another along third interstice; sides of sternal and ventral segments clothed with white; median vitta dark golden-brown, segments sparsely clothed with whitish pubescence between vitta and lateral patches.

Head slightly depressed in front, median line bare in front, but not carinate. External rostral ridges parallel, not continued on to head; median carina bare, not appreciably raised; sublateral sulci rather narrow, deepened posteriorly. Prothorax (3·5 x 4·5 mm.) rather widely dilatate on sides; set with small, moderately closely placed granules, smaller and almost obsolete over centre of disc; sides granulate. Elytra (9 x 5 mm.) little rounded on the sides; base gently emarginate; seriate punctures rather wide, obscured by clothing, intrastrial granules not traceable through clothing; interstices very feebly raised, tuberculate, tubercles small, subconical towards apex; second interstice with two or three, not reaching base, nor extending down declivity; third interstices slightly approximated on declivity, tubercles obscured by clothing, about ten on each, extending from base to down declivity; fourth with one or two; fifth with a moderately distinct humeral tubercle, and a short row rapidly diminishing in size, followed by a few, isolated tubercles; sixth with a continuous row of small tubercles, outwardly directed, not reaching base. Sides with interstices granulate. Undersurface with ventral segments flat. Anterior femora feebly ridged beneath; intermediate tarsi with a strong subapical emargination.

♀. Differs in being somewhat more ovate; elytra not mucronate; ventral surface convex; tibiæ simple.

Dimensions: ♂, 14 × 5; ♀, 12 × 5 mm.

Hab.—S.A.: Port Lincoln. Probably widely distributed in South Australia.

Described from specimens in my own collection. It is somewhat uncertain whether the Australian Museum or the Macleay Museum possesses the type of the species, as it is represented in both collections.

I have elsewhere noted the occurrence of what I regard as varieties of this species; some of these may probably prove distinct. Of present described species, this can be confused only with *S. parvulus* (see under that species), and *S. mucronipennis.* The latter is distinguished by the mucronation of the elytra of the female. The notched tibiæ, *inter alia*, will distinguish it from *S. albovittatus*, which it somewhat resembles.

Sclerorinus parvulus Macl.

Macleay, *op. cit.*, 1865, p.260.

This species is hardly distinct from *S. Germari*, except in the granulation of the prothorax. In *S. parvulus*, the granules are evenly rounded, and not obsolete in the centre. I am unwilling to sink *S. Germari*, which is the later name, until certain that the differences are merely varietal and not specific. I have seen specimens, which I attribute to *S. parvulus*, from the vicinity of Adelaide, if I remember correctly.

It may be noted, that I regard the Macleay Museum specimen as the type; in the Australian Museum, there are two specimens labelled *S. parvulus*; one is a small specimen of *S. horridus*, and the other is probably so also, but it is too dirty for determination.

Sclerorinus tuberculosus Macl.

Macleay, *op. cit.*, p.256; (?)*S. mucronatus* Macl., *l.c.*, p.255.

♂. Size moderately large; elongate-ovate. Black; with rather sparse, brownish subpubescence in depressions; median, ventral vitta dull golden-yellow.

Head moderately strongly ridged on either side in front, with a feeble, median, lævigate carina. Rostrum little excavate; external ridges thick, slightly convergent to base; median carina prominent; sublateral sulci moderately broad, foveate at base. Prothorax (4·5 × 5·5 mm.) rather widely dilatate, widest in front of middle; subapical and median impressions moderately distinct; closely set with moderately large, rounded granules, larger along subapical impression and behind middle; sides granulate. Elytra (10 × 6 mm.) moderately and evenly widened posteriorly; base emarginate, humeral angles tuberculiform, produced anteriorly; disc with seriate punctures shallow but moderately distinct, subtended by small but evident, setigerous granules; interstices with large, strong tubercles, somewhat elongate towards base, conical towards apex of elytra; second interstice with a few about middle; third with a continuous row, about nine in number, from base to half-way down declivity; fourth with one or two; fifth with the humeral tubercle followed by a few, small tubercles, rapidly degenerating into granules; sixth with a regular row of closely set tubercles, about twelve in number, smaller than on other interstices, conical posteriorly and outwardly projecting. Sides with interstices granulate. Beneath, with segments flat. Anterior femora feebly ridged on outer half of undersurface; intermediate tibiæ with a strong, subapical emargination; posterior tibiæ more feebly emarginate; anterior tarsi symmetrical.

♀. More ovate than male, ventral segments convex, intermediate tibiæ simple.

Dimensions : ♂, 16 × 6; ♀, 16 × 6 mm.

Hab.—Victoria. Type in Macleay Museum.

Described from specimens in my own collection. The species varies somewhat in size, but I can detect no other difference between the extremes. The presence of the subapical notch on the intermediate tibiæ would ally this species with *S. Germari*, from which the larger size and sombre clothing will readily separate it. *S. Queenslandicus*, which is also closely allied, is a somewhat shorter, more ovate species, with fewer tubercles, and inconspicuous, intrastrial granules.

S. mucronatus Macl., I place, with some doubt, under *S. tuberculosus*. The type has been misplaced, as, on the name-label in the Macleay Museum, is a large specimen of *S. vestitus*, which does not agree with the size or description given by Macleay. Close to it in the collection, however, is a specimen which fits Macleay's description very closely, and I think it is probably Macleay's type. Compared with female specimens of *S. tuberculosus*, it differs only in the presence of a strong mucro on each side of the apex. I am unable to say whether this feature is constant or individual; but, in the allied species, *S. mucronipennis*, such a feature is constant in the female. Until further specimens are procured, I place it under *S. tuberculosus*.

SCLERORINUS QUEENSLANDICUS, n.sp.

♂. Of moderate size; elongate-ovate. Black; densely clothed with cinnamon-brown subsquamosity; median ventral vitta bright reddish-yellow. Setæ dark.

Head convex, traversed by three lines, the prolongations of the rostral ridges, these extending not quite to vertex, the median much narrower than the lateral ones. Rostrum little excavate; external ridges slightly convergent basally; median carina narrow, a small puncture present at junction with head; sublateral sulci long, shallow. Head and rostrum densely clothed except on ridges, these bare except for a few setæ. Prothorax (4 x 4 mm.) little widened; apical margin lightly sinuous above, with a moderately marked, postocular emargination; subapical constriction indistinct, median line not impressed. Disc set with isolated, rather large granules, much smaller along median and sublateral lines; sides granulate, most evidently above. Elytra (9 x 6 mm.) gently widened on sides; base gently emarginate, very lightly bisinuate, humeral angles marked by a small tubercle. Disc with seriate punctures shallow, obscured by clothing, the intrastrial granules hardly evident; interstices remotely tuberculate, tubercles comparatively large, black, subnitid, the posterior ones obtusely subconical, not spinose; second interstice with six tubercles, extending down declivity; third with four, not extending down declivity; fourth with three or four, not reaching base, nor extending down declivity; fifth with tubercles much smaller, about seven in number, closer together about shoulder, becoming more spaced-out and smaller posteriorly; sixth with a row of nine, rather closely set, larger than on fifth, but smaller than on the other interstices. Sides with interstices closely set with small, obtuse tubercles. Beneath, with a median, hirsute vitta extending from metasternum to apex; fifth segment with a subquadrate depression, more or less obscured by the median vitta. Intermediate tibiæ with a strong, subapical notch.

♀. Similar to ♂, but more robust and ovate; tubercle-index 3, 6, 0, 9, 7; beneath, convex, median vitta much less dense, not hirsute, subsetose. Internal tibiæ with notch much feebler.

Dimensions: ♂, 14 × 6; ♀, 14 × 6·5 mm.

Hab.—Queensland: Upper Logan River, Warwick. Type in Queensland Museum.

Several specimens of this species, sent from the Queensland Museum, are under examination. The type is an exceptionally well clothed specimen, most of the others being more or less abraded. The tubercles on the elytra vary in number, and are sometimes present on the declivity in the second and third interstices and sometimes not. The tubercle-indices of two other females may be given: ♀, 5, 6, 1, 11, 8; ♀, 6, 6, 3, 8, 11.

Two males in the National Museum, Melbourne, probably represent a variety of this species; they are narrower; in one, the fifth interstice has no tubercles, except the humeral one; and, in the other, a few, very small, separated tubercles. They are labelled (?)West Australia.

The character of the fifth interstice appears to associate this species with *S. tuberculosus*, rather than with the *subcostatus*-group, in which the fifth interstice is strongly and closely tuberculate.

Sclerorinus meliceps Pasc.

Pascoe, Journ. Linn. Soc., 1873, p.10.

This species is almost certainly a true Sclerorinus, and probably a member of Group v. I have seen no insect that I can associate with the name. The intermediate tibiæ are notched, and it is possibly allied to *S. Queenslandicus*, which has similar tibiæ. It is not the latter species, however, as a specimen of *S. Queenslandicus* was sent to the British Museum, and compared with the type of *S. meliceps* by Mr. K. G. Blair.

It is just possible that *S. meliceps* may be a Talaurinus allied to *T. pallidus* Macl., the members of the *pallidus*-group having notched tibiæ, and a variable rostrum, in some cases, *e.g.*, *T Gayndahensis*, approaching that of *Sclerorinus*.

Hab.—Queensland: Rockhampton.

Other Species belonging to Group v.

S. inconstans Lea.—N.S.W.: Mt. Kosciusko.
S. alpicola Ferg.—Vic.: Mt. Baldy, Victorian Alps.
S. Blackburni Ferg.—S.A.: Cleve.
S. mucronipennis Ferg.—Vic.: Nelson.

SCLERORINUS HORRIDUS Macl.

Macleay, *loc. cit.*, p.256.

♂. Elongate-ovate, size moderately small. Black; densely clothed with dark brown and pale cinereous; head and prothorax trivittate with the lighter-coloured clothing, elytra variably clothed, as a rule, the light clothing predominating; sides more or less clothed with cinereous; undersurface with moderately long, cinereous pubescence, forming median and lateral vittæ, and clothing greater part of fifth segment, the intervals between the vittæ with dark brown clothing.

Head convex, median line lævigate in front. Rostrum short, little excavate; external ridges slightly convergent to base; median carina moderately broad; sublateral sulci of moderate width, with a deeper fovea at base. Prothorax (3·5 × 4·5 mm.) rather strongly dilatate, subangulate in middle of sides; ocular lobes rather prominent; subapical impression moderately well marked; set with small, rounded, well-separated granules, absent along mesial line and over sublateral vittæ, except in middle. Sides with scattered granules, obsolete towards coxæ. Elytra (8 × 5·5 mm.) moderately strongly widened to behind middle;

base feebly emarginate, humeral angles marked, but not produced; seriate punctures rather large, open, foveiform, the intrastrial granules obscured by clothing; interstices tuberculate, tubercles variable in size in different specimens, all much of the same size in the same specimen, all the interstices, as a rule, closely and evenly tuberculate, the tubercles more separated on the declivity. Sides with small, round, flattened tubercles, obsolete on lower interstices. Ventral segments flattened, basal segments not longitudinally grooved. Anterior femora without ridge beneath; tibiæ not notched; anterior tarsi with third joint feebly asymmetrical. *Dimensions:* ♂, 18 × 5·5 mm.

♀. Rather more ovate, undersurface convex.

Hab.—S.A.: Fowler Bay, Port Lincoln, Ardrossan, Blanchetown, Moonta, Terowie.

Described from a series of specimens in my own collection, which have been compared with the type in the Macleay Museum.

The species is one of the most variable in the whole genus in size, colour, and tuberculation. In some specimens, the clothing is almost entirely of a cinereous colour; in others, the dark colour predominates; as a rule, on the elytra, the lateral margins have a broad, cinereous vitta; and the rest of the surface is maculate, to a greater or less extent, with this colour, so that the dark areas appear as macules on a light ground. In some specimens, the light colour is of a reddish-ochraceous tint; while many specimens appear to be caked with a coloured meal.

The tubercles vary much in size; as a rule, all the interstices are closely tuberculate, but the tubercles on the second may be distinctly more separated.

The ventral clothing, while vittate in character, has not the strong, hirsute structure of the other vittate species; in some, the median vitta is rather darker than the lateral ones.

The even tuberculation of the fifth interstice would associate this species with Group iii., but it has an entirely different facies, and the ventral clothing is very different. I prefer to place it at the end of the genus, as an anomalous species.

Sclerorinus riverinæ Macl.

Macleay, *loc. cit.*, p.246; *S. alternus* Macl., *l.c.*, p.247.

♂. Narrow, elongate. Black; densely clothed with dark brown subsquamosity, vittate with lighter, varying from grey to silvery; head trivittate, the median vitta light brown with a grey centre, subdivided by a median, lævigate line, the two portions diverging on rostrum; prothorax trivittate; elytra with lighter clothing irregularly distributed along lateral margins, about declivity, and forming a narrow line along suture; sides with greyish or silvery clothing along interstices; undersurface maculate with greyish-yellow in the centre, and with grey at the sides of each segment; legs rather densely clothed with white, irrorate with black spots.

Head convex, separated from rostrum above by a slight, transverse impression; median line lævigate. Rostrum little excavate; external ridges little raised, subparallel; median area elongately triangular in shape, not depressed nor definitely carinate, sides of area concealed by clothing of vitta; basal foveæ shallow, inconspicuous, elongately triangular. Prothorax (3 x 3·5 mm.) gently rounded on sides, not dilatate; apical margin rounded above, with moderately distinct, ocular lobes; subapical impression distinct; median and sublateral vittæ free from granules, but not evidently impressed; elsewhere set with small, rounded, discrete granules; sides also granulate. Elytra (8 x 4·5 mm.) elongate, little widened on the sides; base almost truncate, humeral angles marked by a small, outwardly projecting tubercle; seriate punctures small, shallow, intrastrial granules inconspicuous; sutural interstice with a row of separate granules; second and fourth with a few, distantly separated tubercles, not extending to base or declivity, small but larger than on the other interstices; third and fifth each with a continuous row of small tubercles, rounded near the base, becoming larger, more separate, and conical towards apex, extending down declivity; sixth with a somewhat similar row, but with the tubercles rather farther apart, and not extending to base. Sides with granules obsolete. Undersurface with ventral segments flattened; fifth feebly rugosely punctate. Anterior femora not ridged beneath; tibiæ and tarsi simple.

♀. Larger, more ovate; convex beneath.

Dimensions: ♂, 13 × 4·5; ♀, 14·5 × 6 mm.

Hab.—N.S.W.: Wagga, Deniliquin, Mulwala - Vic.: Birchip. Type in Macleay Museum. Described from specimens in my own collection.

Specimens from Birchip, in my own collection, vary somewhat from the above description. The male has the sides of the median area slightly raised at base; and the median area slightly depressed, and with a longitudinal, impressed line in the centre; the third interstice is biseriately granulate in the middle. The female has the sides of the median area more definitely raised, the centre not being depressed; the elytra are tuberculate in single series. I have grave doubts as to whether this species should be allowed to remain in Sclerorinus; the median area is not definitely carinate, though it appears through the clothing as a lævigate line; the internal ridges are not traceable, unless the feeble elevations, at the base of the median area, in the Birchip specimens, represent such. The undersurface, moreover, is not channelled at the apex, as in one Section of *Sclerorinus;* nor does it possess a hirsute, median vitta, as in the other Section. On the other hand, it appears related to no species of *Talaurinus* known to me. For the present, I prefer to regard it as an aberrant species of *Sclerorinus*. *S. alternus* was founded on an abraded specimen of the same species.

AUSTRALIAN TABANIDÆ. No. i.

By Frank H. Taylor, F.E.S.

(From The Australian Institute of Tropical Medicine.)

The species of the genus *Silvius*, Subfamily *Pangoninæ*, occurring in Australia, are more commonly found in those parts north of the Tropic of Capricorn than elsewhere, as only two species are known from localities further south, namely, *S. silvester* Berg., and *S. australis* Ricardo; the latter, however, also occurs at Townsville.

Walker (1848) described *S. marginatus* from Port Essington, placing it in the genus *Tabanus;* and, in 1857, he described *S. nitescens* from Australia. From that time, until Bergroth (1894) described *S. silvester* from Duaringa, no new Australian species were added. Then Summers (1912) described three new species, *S. mansoni*, *S. alcocki*, and *S. strangmani*, all from the Northern Territory.

The present paper adds eight new species to the genus, bringing the total to fourteen species occurring in Australia. There still remain two species, held over for the present, in the Institute Collection, besides four others, descriptions of which, Miss Ricardo informs me, will shortly be published in the Annals and Magazine of Natural History.

The type-specimens are in the Institute Collection.

Silvius hilli, sp.n.

♀. Length, 11-13; width of head, 4-4·2; width of front at vertex, 0·5-0·7; length of wing, 9·8-11 mm.

Head: front grey, with a creamy tinge, black when denuded, with a moderately deep groove running from the apex of the frontal callus to the ocellar triangle; face pale ochraceous, white beneath, clothed with white hairs; frontal callus black, shining, as wide as the front, with its lower edge resting on the subcallus, upper edge convex; ocellar triangle ochraceous, with a brown tinge, ocelli light brown, shining, moderately prominent; antennæ with the first segment greyish, clothed with black, appressed hairs, and about thrice the length of the second segment, the latter short, yellowish, with an apical fringe of black hairs, the third segment yellowish, the base forming a broad triangle; palpi yellow, clothed with minute, appressed, black hairs, first joint cylindrical, second joint basally swollen and gradually tapering towards the apical end, the distal third almost cylindrical, with the apex dark; eyes bronzy-black.

Thorax dull reddish-brown, clothed with dull pale creamy-white, appressed hairs, ventral surface darker, clothed with creamy-white, semi-erect hairs, prealar border-hairs dark and moderately long; scutellum similar.

Abdomen : dorsal surface with a narrow, median, longitudinal stripe of grey hairs; first three segments yellowish-brown, remaining segments brownish-black, clothed with semi-erect, black hairs, longest towards the apex; *venter* with the first four segments reddish-brown, the remaining segments dark brown.

Wings slightly dusky, veins dark brown except the subcostal and first longitudinal veins, which are pale; stigma very pale, inconspicuous; the anterior branch of the third, longitudinal vein with a short appendix (in one specimen, it is *very* short); squamæ brownish, tinged with yellow; halteres brown, the knob with a yellowish tinge in some lights.

Legs reddish-brown, clothed with short, appressed, black hairs, femora also clothed with moderately long, pale, erect hairs, the second to fifth tarsi darker; spur on hind tibiæ small, reddish-brown, and not easily seen unless the tarsi are bent at an angle to the tibiæ.

Hab. - Howard Creek, Stapleton, Northern Territory : (G. F. Hill; No.57).

This species is very distinct from its Australian congeners, owing to its size and colour. In size, it is most nearly related to

S. indistinctus Ricardo; while, in colour, it resembles, in some degree, *S. sordidus* mihi, but it is markedly distinct from both species. Cotype in Coll. Hill.

SILVIUS SORDIDUS, sp.n.

♀. Length, 10·7-11; width of head, 4; width of front at vertex, 0·5-0·75; length of wing, 8·7-9 mm.

Head grey, clothed with fairly long, grey hair; front ochraceous; frontal callus shining-black, nearly quadrate, with its upper edge finishing in a blunt point, and with a shallow groove dividing it into two parts, about two-thirds the width of the front at its base, not quite resting on the subcallus, the latter denuded, glossy black; ocelli black, prominent; eyes deep greyish-black, their inner margins parallel; first two segments of antennæ golden-yellow, clothed with short, black hairs on their dorsal apices, second segment with an apical fringe of black hairs also, third segment yellowish-brown; palpi pale golden-yellow, with truncate, brown apices, scarcely two-thirds the length of the proboscis, the latter black.

Thorax grey-brown, black when denuded, clothed with scanty golden hairs; scutellum similar to thorax; pleuræ and pectus clothed with greyish-white hairs.

Abdomen: the first three segments cinnamon-brown (in one specimen, the first two segments only are cinnamon-brown), the remainder dusky-brown, clothed with brown hairs, segments three to six with small, median, apical spots of golden hairs; venter brown, changing to dusky-brown toward the apex, clothed with greyish bloom.

Legs: coxæ and basal half of femora slaty-grey, apical half of femora and tibiæ pale reddish-brown, tarsi dusky-brown; tibial spurs on midlegs dark brown, fairly long, conspicuous, those on the hindlegs short and inconspicuous.

Wings hyaline; veins dark brown, except the first longitudinal, which is light brown; stigma lemon-yellow, elongate, inconspicuous; squamæ pale creamy, edges brown; halteres brownish.

Hab.—Stapleton, Batchelor, Northern Territory (G. F. Hill).

Described from two specimens. Allied to *S. borealis* mihi, but it is a more slender species. For other differences, see under that species. Cotype in Coll. Hill.

SILVIUS BOREALIS, sp.n.

♀. Length, 10·25; width of head, 4; width of front at vertex, 0·5; length of wing, 9·5 mm.

Head grey, clothed with grey hairs, basioccipital region very pale ochraceous; eyes with inner margins parallel, the upper third dull black, lower two-thirds with three, horizontal rows of dull fiery-red, and two of pale purplish-blue, the rows alternating; front rusty-brown, the edges grey; frontal callus irregularly triangular, shining-black, tumid, apex drawn out to a point, and terminating about the middle of the front; ocelli shining-black, conspicuous; subcallus pale ochraceous, first segment of antennæ dusky-brown, swollen, clothed with scattered, semi-erect, black hairs, second and third segments pale vandyke-brown, the former very short, with a few, scattered, black, semi-erect hairs, base of the latter broadly triangular; palpi yellowish, tips brown, truncate, slender, about two-thirds the length of the proboscis, the latter black.

Thorax dull reddish-brown, with a faint, black, median, longitudinal stripe, clothed with mixed grey and dusky hairs, lateral margins clothed with moderately long, dusky hairs in front of the wings; scutellum similar to the thorax, but with the apical half brighter reddish-brown; pleuræ and pectus dusky, the former tinged with brown on the upper margins.

Abdomen reddish-brown, becoming darker towards the apex, densely clothed with semi-erect, black hairs; venter reddish-brown, clothed with scanty, pale hairs on the apices of the segments.

Wings moderately broad and elongate, veins on apical half of wing black, paler on the basal half, anterior branch of the third, longitudinal vein with a short appendix; stigma elongate, narrow, inconspicuous, pale yellow; squamæ with a faint, yellowish tinge; halteres mummy-brown, knobs creamy.

Legs: fore-femora dark reddish-brown, dusky in some lights, tibiæ with the basal half light brown, remainder and first four tarsi dusky, fifth tarsals brown; mid- and hind-femora reddish-brown, apices paler, tibiæ light brown, apices darker; tarsi brown, in some lights dusky; femora clothed with brown hairs, tibiæ and tarsi with black; mid-tibial spurs long, on the hind short and inconspicuous.

Hab.—Howard Creek, Northern Territory (G. F. Hill; No.58).

Described from a single specimen, presented to the Institute by Mr. Hill. This species is related to *S. sordidus* mihi. The abdomen is wider, however, than the thorax, whereas, in the latter species, it is uniform in width. The abdomen has an opalescent sheen, which is lacking in *S. sordidus* mihi.

SILVIUS FULIGINOSUS, sp.n.

♀. Length, 11·2; width of head, 4·2; width of front at vertex, 0·7; length of wing, 9·2 mm.

Head dusky, clothed with grey hairs beneath, subcallus denuded, shining-black; front a dirty-brown; ocelli deep brown; frontal callus shining-black, more or less quadrate, with the upper angles rounded; palpi dark yellowish-brown, with truncate, dusky apices, about two-thirds the length of the proboscis; antennæ reddish-brown, the distal end of first segment swollen, about twice the diameter of the base, second segment very short, both segments clothed with black hairs, third segment with the base broadly triangular; proboscis black; eyes blue-black, with coppery reflections, their inner margins converging towards the base.

Thorax dark brown, covered with grey bloom, with four, longitudinal stripes, two submedian, the others lateral, clothed with short, golden hairs, with a prealar border of mixed grey and dark hairs; pleuræ and pectus slaty-grey, clothed with grey hairs; scutellum slaty-grey.

Abdomen black, clothed with black hairs, segments two to four with the apical edges pale, clothed with pale hairs, segments three to six with traces of white, median, apical spots; venter with the first two segments dusky-brown, remaining segments black, all the segments with the apical margins pale yellowish-brown.

Legs reddish-brown, clothed with pale hairs, tarsi darker, tibial spurs black, on midlegs fairly long and conspicuous, on hindlegs short and inconspicuous.

Wings with the veins yellowish-brown on the basal half, the remainder black; stigma pale yellow, elongate, inconspicuous; squamæ pale yellow, edges brown; halteres reddish-brown.

Hab.—Stapleton, Northern Territory (G. F. Hill; No.36).

SILVIUS TRYPHERUS, sp.n.

♀. Length, 7; width of head, 2·25; width of front at vertex, 0·25; length of wing, 6·7 mm.

Head: front cinereous, densely clothed with minute, grey hairs; face grey, clothed with moderately long, greyish hairs; subcallus grey; frontal callus dark reddish-brown, prominent, nearly as broad as the front at its base, almost resting on the subcallus, and gradually tapering to a blunt point near the ocellar triangle; ocelli shining-brown, inconspicuous; eyes dull black, nude, with their inner margins gradually sloping inwards towards the vertex; antennæ with the first two segments yellow, and clothed with fairly long, semi-appressed hairs, third segment with the base light yellowish-brown, clothed with minute, appressed, pale hairs, and forming a broad triangle, annuli dark brown; palpi yellow, sparsely clothed with semi-erect, black hairs, and slightly more than half the length of the proboscis, the latter comparatively short, dark brown, clothed with erect, brown hairs, fairly long on its apex.

Thorax reddish-brown, clothed with grey bloom and golden, appressed hairs; pleuræ similar to the thorax, thinly clothed with erect, grey hairs; scutellum similar to thorax.

Abdomen: first two segments reddish-brown, the remaining segments dark brown, clothed with grey bloom, and golden, appressed hairs; venter dark brown, clothed with grey bloom, with fairly long, semi-erect hairs at its apex.

Wings hyaline; stigma elongate, yellowish-brown, moderately conspicuous; veins yellowish-brown; squamæ grey, with pale brown edges; halteres brown.

Legs reddish-brown, clothed with semi-erect, dark hairs; tarsi darker than femora and tibiæ; tibial spurs brown, very short.

Hab.—Booroolooloo, Northern Territory.

Described from a single specimen, collected by Mr. H. S. Giles, January, 1912, and presented to the Institute. It is a small, and dingy species, which distinguishes it from other Australian species.

Silvius elongatulus, sp.n.

♀. Length, 7·5-9; width of head, 2·1-2·5; width of front at vertex, 0·2-0·3; width across lower edge of frontal callus, 0·5-0·75; length of wing, 7-8·8 mm.

Head: front grey, tinged with pale brown; ocellar triangle light brown; ocelli light brown; frontal callus shining, dark reddish-brown, broadly wedge-shaped, the lower edge slightly rounded, and nearly resting on the subcallus; eyes black, naked, their inner margins converging towards the apex; face dark grey, clothed with grey hair; antennæ with first segment dark reddish-brown, fairly long, second segment about one-third of the length of the first, slightly paler, both clothed with black hairs, base of third segment bright reddish-brown, broadly triangular, annuli dark brown; palpi brown, about two-thirds the length of the proboscis, the latter comparatively long.

Thorax uniform, dull reddish-brown, clothed with a moderately dense covering of dull, golden bloom, and brown hair; scutellum brown, covered with grey bloom; pleuræ and pectus dark brown, covered with grey bloom.

Abdomen brown, with the posterior margins of the segments pale, giving the abdomen a banded appearance; venter brown, clothed with greyish-white bloom, and scattered, pale hairs.

Legs: femora, tibiæ, and tarsi dark reddish-brown; femora clothed with grey hairs; tibiæ and tarsi clothed with dark brown hairs, knees pale; tibial spurs reddish-brown, spurs on hind-tibiæ about half the length of those on the mid-tibiæ.

Wings hyaline, veins dark; stigma light amber, elongate; squamæ creamy; halteres with the stem ochraceous, the knob black.

Hab.—Batchelor, Stapleton, Northern Territory (G. F. Hill; No.35).

Described from specimens forwarded to the Institute by Mr. Hill. This is a somewhat elongate species, and most nearly allied to *S. australis* Ricardo. Cotype in Coll. Hill.

SILVIUS TABANIFORMIS, sp.n.

♀. Length, 10; width of head, 4; width of front at vertex, 0·5; length of wing, 9 mm.

Head: face grey, with a scanty, grey beard; front black, ochraceous between the frontal and subcalli, the former black, pear-shaped, tumid, shiny; subcallus shining-black; first and second segments of antennæ dull golden, the first with prominent, black, apical hairs, third segment light testaceous, base broadly triangular, annuli brown; palpi light testaceous, about two-thirds the length of the proboscis, the latter pitchy black; eyes deep greenish-black, the inner margins slightly converging towards the base; ocelli black.

Thorax black, clad with numerous, appressed, golden hairs; pleuræ black, clothed with grey hairs, fairly long at the wing-roots; scutellum similar to thorax.

Abdomen black, anterior portion of first and second segments light brown, posterior margin of all segments brown, clothed with pale hairs, and a small, median, apical patch of pale hairs, giving the segments a striped appearance; venter with the first three segments mummy-brown, the remainder dark brown

Wings hyaline; veins dark brown; stigma elongate, inconspicuous, pale cream; squamæ grey; halteres brown, knobs creamy.

Legs: forelegs black, knees and basal two-thirds of tibiæ mummy-brown; in the midlegs, the apical two-thirds of femora, the tibiæ and first two tarsals mummy-brown, remainder black; the hindlegs with the apical third of the femora, tibiæ, and first two tarsals mummy-brown, the rest black, the femora and tibiæ clothed with grey hairs; spurs conspicuous on the mid-tibiæ, minute on the hind.

Hab.—Thirty miles N.E. of Darwin, Northern Territory (G. F. Hill; No.100).

This is a very distinct, and Tabanus-like species, and quite unlike other Australian species in general appearance.

SILVIUS FULVOHIRTUS, sp.n.

♀. Length, 11·5; width of head, 4; width of front at vertex, 0·6; length of wing, 9 mm.

Head with the front golden-yellow; subcallus buff; face light buff, cheeks pale creamy; beard grey; frontal callus pale lemon-yellow, pear-shaped, tumid, with a yellow, lineal extension reaching the ocellar triangle, the latter clad with numerous, fairly long, black hairs; ocelli black; antennæ with first two segments bright golden, with scattered, black hairs, and an apical fringe, third segment testaceous; palpi orange, with minute, black hairs; eyes black (green when alive), their inner margins converging towards the base.

Thorax yellow, clothed with short, appressed, yellow hairs; scutellum yellow, clothed with erect, yellow hairs, ground-colour of both black; pleuræ grey.

Abdomen with the first two segments pale tawny, third and fourth dark brown, fifth and sixth dusky, posterior margins paler in segments three to the apex; venter similar to dorsum.

Legs with the coxæ and trochanters greyish, clothed with fairly long, grey hairs; femora tawny, clothed with grey hairs, the apical third of the first with black hairs; tibiæ brown, apices dark brown; tarsi black, tarsi and tibiæ clothed with black hairs; mid-tibial spurs black, prominent, hind inconspicuous.

Wings faintly dusky; veins brown; anterior branch of third long vein with a small appendix, stigma brown, faintly yellow on the edge at apex; squamæ orange; halteres-stems orange, knobs brown.

Hab.—Townsville, Queensland (F. H. Taylor; January, 1914).

Described from a single specimen, which was taken in conjunction with other Tabanidæ in light scrub-country. It is a very distinct and easily recognisable species.

SILVIUS ALCOCKI Summers.

Ann Mag. Nat. Hist., ser.8, Vol. x, p.227 (1912).

Specimens forwarded from Darwin, Northern Territory, by Mr. Hill, show some discrepancies from Miss Summers' description; but until a specimen has been compared with the type, it is better to leave them under the above name.

I have been unable to determine *S. mansoni* and *S. strangmani* of Summers, in the material sent by Mr. Hill.

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[Printed off, February 19th, 1916.]

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(1915.)

(*a*) GENERAL INDEX.

(The first twenty-four pages are separately paged in Roman numerals.)

(*b*) BIOLOGICAL INDEX.

Names in italics are synonyms.

(The first twenty-four pages are separately paged in Roman numerals.)

[Printed off, February 19th, 1916.]

Issued 16th June, 1915.

Vol. XL.
Part 1.
No. 157

THE PROCEEDINGS OF THE LINNEAN SOCIETY OF NEW SOUTH WALES

FOR THE YEAR

1915

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PROCEEDINGS, 1915, PART 1.

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CORRIGENDA.

The legend of Plate xxx. should read—

1-2.*Sertularella ritchiei*, nom.nov. 3-7.*Halicornaria goniodes*, n.sp.

On p.833 of Part 4 of Proceedings for 1914, the names of the analysts were inadvertently omitted. These should read—Analysis i. (J. C. H. Mingaye); ii. (L. A. Cotton); iii. (L. de Launay).

Issued 15th September, 1915.

Vol. XL.

Part 2.

No. 158

THE

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OF THE

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OF

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FOR THE YEAR

1915

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PROCEEDINGS, 1915, PART 2.

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CORRIGENDUM.

Page 256, Table v., in the heading at the top of the right-hand double column—*for* Temperature of air, *read* Temperature of animal.

Issued 10th December, 1915.

Vol. XL.
Part 3. **No. 159**

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1915

PART III. (pp. 417-624)

Containing Papers read in

AUGUST-SEPTEMBER,

WITH

SEVEN PLATES

(Plates xlvii.-liii.)

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PROCEEDINGS, 1915, PART 3.

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Correction.

The blocks above the legends of Text-figures 1 and 3 on pp.215 and 217 of Mr. Tillyard's Paper (*antea*) were inadvertently transposed. The figures above the legend of Text-fig.3 (p.217) should have appeared above the legend of Text-fig.1 (p.215); and those on p.215, above that of Text-fig.3 (p.217).

Issued 23rd February, 1916.

Vol. XL.
Part 4. **No. 160**

THE

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OF THE

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OF

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FOR THE YEAR

1915

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