THE PROCEEDINGS OF THE LINNEAN SOCIETY OF NEW SOUTH WALES.

FOR THE YEAR

1908.

Vol. XXXIII.

WITH THIRTY-SIX PLATES.

(Pl. i.-x., x.*bis*-xxxv.)

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CONTENTS OF PROCEEDINGS, 1908.

PART I. (No. 129).

(Issued June 11th 1908),

PART II. (No. 130).

(Issued August 14th, 1908.)

PART II. *(continued.)*

Note.—Attention is called to the following preliminary list of corrigenda in Mr. Kirkaldy's paper :—

p.346, line 7, *for* Stalagmosthetus *read* Stalagmostethus.
p.347, line 3, for *Mesocrypha corticicola* read *Nesocrypha corticicola.*
p.350, after line 25, read Fam. **ARADIDÆ.**
p.356, line 2 of footnote, after "genus" read *Cymoninus.*
p.367, for line 10 as printed, *read* Limnometra ciliata Mayr, 1865, Verh. zool. bot. Ges. Wien, xv. 444.

PART III. (No. 131).

(Issued November 20th, 1908)

PART III. *(continued).*

Notes.—(1) The three text-figures on pp.485 and 487 have been reprinted as Plate x. *bis*.

(2) Plate xxiii., illustrating Prof. David's "Geological Notes on Kosciusko," &c., will be issued with Part 4 of this Volume.

PART IV. (No. 132).

(*Issued March 11th, 1909*).

PART IV. *(continued).*

LIST OF PLATES.

PROCEEDINGS, 1908.

CORRIGENDA.

Page 70, line 5—for **THYNINNÆ** read **THYNNINÆ**.
Page 88, line 1—for *puchellus* read *pulchellus*.
Page 258, line 22—for *A. aucklandensis* read *A. aucklandicum.*
Page 263. line 1—for *A. simulatum* read *A. similatum.*
Page 264, line 33—for *A. angurale* read *A. augurale.*
Page 272, line 18—for *A. punctum* Cav. read *A. punctum* Carter.
Page 346, line 8 – for Stalagmosthetus read Stalagmostethus.
Page 347, line 3—for *Mesocrypha corticicola* read *Nesocrypha corticicola.*
Page 350, after line 25, *insert* Fam. **ARADIDÆ**.
Page 356, line 2 of footnote, *after* "genus" read *Cymoninus.*
Page 367, *for* line 9 as printed *read* Limnometra-ciliata Mayr, 1865, Verh. zool. bot. Ges. Wien, xv., 444.
Page 396, line 34—for *S. nasodermoides* read *S. nosodermoides.*
Page 398, line 9—for *repandum* read *repanda.*
Page 456, line 25—after *Buccinum funiculatum* Reeve, add (= *B. contractum* Reeve, fide E. A. Smith).
Page 519, line 28—for *Hyyothesis* read *Hypothesis.*
Page 604, line 3—for *Xan. Coogeanum* read *Xan. Coogeeanum.*
Page 633, line 10—*for* importauce *read* importance.
Page 799, line 1—for *Stemonites* read *Stemonitis.*
Page 843, lines 14-15—*for* precitated *read* precipitated.

LIST OF NEW GENERIC AND SUBGENERIC* NAMES

Proposed in this Volume (1908).

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(1908.)

Names in Italics are Synonyms.

[Printed off March 8th, 1909.]

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES,

WEDNESDAY, MARCH 25TH, 1908.

The Thirty-third Annual General Meeting, and the Ordinary Monthly Meeting, were held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, March 25th, 1908.

ANNUAL GENERAL MEETING.

Mr. A. H. S. Lucas, M.A., B.Sc., President, in the Chair.

The Minutes of the preceding Annual General Meeting (March 27th, 1907) were read and confirmed.

The President delivered the Annual Address.

PRESIDENTIAL ADDRESS.

The thirty-second volume of the Society's Proceedings—the visible fruitage of last year's work—has been completed in good time, and made available to you. On the whole it is a very satisfactory contribution to our knowledge of the Natural History of Australia and Oceania, in the broad interpretation of the term we are accustomed to give it; and I think we may venture to say that it is a volume of which our Founder would have approved.

The Membership increased slightly during 1907, as ten Members were elected; two Members, one of them, Professor Liversidge, an Original Member, resigned in consequence of departures from Australia; and another of the dwindled little group of Original Members, Mr. David Scott Mitchell, deceased on 24th July. Professor Liversidge's connection with the University of Sydney dates from the year 1872, so that he has been closely identified with higher education and with scientific developments in New South Wales during the most expansive period of its history; and therefore we part with him with great regret.

Mr. David Scott Mitchell, M.A., whose association with the Society goes back to the 8th December, 1874, was born in Sydney in 1836. His second name recalls his relationship to the late Alexander Walker Scott, M.A., and his two accomplished daughters, Mrs. Morgan, recently deceased, and Mrs. Forde, the author and illustrators of that meritorious but, alas! uncompleted work "Australian Lepidoptera and their Transformations; drawn from the Life, by Harriet and Helena Scott; with Descriptions, general and systematic (7 Pts. 1864-98). Mr. Mitchell was one of the first batch of graduates of the University of Sydney, taking his B.A. in 1856, and his M.A. in 1859. In 1858 he was admitted to the Bar, but did not practise as he had inherited considerable private means from his father. Thereafter he devoted his time and energy to the conduct of his private affairs, and to the gratification of his individual tastes as a bibliophile and collector. The results of forty-five years' discriminating and unstinted collecting of books, pamphlets, manuscripts, pictures, &c., chiefly but not exclusively relating to Australasia, henceforth to be known as the Mitchell Library, were bequeathed to the State, together with the sum of £70,000 for endowment, upon certain conditions. The more important of these were that the individuality of the collection should be conserved, that it should be suitably housed in a separate wing of the contemplated National Library of the State, and that it should be maintained and rendered available to those who are competent to make use of it, under similar regulations to those which are in force in the British Museum Library.

The foundation stone of the Mitchell wing was laid by the Premier of the State, with appropriate ceremony on October 11th, 1906; and the edifice is now approaching completion. Meanwhile tenders for the erection of the main building have been accepted, so that in about three years hence, the Mother State of the Commonwealth may look forward to possessing a State Library which, to speak without boasting, will be a very marked advance upon the state of things existing hitherto.

Mr. Mitchell was a very reticent man upon the subject of the Mitchell Library, because he was an extremely modest man. His aim was not to be talked about for doing something; but to do something great because it was a fruitful thing to do. But we may hope that his modesty did not lead him to withhold the history of the accumulation of his unique collection, his knowledge of its special features, and the subjects of exceptional interest upon which its utilisation might be expected to throw light, or, in other words, the more important results of his own extensive knowledge of his unrivalled collection.

Mr. Mitchell did not add the pursuit of science to his accomplishments, so that we may reasonably attribute his sustained interest in this Society to that of the bibliophile in an Australian publishing organisation which began auspiciously, and showed promise of lasting. Be that as it may, the Society is honoured in having had among its Foundation Members, in the person of Mr. Mitchell, another brilliant example of the private individual possessed of wealth, who made it his very special care to start a prolific enterprise and to provide for its maintenance, for the benefit of those who came after him.

Dr. R. Greig-Smith, Macleay Bacteriologist to the Society, who departed for Europe, on leave, at the end of December, 1906, rejoined us again in October last. At the Society's Meeting on 30th October, Dr. Greig-Smith gave us an interesting summary of his impressions and experiences on visiting a number of the more important bacteriological laboratories and institutions of the United Kingdom and on the Continent, during his tour. Since his return, our Bacteriologist has settled down to work again, and has been for some time engaged upon the very interesting study of certain points in connection with the opsonisation of Bacteria.

Mr. H. I. Jensen, Linnean Macleay Fellow in Geology, has completed his work on the geology of the Warrumbungle and Nandewar Mountains, and the results will be found embodied in two important papers included in the Proceedings for last year. In addition, Mr. Jensen has spent some time in Queensland investigating the geology of the Mount Flinders trachyte area; and also, in conjunction with Mr. C. A. Süssmilch, upon the study of the petrology of the rocks of the Canoblas, New South Wales. Considerable progress has been made with these investigations, and during the year Mr. Jensen expects to be ready with papers treating of these important matters. At the end of the month we part with Mr. Jensen as a Linnean Macleay Fellow, as he has decided to take up other work. He was the first Linnean Macleay Fellow to be appointed, and has held a Fellowship for three years. He accepted his Fellowship, and has carried on his work, in the spirit which prompted Sir William Macleay to found Fellowships—as an aid to do work; an aid to do work which could not be done so satisfactorily and promptly by anyone else, unless he were a leisured individual possessed of private means. Mr. Jensen undertook a big problem—the study of the natural history of the volcanic rocks, and particularly of the trachytes of Eastern Australia and cognate matters. He has investigated it with great enthusiasm and ability, both in the field and in the laboratory, and he has settled its main features. He has the satisfaction of having done an excellent piece of work; and in the name of the Society I cordially offer him hearty congratulations and good wishes for his prosperity and success in his new sphere of activity.

Dr. J. M. Petrie, Linnean Macleay Fellow in Biochemistry, has almost completed his first year of work. He has finished his investigation of the new midriatic alkaloid, Solandrine, yielded by *Solandra lævis*, in so far as the material available has allowed him to do so. The results of this investigation will befound in the last Part of the Proceedings. In addition Dr. Petrie has had in hand two promising subjects for investigation, namely, the distribution of nitrogen in seeds, and the nature of the non-protein substances which appear to be mainly the products of decomposition of the proteins; and the nature of certain products obtainable from the Australian plant *Ochrosia*. Of course, in quantity of output, the Biochemist cannot hope to rival the geologist. I may add that the Council has reappointed Dr. Petrie to a Fellowship.

I have much pleasure in formally announcing to the Society the name of the Third Linnean Macleay Fellow, Mr. E. J. Goddard, B.A., B.Sc., whose appointment will date from the 1st proximo. Mr. Goddard took his B.Sc. degree in 1905, obtaining Professor David's Prize for Physiography in his first year, and Honours in both Biology, and Geology and Palæontology in his second and third years. Since 1904 he has filled the post of Junior Demonstrator in Biology at the University of Sydney, and for a time that of Acting Senior Demonstrator. Mr. Goddard has contributed a paper on "Foraminiferal Sand dredged twenty-two miles east of Sydney at a depth of eighty fathoms" to the Records of the Australian Museum (Vol.vi.pp. 305-311, 1907); and a paper entitled "Contributions to a Knowledge of Australian Foraminifera," written in collaboration with Mr. H. I. Jensen, B.Sc., will be found in last year's Proceedings (1907, p.291). He has been investigating Australian freshwater leeches (*Rhynchobdellida*), and will shortly communicate his results to the Society. Mr. Goddard will take up branch No. 5, General Biology, especially devoting himself to the study of the Freshwater Annulata of Australia. Trout are being introduced into our creeks and rivers in such a wholesale manner, that the welfare of the freshwater fauna of New South Wales and other States is being threatened very seriously, before any satisfactory systematic attempts have been made to estimate its character and variety. Such investigations as Mr. Goddard has in view are urgently needed; and we earnestly hope that he will not find that trout and the operations of the river-dredger have had sufficient opportunity seriously to discount his efforts to make something of a question whose consideration has been delayed so long. For the purpose of making botanical and zoological collections, Mr. Goddard accompanied Dr. Woolnough on his second visit to Fiji in 1906, but has not yet been able to complete his account of them. In the name, and on behalf of the Society, I have great pleasure in wishing Mr. Goddard a very successful career.

It is with very great regret that I have to announce the contemplated early retirement of the Society's esteemed Hon. Treasurer, Mr. J. R. Garland, M.A., on account of delicate health. Since its foundation, four Honorary Treasurers have ably and successfully looked after the Society's finances; and, after the first, every one of them has had increased responsibility as compared with his immediate predecessor, concomitantly with the development of the Society's efficiency. Mr. Garland succeeeded the late Mr. Trebeck in August, 1901; and though he has encountered a maximum of work and responsibility it in no wise disconcerted him, until a break down in health enforced upon him the need of resting from his labours. He has been a man of few words, but an effective worker, thoroughly to be relied upon. Our retiring Treasurer deserves the Society's most hearty appreciation and gratitude for having so worthily maintained the succession, and developed and carried on the work of those who have from time to time undertaken the management of its finances with such satisfactory results. We regret very much to part with him in an official capacity, but still more do we regret the cause of the separation. I am very glad indeed to be able to announce a marked improvement in Mr. Garland's health, and I am sure that you will heartily join with me in wishing that it may continue until he is able to resume his accustomed avocations.

Our faithful old caretaker, Alfred Stapleton, and also his wife, died in October and August of last year, breaking up an association with some member of the Macleay family, beginning with Mr. W. Sharp Macleay, or with the Society, of about half a century. The dwelling house has been renovated and improved, and one of Alfred Stapleton's sons—W. Stapleton—has been appointed to succeed his father, and gives promise of worthily doing so.

It is only on rare occasions that circumstances permit interruption of the regular, appointed procedure of the Society's work in such a manner as to provide an interlude of a less formal character, of which we can take full advantage. On October 31st, 1885, on the occasion of the dedication of the Hall in which we are now assembled, Sir William Macleay entertained the Members and other guests in characteristic fashion. On June 22nd, 1889, the Members of the Society had the pleasure of returning the compliment, on the occasion of the unveiling of the bust of Sir William Macleay, erected in the conspicuous place of honour which it has ever since occupied, by express wish of the donors. Nearly eighteen years elapsed without offering the Society another opportunity of meeting in its corporate character for some other purpose than merely routine business. On the 23rd May, 1907, the Bicentenary of Carl von Linné, the Society did its best, amid some drawbacks, to join in the world-wide recognition of the significance of the occasion, and to do homage to the memory of the remarkable man whose name the Society bears. I refer to then existing drawbacks, in order that I may mention that they have since vanished. I may remind you that Carl von Linné's only possible opportunity of seeing any example of Eastern Australian indigenous plants or animals would arise in connection with the visit of Sir Joseph Banks and Dr. Solander to New Holland on Captain Cook's First Voyage. In a letter to his friend, Mr. John Ellis, in London, Carl von Linné bitterly lamented that Solander's neglect to keep his promise to visit him on his return was bereaving him of his only chance of learning something of the productions of New Holland at first hand. He died without his desire being gratified. This explains how it is that Australian animals bearing names bestowed by Carl von Linné are not indigenous and were first described and named from specimens brought from other countries which the species inhabit, as well as Australia. On this account, Australian naturalists have not that direct and inevitable interest in and concern with the Systema Naturæ as Carl von Linné left it, that naturalists of Europe, Asia, Africa and America have. The Australian naturalist's interest in the Systema, as far as strictly indigenous species are concerned, begins with the later editions. Hence it is that the works of Carl von Linné, and especially the earlier editions, are not so easily to be found in Australian libraries as in those of other countries. In our own case, too, one library, including about 1,000 volumes the cream of Sir William Macleay's private library, was destroyed by fire, and some of the works represented in that library have not been replaced. However, thanks to the liberality and kindness of Professor Fries, donor of his Biography of Carl von Linné, of the Royal Academy of Sciences of Stockholm, and of the Royal University of Upsala, our drawbacks in respect of want of literature have been largely if not altogether dissipated. [For a list of the memorial edition of a number of the works of Carl von Linné so presented, see pp.391, 932, 934 of Proceedings for 1907].

We have to regret that our distance from Europe left Dr. J. P. Hill, our chosen representative in London, so little time to make arrangements for setting aside some important work with which he was engaged when the Society's mandate reached him, that he was quite unable to justify the Society's choice of him, or communicate with it respecting some one to take his place.

To Count Mörner, Consul General for Sweden, in particular, to Professor David Starr Jordan, to the other visitors and to all the Members who were present at or took part in the evening's proceedings the Society is greatly indebted for a pleasurable and profitable evening of an altogether unusual character.

The visit of Dr. Jordan for the purpose of delivering a course of University Extension Lectures was a noteworthy event of last year, and afforded Australian biologists and educationalists an excellent opportunity for pleasant and profitable intercourse and exchange of experiences. The Great Republic, as befits its magnitude and seniority, has succeeded to a greater extent than we have in emancipating itself from inherited tradition in educational matters, and in working out its own destiny along lines which have been evolved in response to its own special needs. Dr. Jordan is such a capable and brilliant representative and exponent of advanced American thought in higher education and science that his visit must have done much more to stimulate and encourage Australians than it is possible to estimate satisfactorily by mere conjecture. The goal of the Americans is substantially ours, and it has been good for us to be reminded that there are other practicable routes to it besides the one we may have been led to follow; and that a free interchange of thought and experience may be expected to show the way to fresh and higher ideals, as well as to improved methods of work.

In the second of two Presidential Addresses delivered to the Members of this Society in 1894 and 1895, which will well repay your perusal, Professor David summarised what was then known of the Antarctic Continent, and discussed the prospects of further exploration, little imagining that the future had in store for him the opportunity of experiencing the hardships of that inhospitable region, of sojourning for a year in Antarctica, and of establishing scientific relations with the great ice barrier, with Mounts Erebus and Terror, and other features of the great lone land which give it some of its salient characteristics. The lecture which Lieutenant Shackleton, leader of the British Antarctic Expedition, 1907-08, delivered in Sydney on 6th December attracted an audience of phenomenal dimensions, and aroused extraordinary interest, which was greatly intensified by the knowledge that Professor David and some of his pupils were to accompany the expedition during at any rate one stage of its operations. The recollection of the capable and eloquent way in which the lecturer presented and treated the subject of his discourse; and of the truly Davidian fervour which characterised the Professor's reply to the enthusiastic demand of the large audience for just a few remarks, will be fresh in your minds. The enlightened action of the Federal Government in voting the sum of £5,000 to supplement and complete the necessary outfit and equipment of the expedition led by Lieutenant Shackleton, and the inclusion of Professor David in its personnel as leader of the scientific staff, as well as of other Australian representatives of Science, have given Australia a direct and personal interest in its progress and welfare, as well as in the subject of Antarctic exploration in general, which is altogether unique in character.

It is not necessary for me to attempt to follow the course of events in detail, because the newspapers have given wide publicity to all that there is to be known at present; and Professor David's narrative, up to the time of the departure of the "Nimrod" on the return voyage, is still in course of publication in the leading daily papers. We have all heard with great regret and disappointment that the "Nimrod" had throughout so much more tempestuous and trying a time of it than the "Discovery," under Captain Scott, over very much the same route in January, 1902; and that the leader's plans for seeking winter quarters in King Edward Seventh's Land, and making this portion of the Antarctic Continent his base of operations were frustrated by insuperable obstacles. In another respect, however, the "Nimrod's" adventurous cruise provides no ground for disappointment. The record of the indomitable courage and daring of the officers and crew of both the "Nimrod" and the "Koonya," would have warmly commended itself to Captain Cook; just as the readiness of the passengers, including the scientific staff, to turn to and try to save the Manchurian ponies from being battered to death or drowned in the stalls, or to man the pumps would have evoked as warmly the approval of Sir Joseph Banks. And we may rejoice that the race which used to breed the grand old stamp of voyager ready to venture all in pursuit of geographical and scientific knowledge, still produces worthy modern representatives.

We have now to wait in patience and in faith for the return of the courageous and steadfast wanderers, encouraged by strong hopes of their success in most, if not in all their enterprises. In the meantime we may not forget, even if we cannot lighten, the anxious solicitude of Mrs. David and the wives, other relatives, and friends of the absent explorers and investigators, both in Australia and in the Old Land.

We have to congratulate Professors Hill and Wilson on the publication of their monograph on the development of *Ornithorhynchus* in the Philosophical Transactions of the Royal Society of England.

I believe that we may claim that this Society is doing a very useful, though unostentatious, work for the community. We combine together to carry out the work designed by our liberal-minded and liberal-handed founder, Sir William Macleay, by studying in precision and in detail our rocks, our fauna and our flora, and by publishing the fresh information so obtained in our Proceedings. Each year a volume of some 800 pages, carefully edited and comprehensively indexed, and illustrated by many plates, bears witness to the industry, the enthusiasm and the patience of the Members and of the Secretary. We hold that our highest duty is to pure Science, to extend our knowledge of Nature for its own sake. This object must be the special care of such Societies as ours, for individual effort is uuequal to the task, and Governments will be unwilling, for years at least, to undertake it. It is this work that men of science all over the world look to us to perform, and I think we may say that they recognise that the Society is doing this work with credit.

But all Science is liable to have a practical bearing. And our members, in their work published by the Society, and in work done outside it, have shown that they are by no means neglecting the practical needs of the community. During the year Professor David has completed his magnificent Memoir on the Northern Coalfield. Our Macleay Fellow, Mr. Jensen, has single-handed carried out a geological survey of the Warrumbungle and Nandewar Mountains. Dr. Petrie, another Fellow, is doing good work in determining the toxic and other substances of interest produced by Australian plants. Mr. Halligan has been instructed by the Government to make a hydrographic survey of the whole of our coast. Mr. Maiden, besides being the Watchdog of the Domain and the Botanic Gardens, is bringing out a richly illustrated "Forest Flora of New South Wales," with a full account of the economy of each tree. The Forestry Commission availed itself largely of Mr. Turner's knowledge of the local distribution of our trees. I may recall to you the very extensive and careful work done by Messrs. Baker and Smith on the essential oils of the Eucalypts and other Australian plants, work which paves the way to an extensive trade with Europe and America. Every year is showing with startling emphasis the need of the exact diagnosis, and of knowledge of the life-histories, of insects, mostly injurious but some useful. We have an active band of workers on insects in the Society, and an immense amount of information is being accumulated. I may mention the names of Messrs. Masters, Meyrick, Sloane, Blackburn, Lea, Froggatt, Turner, Carter and Tillyard. Two illustrated books on Australian Entomology have been published during the year, by Messrs. Froggatt and Rainbow, and another by Messrs. Waterhouse and Lyell, on the Butterflies, is in course of preparation. Mr. Stead is working under the Fisheries Board. Mr. Hedley has published an account of the Ship-worms, *Teredo*, and his extensive researches on the Mollusca in general are sure to possess practical utility. Lastly, we will cite two recondite investigations, those of our Macleay Bacteriologist, Dr. Greig-Smith, on the opsonisation of bacteria; and those of Dr. Chapman, in conjunction with Professor Welsh, on the true nature of precipitin reactions, and their application to Forensic Medicine, in the identification of blood-stains in suspected criminal cases, the recognition of human or other animal remains, and the detection of substitutions and adulterations in food, as well as, in certain cases, in ordinary clinical diagnosis. This partial enumeration shows that the work of our members has a many-sided and far-reaching bearing on the practical concerns of life.

THE RELATIONS OF SCIENCE AND GOVERNMENT.

To prevent misconception we will define our terms. By Science we mean the systematic study of natural phenomena and of the orderly sequences of natural events, and the classified and co-ordinated knowledge which is the fruit of this study. By Government we shall understand the organisations which have been created by the public will, or by the public acquiescence, for carrying out by exercise of legislative and executive powers those functions of national importance, which the nation decides to be unsafe or undesirable to intrust to individual or private control.

Since men are units of the order of Nature, subject to her laws and dependent at every turn on the changes which take place in the relations of the other units, it would seem obvious enough that Government in its working should ever have in mind the importance of the conditions imposed upon us by our being and by our environment. If we are to be the lords of creation or Nature, it can only be by mastering Nature. And to master nature we must understand Nature.

As Sir Ray Lankester* has pointed out, there is greater need now than ever before of this knowledge and understanding. While man was in the savage stage a stable equilibrium had practically obtained among existing organisms. Man, by his interference, has upset this equilibrium. He has aggregated and associated abnormally. His needs have multiplied: the luxuries of yesterday are the commonplace necessities of to-day. To meet his new and wilfully induced conditions, and to supply his new and multiplied requirements, he has at first slowly and and slightly but later, and especially in the last century with its marvellous record of discoveries and inventions, rapidly and comprehensively modified the very face of Nature. He has taken charge of the geographical distribution of plants and animals. He is on the verge of taking charge of the distribution of fresh

* "The Kingdom of Man." By E. Ray Lankester, LL.D., F.R.S. London, 1907.

water. He is drawing with a lavish hand on the mighty but still finite stores of energy which he has discovered lying ready in the bowels of the earth, and already sees himself face to face with the necessity of finding means to draw on solar radiation, the interior heat of the globe, and tidal energy. Incidentally by disturbing the balance of Nature he has introduced foes into his own household, and among the organisms which he has taken under his protection. By nursing his sick and cherishing his weak, he has unwittingly fostered an army of diseases, and by the greatly increased facility in transit and transport he has spread them far and wide. And in the same way he has introduced and maintained diseases amongst his domestic animals, and pests amongst his domestic plants.

In consequence of these and other extraordinary displacements of the ordinary arrangements of Nature which had become established by immemorial usage, man, as the disturbing body, arouses the resistance of all bodies disturbed. He can only maintain his position by the exercise of tremendous energy, and by a precise and extended knowledge of the stresses to which he has exposed himself. Using a different metaphor, Lankester styles him Nature's Insurgent Son. Pursuing this conception, he shows that, having advanced so far into the provinces of Nature, man must fortify the position he has won, and must advance still further until he has the keys of the kingdom in his possession. To hold his own, and to advance further, he must learn well the nature of the country, and the resources and disposition of the opposing forces. This knowledge he can only obtain from his scouts and pioneers—the workers in Science.

That this essential fact is not sufficiently recognised either by the public or by politicians is only too manifest. How far can our legislative bodies claim to be qualified by a scientific knowledge of the material resources of the State, and of the laws under which they may be utilised and developed and conserved in the interests of the State as a whole regarded as a permanent institution, an enduring nation? They have to consider in a minor degree the scientific development of manufactures, but far more urgent is the case of the land and its products, for it is on these that Australia must ultimately depend. Hence urgent need for knowledge of the multifarious and peculiar climatic conditions, of the natural economy of our soils, of our waters, of our forests, of our birds and of our insects. Do the members of the Legislatures possess this knowledge, or are they able to obtain the knowledge from a sufficient number of experts within or without the Public Service, and are they willing to weigh with care the dispassionate advice of the experts? Our members are chosen because of their knowledge of men, not forgetting their weaknesses, their knowledge of law and of the workings of the political machine, and their knowledge of business, but not because of their knowledge of Nature. The few medical men elected are almost the only members with a scientific training. I think, in our own State at all events, there is a growing willingness to acquire exact information by the appointment of Commissioners including scientific experts, but how often in the past the reports of skilled officers and the findings of Commissions have been neglected or ignored! On the Executive side what an army of clerks there is in comparison with the few scientific experts, and how often these are looked upon askance and with suspicion as idealists and faddists, who bring forward awkward objections to cut and dried schemes which the will of the Minister or the exigencies of party have decided must go through.

The public is generally not sufficiently educated to realise the importance of scientific knowledge in the Government. Yet it is the public which pays for the mistakes of the Government. And it is the public upon whose behalf the expert speaks. It was the science of the skilled expert which stayed the plague and checked diphtheria. It is the science of the skilled expert which has reduced, and only can reduce, the scourge of typhoid. It is only by the science of the expert that we can hope to be able to exterminate those curses of our civilisation, phthisis and cancer and syphilis, and, I think I may add, that greater curse still, the craving for strong drink. It is only science that can teach us how to deal with our droughts, how to profitably cultivate our lands without impoverishing or exhausting them, how to maintain and improve our stock, how best to draw on our mineral supplies, how to most efficiently and most economically work up our raw materials into manufactured products. Every commercial interest in the State, every individual, is most deeply interested in the manner in which our country is handled by Government. John Smithson, who provided America with the incentive and the means to found the magnificent Smithsonian Institution, declared his strong conviction "that it is in his *knowledge* that Man has found his greatness, . . . and consequently that no ignorance is probably without loss to him, no error without evil."

How much have Australians had to pay for the ignorance of of one of the Legislatures of the habits and propagating powers of the common rabbit? We learn that over 20,000 foxes were destroyed in Victoria last year. It is the Victorian farmers who now pay most heavily for the wicked ignorance which allowed of the introduction of this vermin. In a few years it will be the farmers of New South Wales and South Australia. How lightheartedly the sparrow was admitted to the rights of Australian citizenship, just owing to ignorance of the generic distinction between *Passer* and *Accentor*! How much money is needed for the eradication of Bathurst Burr, Prickly Pear, Water Hyacinth, Bramble and Sweetbriar, Codlin Moth, Waxy Scale, Pear Slug, and Red Spider, owing to carelessness or lack of knowledge in the early days? How France paid for the careless introduction of Phylloxera into her vineyards, and Ireland suffered for admitting the Colorado Beetle among her potatoes! Fortunately these costly lessons have not been lost upon the Legislatures of the present, and watch is kept at our gates against the admission of such undesirable immigrants, whether they threaten our pastures, our poultry, or our fruit. By such heavy punitive payments Government, Newspapers and People are learning by degrees that ignorance of Nature is costly. It is an easy corollary that to avoid such penalties in the future we need to multiply, to train, to employ and to trust the scientific worker.

There are signs here and elsewhere that responsible Ministers are recognising that skilled knowledge must play a larger and larger part in the administration of public affairs. Mr. R. B. Haldane, the British Secretary for War, speaking at Liverpool last September, said—"The creation of the Committee of National Defence carried scientific principles into the sphere of government, and was the first step towards getting military and naval notions into order. We have now a general staff which is a body, not to exercise command, but to give advice in a thoroughly practical fashion and in a fashion which can be enforced. The speculation may be indulged in whether one of the great reforms of government to which we are coming—because we have been driven to it—will not be the creation in an organised fashion of just such a general staff for departments of government, and not merely for the army." He goes on to give "a concrete instance of the value of scientific advice."

Our own Premier, Mr. C. G. Wade, speaking recently at Newcastle of the failure of the Arbitration Court, outlined the proposal of a new tribunal "which is not to leave to the mercy of one Court in the State the problem of dealing with all its industrial troubles, that Court composed of men who have no special knowledge in the industry concerned. The tribunal which must deal with these disputes is one to be presided over by men engaged in the particular industry concerned, men who have been experienced and trained in such industry." This is a wise and clear statement of a general principle which if applied to problems which involve special knowledge of natural science will give science workers all that they can reasonably ask. The practical man with practical interests and the man with the requisite technical knowledge could then work hand in hand for the common good.

To again quote Mr. Haldane. "If people were but aware what can be accomplished and what can be saved to the State, and the extent to which our community can be made more efficient by dealing with these things on a scientific footing, the nation would be wiser and better. This may seem to be the bureaucratic point of view, but when it is founded on science it is the right point of view; and the governments of the future will find more and more work of this kind forced upon them."

We have other practical evidences of an awakening to the recognition of the importance of scientific knowledge and scientific method, which it would be ungrateful and unfair not to cordially recognise. Mr. S. W. Moore, while Secretary for Mines and Agriculture, convened a Conference of the Government Entomologists of the five Eastern States to discuss the advisability of common action, and the best measures for dealing with our numerous insect pests; and when the Conference declared that "It is desirable that a Government Entomologist should be sent to California to investigate internal parasites, especially those of the codling moth," the various Governments combined to send our Mr. Froggatt, unanimously elected by his colleagues, on a wide commission to hunt the world over for parasites to attack the insect pests, especially the fruit flies (*Ceratitis*, *Tephritis*, and *Trypeta*), and to defray all the expenses.

Again, the Government has authorised a grant of £18,000 for the extension of the South Wing of the Australian Museum, consisting of a basement and two galleries. The basement will be employed to provide additional workshops and an up-to-date crematorium for rejectamenta. The first floor will continue the extensive mammalian and osteological collections. The second floor will be devoted to Man and his work. Further we are glad to record that in 1907 the Trustees were enabled to obtain an increased money grant from the Treasury, so that they were able to give a substantial increase of salary to everyone engaged in the Museum.

Let us now consider more in detail some of the fields in which scientific knowledge intimately concerns the administration of our country.

Weather.—The great factors which determine our climate, the presence of the cold Antarctic to the South, our situation in the High Pressure belt in the course of the procession of Anti-cyclones, and in the North in the Trade Wind track, and the contours of our Continent, are beyond our control, but they ought not to be beyond our knowledge. The climate has its peculiarities, some highly favourable, others sufficiently trying, but the only way to make the best of it is to understand it, and to regulate our action in accordance with our understanding. Hitherto the separate States have with varying degrees of attention created, administered, or neglected their Weather Bureaus. The Commonwealth Government has now, however, taken over the whole Department. This in itself is a vast improvement. The climate of Australia can only be studied scientifically as a whole, and one organisation can compass the work much more efficiently than half a dozen independent bodies. Another most hopeful feature is that last winter on the direct invitation of the Minister for Home Affairs a Conference of scientific men, including Professors from the Universities of Sydney, Melbourne, and Adelaide, and presided over by the Commonwealth Meteorologist, Mr. Hunt, was held for the purpose of securing uniformity in meteorological methods throughout Australia, and with a view to ascertaining the best methods of obtaining the most efficient services. All the States were represented with the not very creditable exception of Queensland. The subjects discussed were :—

(1) The range of practical meteorological observation to be at once undertaken.

(2) The expansion of meteorological work to be undertaken in the future.

(3) The extent of purely scientific investigations, the undertaking of which is desirable in the interests of meteorology.

(4) Meteorological records, reports, and publications.

(5) Maritime meteorology.

(6) The relation of river observation to flood forecasting.

(7) The co-operation of the Commonwealth and States Departments.

These form a comprehensive programme, and the recommendations brought forward showed the value of the happy combination of skilled officials and representatives of pure science. Of the broad view taken we can judge by the first sentence of the sub-committee's report: "It is of the first order of importance that the work of the Meteorological Bureau should not be confined to the accumulation of facts on stereotyped or traditional lines, but should be strengthened and unified by the inclusion of original research." The wisdom of the Federal Government in summoning the Conference to advise leads us to expect that as far, and as soon, as possible the advice will be followed. Another strong evidence of the disposition of the Government was furnished by the handsome contribution of £5,000 made by it to the present Expedition, which has for one of its objects the investigation of the conditions of Antarctic weather. As seen above, Maritime Meteorology was one of the subjects discussed at the Conference, and it was suggested that a branch be established in the Bureau for collecting data of atmospheric phenomena and of temperatures and currents of the seas which lie to East and West and South of us, presumably not omitting the region of "the Roaring Forties and Shrieking Fifties," as Professor David calls them, writing feelingly from Lat. 61° S. No doubt too one of the bits of work to be undertaken by the Bureau will be the testing of the attractive but alas, evasive theories of the recapitulation of climatic conditions in cycles.

Minerals.—Generally speaking we must look upon our mineral resources as pure capital. Doubtless the natural agencies which have produced our auriferous reefs and our mineral veins are still in operation, but the time required for reproduction is beyond the time-limit of man. We do not know that anywhere in the world, we do know that nowhere in Australia, are the processes going on which would produce new coal seams. Practically every ounce of gold and every ton of coal we draw from the earth is withdrawn from it finally and leaves us the poorer. The supplies though bountiful are after all finite, and some day there will be an end. Hence it is plain that the land itself is our most important, as our most abiding, possession. That we should use this other lavishly furnished capital to the best advantage is also plain. The most scientific methods of extraction and of treatment should be practised. How far do—can—our Schools of Mines experiment with refractory ores? The policy of our Australian Governments has been to give up the whole of our mineral resources to private exploitation. This is not the place to discuss or criticise this policy. But the scientific man may consider its bearing on the development of the country, which we have seen must be eventually the development of the land-industries. Looking upon our minerals as a generous capital, we may ask, is it being expended, as would seem natural, in the development of the country? It may be replied that we have used it to attract population, to establish manufactures, to help to support our railway systems, to build mining towns and communications with them, to pay wages to a large army of miners, and indirectly to necessitate a great production of animal and vegetable food for the sustenance of the large numbers concerned in the mining industries. Perhaps this reply is sufficient. Will it be eventually considered sufficient? We must content ouselves here with having put the question.

Water.—There is one substance which the geologist classifies as a mineral, however, which is on a different footing. That is water. Our climatic conditions being mainly regulated by large world-conditions we may look upon our rainfall as practically constant for a certain cycle of years, though it may be, in accordance with some general law, slowly decreasing. Our fresh water then, unlike our coal, is perennially renewed, whether it be dispersed in the soil and rocks or collected in our rivers or our artesian supplies. We need it for our towns and cities, and for natural or artificial irrigation of our soils. In New South Wales its uses for navigation purposes are very limited. Australia is not a land of canals. But what a prodigious problem we are confronted with: How to procure and to maintain a permanent supply of water for our rapidly increasing towns, and for our as rapidly increasing agricultural and pastoral industries?

The metropolitan water supply has been recently a scalding, if it is too Irish to call it a burning, question. It may perhaps be useful to glance at the views forced upon the British Government and the London and other British Water Boards by the press of population in the Old Country. The average daily supply to London has increased from 144 million gallons in 1881 to 225 millions in 1906-7, the amount consumed per head being 33 gallons in each year. In 1960, at 35 gallons per head, the Metropolitan Water Board estimates the demand at 420 millions. By the construction of immense storage reservoirs, and elaborate connections, the chief engineer believes that it will be possible to obtain a supply of 450 million gallons from the Thames, but that this is the absolute limit. It is thus plain that London will have to draw water by an heroic scheme from a distant source, probably the mountains of Wales, and that within the lifetime of a number of the existing population. And the other cities of Great Britain have to face correspondingly heavy expenditures. And here comes in the further difficulty that several of these have their eye on the same sources. Hence the Water Board has adopted this resolution : "That as the increase of population will eventually render resort to some other source than the Thames watershed imperative, the Board view with great alarm the increasing tendency of authorities throughout the kingdom to appropriate water-supplying areas for their particular use, and in these circumstances desire to urge upon Parliament the necessity for regulating the appropriation of water-supplying areas, so that the needs of the metropolis as well as of other populous places may receive due consideration." In England, then, they are, of compulsion, looking ahead half a century in making arrangements for the metropolitan water-supply.

With this example before us, it would seem to be an evidently wise policy to make sure betimes of the most extensive catchment areas for the ever expansive water supply needed for the metropolis, for Newcastle, Bathurst, and the other large towns. Though our numbers do not compare with those of the British cities, our need for water per head is greater, for our gardens and parks, and for our growing manufactures, while the loss by evaporation is far greater than anything known in Great Britain. There is need to keep watch on these catchment areas, to see that the tree-growth is not removed from the sources of the contributing streams, and to prevent contamination of the water by the establishment in the area of vested and injurious interests. In the particular case of the metropolis now under discussion, two eminently scientific objectives have come into collision. It is urgent to establish effective Consumptive Homes, and it is urgent to secure a high-level water source in order that pressure of water sufficient to cope with city fires may be obtained by gravitation only, and to secure as large a catchment area as we can in face of the great needs of the future. We have every reason to credit the present Government with perfectly disinterested motives in their decision, but we cannot but think that the larger need should take precedence of the smaller. And I feel sure that the sympathy of every man of science will be with Mr. Keele, who has so bravely and so persistently fought for the needs of his department, of which he has the expert knowledge which no one else can possess so fully. And it would be a disgrace to the country if faithful and courageous expression of the views which he knows and can show to be scientifically just and correct should redound to the hurt of any scientific officer of the State.

The even larger question of the provision of water for irrigation purposes demands also a wide and early grasp of the possibilities of supply. The Minister for Works, Mr. Lee, is an enthusiast in the matter. He may well be proud of the Barren Jack scheme, and he has recently expressed his wish to provide a great extension of irrigation to the Nepean country, and incidentally regretted "my limited staff of engineers for the purposes of investigation."

In truth we need a comprehensive investigation of the catchment areas of the different river-basins of the State, and also of the possibilities of artesian water-supply. That these last are great is known, the present artesian water supply being many times greater than that of Cataract Gorge and Prospect Reservoir combined. But there has been no systematic investigation of the water-bearing zones, of their extent and capacity, of the intake beds, of the real causes of supply, of the fluctuations in output, of the interdependence of the bores. For full efficiency, for us to get the most out of this invaluable asset of our interior, casual trials here and there where water is wanted are inadequate; the system must be considered as a whole, and then only can we have a fair and wise general organisation and control.

The Land.—That the Press is realising the importance of the cultivation of the land is plain by the large amount of space given up to the subject in the daily papers. To quote the *Sydney Morning Herald* of Feb. 15th, 1908, "Our duty to primary production is clear. Whatever else we may neglect we should make this our especial care." Advocating the establishment of a Federal Department of Agriculture, the *Herald* goes on to say "The Commonwealth's model in this respect may well be the United States Department of Agriculture. It has taken shape under conditions similar to ours, and it stands to-day the finest State organisation of the kind in the world." Everybody who has studied the methods and the publications of this grand Department will heartily endorse the encomium. Armies of experts are employed in the Laboratories and in the Experimental Stations. Every problem which confronts the farmers is attacked with adequate means, and with a full determination to obtain the best possible solution. By no means content with a knowledge of what is being done in the States and Territories, the Department makes itself acquainted with the organisation and progress of similar institutions in foreign countries. [In a special Bulletin published in 1905 and giving information on the important subject of Agricultural Instruction for adults in the British Empire, it is somewhat galling to find 12 pages given to Australia and over 40 to Canada, and especially to find New South Wales dismissed with the single sentence "Nothing corresponding to the farmers' institute system of the United States is in operation in New South Wales."] For a cardinal principle with the Department is that the knowledge wrested from Nature shall be brought home to the men who are actually conducting the operations on the soil. This is accomplished by the free and profuse distribution of Bulletins bearing on every side of farm life, written in exact but simple language, by the employment of itinerant instructors, and especially by encouraging the farmers to form Farmers' Institutes. These last are associations or clubs for discussion of common difficulties and interchange of opinions, organised under the auspices of the Department so as to effectively disseminate "the results of the work of the Department of Agriculture and the Agricultural Experiment Stations and of improved methods of agricultural practice." Thus the Department tries to reach the farmer's son and the farmer's daughter as well as the farmer himself. For the Department recognises that general improvement in cultivation can only be secured by the willing and intelligent co-operation of the agricultural population. And it therefore sets itself the task to prove to the cultivators that it is worth their while, in pounds, shillings and pence, or perhaps in dollars, to follow the scientific advice which is brought to their doors. Our State Department of Agriculture is being re-organised, and a Federal Department is likely to be established, and we may hope, with the *Herald*, that the experience of America will be largely utilised in the new developments.

This Department strikes admiration into everyone who sees its working. Its Experimental Stations are numbered in scores, and the Farmers' Clubs in hundreds. These latter are established in every State and Territory except ice-bound Alaska. Prof. H. E. Armstrong, of the Moseley Commission, says of the Central Department of Washington that it is "not merely an office—it is also a busy hive of research." "In 1902 the staff numbered 3,789, of whom 1,209 were executive officers, clerks and messengers, 2,081 scientific investigators, and 409 labourers." I would call attention to the proportion of scientific investigators. Why they outnumber clerks and labourers combined. In Australia heads of departments can usually obtain as many clerks as they ask for, and always as many pick and shovel men as can be crowded on the place, while scientific appointments are too often grudgingly made, temporary in tenure, and badly paid. The Americans have found that genuine scientific servants are the hub of the whole concern. May our re-organised Department of Agricultnre find the same.

A happy feature of the American organisation is the holding of Conventions of delegates from the Agricultural Colleges and Experiment Stations of the whole Union in which technical and general questions are discussed. Recommendations from such bodies of experts in theory and practice carry with them a weight which it is difficult for officialism or political interest to resist.

The fine spirit which animates the central government is well shown in an Address by President Roosevelt at the Jubilee celebration of the Founding of Agricultural Colleges of the United States, held at Lansing, Mich., last year. May I quote some of his sayings? "We of the United States must develop a system under which each individual citizen shall be trained so as to be effective individually as an economic unit, and fit to be organised with his fellows so that he and they can work in efficient fashion together." "The question is vital to our future progress, and public attention should be focussed upon it." "The calling of the skilled tiller of the soil, the calling of the skilled mechanic, should alike be recognised as professions, just as emphatically as the callings of lawyer, of doctor, of banker, merchant, or clerk. . . . They should be trained alike in head and in hand. They should get over the idea that to earn 12 dollars a week and call it 'salary' is better than to earn 25 dollars a week and call it 'wages.'" "In every great crisis of the past a peculiar dependence has had to be placed upon the farming population, and this dependence has hitherto been justified. But it can not be justified in the future if agriculture is permitted to sink in the scale as compared with other employments. We can not afford to lose that pre-eminently typical American, the farmer who owns his own farm." "The prime need must always be for real research, resulting in scientific conclusions of proved soundness." "Hereafter another great task before the National Department of Agriculture must be to foster agriculture for its social results, or, in other words, to assist in bringing about the best kind of life on the farm for the sake of producing the best kind of men." "Farmers must learn the vital need of co-operation with one another." "The farmers in the region affected by the boll-weevil, in the course of the efforts to fight it, have succeeded in developing a most scientific husbandry, so that in many places the boll-weevil became a blessing in disguise. Not only did the industry of farming become of very much greater economic value in its direct results, but it became immensely more interesting to thousands of families." "It is only through such combination that American farmers can develop to the full their economic and social power. Combination of this sort has, in Denmark, for instance, resulted in bringing the people back to the land, and has enabled the Danish peasant to compete in extraordinary fashion, not only at home but in foreign countries, with all rivals."

Again the President speaks out in his opening Address to the American Forest Congress, held at Washington, January, 1905. "All of you know that there is opportunity in any new country for the development of the type of temporary inhabitant whose idea is to skin the country and go somewhere else. You all know, and especially those of you from the West, the individual whose idea of developing the country is to cut every stick of timber off of it, and then leave a barren desert for the home-maker who comes in after him. That man is a curse and not a blessing to the country. The prop of the country must be the business man who intends so to run his business that it will be profitable to his children after him. That is the type of business that it is worth while to develop." "I ask, with all the intensity that I am capable of, that the men of the West will remember the sharp distinction I have just drawn between the man who skins the land and the man who develops the country. *I am going to work with, and only with, the man who develops the country. I am against the land-skinner every time.*" And so, gentlemen, I think, say all of us. We are against the forest skinner and against the man who grazes out the saltbushes.

Forests.—The address of President Roosevelt was, as we have said, delivered at the National Congress of 1905, held to consider the great subject of Forest Reservation and National Prosperity. At this Congress "practical methods of safeguarding the broad business interests of the nation, now threatened by wholesale forest destruction, were considered by lumbermen, railroad men, engineers, foresters, and representatives of the mining, grazing, cooperage, and other interests, of the several States and of the National Government." The President of the United States himself delivered the opening address.

Australia, and New South Wales in particular, has been lavishly endowed by nature with forests of the most valuable timbers in the world. These have been handed down to us intact by the simple-minded Aborigines. It has been reserved for the white man to set about skinning the country. Our immensely valuable forests have been recklessly devastated by fire and axe, by men regardless of all but immediate and personal returns, until the very existence of some of the most important timbers is threatened. The timber wasted has been infinitely greater than the timber used. The forests have been destroyed, not reaped. Here, again, the Government is confronted with a tremendous problem—How to maintain and supervise our forests, so that we may have a perennial supply of timber for all our own increasing needs and for export to less favoured countries, and that the forests themselves may remain efficient to perform the important functions which it is their business to perform in the general economy of nature. It is no mere sentiment, the desire to preserve things beautiful, though there is no sin in that, but the absolutely material necessities of every commercial and industrial class, of every individual in the Commonwealth, which compel us to urge upon the Government the scientific supervision and care of our forests. We need living trees and much wood, and our children's children will need them no less than we. What are we going to do in order to make sure that those needs shall be abundantly satisfied?

The Americans have been as careless over their forests as the Australians. They have experimented in destruction on the same large scale, and from the views expressed in the Forest Congress we can learn large lessons from their experience.

First as to the connection of the forests with natural and artificial irrigation. Probably the total amount of rainfall in Australia is determined by other factors. But the distribution of that rainfall, its retention in the soil, is mainly determined by the existence of forests. The Hon. James Wilson, Secretary for Agriculture, said : "Forestry and irrigation go hand in hand in the agricultural development of the West. The West must have water, and that in a sure and permanent supply. Unless we practise forestry in the mountain forests of the West, the expenditure under the national irrigation law will be fruitless, and the wise policy of the Government in the agricultural development of the arid regions will utterly fail. The relations in the arid regions between the area under forest and the area in farms will always be constant. We can maintain the present water supply of the West by the protection of existing forests. In exactly the same way we can increase this supply by the foresting of denuded watersheds. The full development of the irrigation policy requires more than the protection of existing forests—it demands their extension also." Surely this shows to us the wisdom of maintaining our forests about the heads of the eastern rivers for the sake of agriculture in the valley flats, and the possibility of increasing the irrigation of the great plains by afforesting the western slopes of the Divide around the heads of the tributaries of the Darling.

Again, the Hon. John F. Lacey, Representative in Congress from Iowa, said : "I was born in the woods of Virginia. I moved to the prairies, and one of the most unpleasant things of my subsequent life was to return to the woods of Virginia and find that the old streams and the holes we used to swim in and where we used to go fishing are now gravelly roads. They are highways as dry, as arid, as one of the deserts of Arizona or New Mexico. Why is it? Because the trees have been cut down, and the springs, the children of the forest, dried up. Instead of a slow-running brook digging out holes here and there clear as crystal, we have simply a torrent carrying the pebbles and sand from the hills, and then a desert."

The Ambassador of France to the United States stated that "in France our forests, like all the other inhabitants of the land, have their own code of laws. One of them is the law of 1860, which provides that every landowner who possesses mountain slopes is obliged, whether he wills or not, to re-forest them if denuded. In 1882 a new law, perhaps a little less stringent, but more practical, was enacted. According to this law, which is still in force, the Government has the right to serve an injunction on any owner of mountains who has not re-forested them. The owner has a right to refuse, and in that case the Government expends a fair sum of money and plants the trees for the good of the community. The results have been very happy. In every part where these rules have been applied it is noted that the temperature is more equal, that the water supplies from springs have been more regular, and the torrents less destructive." If in France, where the climate is temperate, where the lower vegetation is more continuous, and the ground is not baked brick hard by a fierce sun, it is considered of national importance to preserve the forests of the highlands by such stringent laws, it is surely a lesson to us with our generally more arid conditions, our bright sunshine and our exceptional monsoonal rains.

The importance of forests in the upper reaches in preventing disastrous floods in the lower reaches of the rivers has been demonstrated abundantly in the States. Mr. Wilson says: "We have to tell the people of the lower Mississippi every few years to raise their levees to hold the floods that exceed themselves, as the forest ceases to hold waters that in previous years were directed into the hills and held back." Sydney, of course, is in no danger of serious floods, but Newcastle, Maitland, Grafton and the other towns similarly situated are strongly interested in the preservation of the forests in the catchment areas of these rivers.

Another practical lesson in the economy of the forest may be learnt from American experience. President Roosevelt said: "Those of us who have lived on the Great Plains, who are acquainted with the conditions in parts of Oklahoma, Nebraska, Kansas, and the Dakotas, know that wood forms an immensely portentous element in helping the farmer on those plains to battle against his worst enemy—wind. The use of forests as wind-breaks out on these plains, where the tree does not grow unless man helps it, is of enormous importance." We have evidence of this truth in our own Blue Mountains, where the cutting down of the trees and the uncontrolled bush fires are not only making the water supply for the local towns precarious, but allow the strong westerlies to sweep away the soil and expose the bare rock. The Blue Mountains will never be an agricultural paradise, but must depend on those who visit them for the sake of health and recreation. Here a timely planting of trees around the water-courses is probably the only means of preserving the beauty and the utility of these charming health resorts.

The use of wood is rapidly increasing all over the world, and timber is steadily growing in value. That means the rapidly increasing commercial value of our forests. Wood is consumed locally in a thousand ways, for fuel and fencing, for the construction of all buildings, for railway sleepers and telegraph poles, for the mines, for street paving, for the making of barrels and boxes and cases used in the transport of every kind of merchandise. The greater our population, the more extensive our mining and manufacturing enterprises, the more timber we shall need. What a complete disorganisation of commerce would be brought about by a Wood Famine! The oldest necessities of mankind were food, water and wood, and these will be prime necessities to the end of time. It is everybody's interest to see that we secure betimes an ample local supply for local needs, and a supply for export on what must be ever more remunerative terms. The Government then, acting on behalf of the whole community, must see to it that our forests are not skinned and destroyed, but that they be maintained in full efficiency and widely extended. We need a strong Forestry Department, whose skilled officers shall be listened to, and their recommendations carried out. Money spent, freely spent, on the conservation of our forests, will be money well invested.

Fauna.—The Australian native Fauna is largely unique, and is remarkable for the comparatively small number of destructive vertebrates which, from man's point of view, may be looked upon as pests. The serious enemies to man are the insects, locusts, grasshoppers, caterpillars, beetles and the small fry that destroy the trees, shrubs and herbs. The Marsupials are mostly fur-bearing animals, and their pelts are likely to become increasingly valuable in the markets of the world. Every year millions of Opossum skins and hundreds of thousands of Macropus skins are exported to the Old World at good prices. The farmer and the farmer's wife, the farmer's sons and the farmer's daughters, make pin money by skinning the opossums, literally and in President Roosevelt's sense. These animals are necessarily becoming greatly reduced in numbers, and in many districts are practically exterminated. The Kangaroos and Wallabies are shot for sport, for their pelts, for their soup-making tails, or because they are rivals of the sheep and cattle. Is Australia prepared to lose altogether its fur-bearing Marsupials? I have inquired at times amongst practical men, and find that at present prices it is much more profitable on fairly good land to rear sheep and cattle than to rear Kangaroos and Wallabies. In poor country, rocky and hilly, the comparison is not so unfavourable to the latter. The feasible policy then seems to be to protect the Marsupials to such an extent as to prevent extermination on the good grounds, to give them a good chance in poor country, and to set aside areas, the Government on a larger scale as in national parks and reserves, and broad minded landowners, as some are doing, on a smaller scale, in which a stock of Marsupials may be preserved. Then, when prices are favourable, it will be at least possible to develop on a feasible scale a fur industry which may compare with the ostrich farming which has been found so profitable in Cape Colony.

The Act at present in force in New South Wales, assented to in 1903, prescribes a close season from August 1st to January 31st of each year for the Red Kangaroo and the Wallaroo, our friend the Native Bear, the Wombats and Flying Phalangers, and for the Platypus and the Echidna. This is a welcome step in the right direction, and we trust that the list will be extended to include the other fur-bearing Marsupials.

Fish.—The Fisheries Board is doing excellent work in the protection and the introduction of edible fish, both in our fresh waters and in the shore waters of the ocean. We would like to see its hands strengthened, and its operations extended to the deeper waters. This part of our natural food-supply is of vast importance to the community, and we know but too little at present as to the habits and migrations of our sea-fish.

Birds.—It is hard to speak in terms of calm moderation on the subject of the Protection of our Native Birds. Enthusiasm is liable to be looked upon with suspicion. But the point is that everyone who studies the useful work done by our beautiful feathered friends inevitably becomes an enthusiast for their protection. Great credit is due to the members of the Australasian Ornithologists' Union, to Colonel Legge, Colonel Ryan, Mr. Dudley Le Souef, Mr. A. J. Campbell, Mr. Mattingley, and the rest for their persistent endeavours to bring the importance of the work done by the birds home to the Governments and people of the Commonwealth. To quote Mr. Campbell, "Apart from the physical elements, the most important allies of the farmer, pastoralist or orchardist, are our beloved birds—not to mention the delight that many of them give us in form, colour and song. Australian producers appear slow to recognise the great utility of birds, because their (the birds') work is mostly unobserved. The diet of numerous birds consists mainly of the lower forms of life—insects and such-like crawling creatures. Experts who have studied the question know how the lowly hordes of insect pests increase, often at an astounding rate, and what a destructive power they are to almost every living green thing. Happily this insect life is kept in check by birds. Contemplate what would become of the forest and field—the pastures of man and beast—were there no birds? The land would in time become a wilderness. In endeavouring to combat the attacks or increase of insect pests there is no "insecticide" so cheap or so effective as the original and natural one—birds."

We may recall the old picture of desolation presented by the Hebrew prophet Joel. "That which the palmer worm hath left hath the locust eaten; and that which the locust hath left hath the cankerworm eaten; and that which the cankerworm hath left hath the caterpillar eaten." But wheresoever the grasshoppers and the caterpillars be there will the insectivorous birds be gathered together. Recently in Victoria there was an interruption on one of the telegraph lines. The officers sent to discover the cause found the upper wire brought down into contact with the lower by the weight, the papers say, of thousands of crows. There was a grasshopper plague in the district, and the crows, usually only seen in pairs, had assembled from miles around, had caroused on the pest, and were reposing on the upper wires, which their weight, assisted by that of the grasshoppers, brought into contact with the lower. And, strange to say, in this case the attacking allies of man were from the tribe of the much-abused crow.

An army of insectivorous birds works to keep our orchards clean, and among the fruit-growers this is so well recognised that the birds are looked upon as friends of all except by the cat, the schoolboy—and the collector. The Bustards do their best with the grasshopper, devouring them until the birds are so heavy they can be knocked over with a stick. And white men will do it. The Herons and Egrets and Ibis "police the irrigation channels," seeking out the "yabbie" crayfish, which have done so much damage by drilling holes through the retaining banks at Mildura and elsewhere. These birds and others destroy the molluscs on the wet flats which serve as hosts to the liver-fluke so deadly to the sheep. But instances might be multiplied indefinitely.

Colonel Ryan and Mr. Campbell have in successive addresses to the Ornithologists' Union shown what measures have been adopted in America and Europe for the protection of birds. The Lacey Act, approved by the American Congress in 1900, the broadest and most comprehensive measure ever introduced for the protection of wild birds and animals, contains three main divisions :—

(1) It places the preservation of birds under the jurisdiction of the Department of Agriculture.

(2) Authorises the Secretary for Agriculture to regulate the importation of foreign birds and animals.

(3) Prohibits interstate traffic in birds killed in violation of State laws.

The results have been effective protection of native game birds, the importation of new game birds, the establishment of national reserves for the protection of birds and animals, and the creation among the people of a strong sentiment in favour of the wise preservation of the avifauna.

To what extent importance is attached to bird protection in Europe is seen from the fact that the great countries of the Continent have combined to adopt international legislation on the subject. Mainly through the efforts of the Austrian and Hungarian Governments, all of the Continental nations, except Italy, Russia and Turkey, in 1902, accepted through their plenipotentiaries a model bird bill to be incorporated in the laws of the several countries. The necessity for common action arises because the land-frontiers of the countries are no barriers for the birds. For the same reason it is eminently desirable that the whole of the Australian State Governments should adopt the same legislation in the matter. It is obviously more effective to protect the birds in all the States than in a few, and it is eminently desirable that destroyers of protected birds in one State should find no refuge against prosecution in an adjoining one. They have found this out in Europe; they have found this out in the United States. We may well follow suit in Australia.

Difficulties in administration in Russia and in Turkey may explain the non-inclusion of those countries. That Italy, the land traversed twice a year by hosts of migrating birds, should have remained outside the union is a matter of great regret. The rulers of the country were in favour of the Bill, but found themselves unable to enforce it among their people—one blushes to write it—"owing to the incurable passion of the Italians for 'robins on toast.'" Fortunately Australians have not developed any such tastes, and the Skylarks, the Robins, the Blue Wrens and the Flycatchers and our other small birds are in no danger of being netted in hundreds for the domestic pot.

The Act adopted in Europe is thorough-going. Article 2 enacts that it shall be forbidden, at any season and in any manner whatsoever, to steal eggs and nests, to take or destroy nestlings. The import of these nests, eggs and nestlings, their transport, the colportage of the same, their putting up to sale, sale and purchase shall be prohibited.

Article 3. The construction and employment of traps, cages, nets, nooses, lime-twigs, or any other kind of instruments used for the purpose of rendering easy the wholesale capture or destruction of birds shall be forbidden.

There are of course reasonable exceptions made to these sweeping regulations, but the point is that the Governments do not publish lists of a few birds to be protected, but publish the exceptions, and the conditions under which they may be taken or destroyed.

In contrast to this European example, in Australia the several States have independent Acts, more or less incomprehensive, and have no regulations for inter-State action. The list of protected birds in our New South Wales Act of 1901 is a strange jumble in which the Seagulls, singled out alone from the sea birds, find themselves sandwiched in between the Emu and the Brush Turkey, "Seagulls of every description" (there are only two species to be found all round the coasts of Australia), in which the Butcher Bird lies down by the Coachwhip, in which the 21 genera and 88 species of Honey Eaters are represented only by "the Honey Sucker, *Meliornis*," in which *Gerygone* and *Rhipidura* and most of the technical Fly-Catchers find no place at all. It may not be necessary to go so far as the

Swiss, who absolutely forbade the destruction of any wild birds at all, but we should protect all birds, *except those known to be injurious,* and schedule these, taking it for granted that all not excepted are being protected for the good of the community.

It is generally best to obtain one's ends by persuasion rather than by compulsion, and while it may be necessary to restrain the larrikins of the town, it is eminently desirable that the rural population should have the facts brought home to them, and should heartily co-operate with the Government in a work which so nearly concerns themselves. The larger useful birds of the interior are being destroyed wholesale by the poison laid for pests, and the country thus denuded of its native police is being opened up for the awful plagues of caterpillar and locust. We must try and win the farmer and his household, the squatter and his riders, to the side of their truest friends and best allies, the birds.

The adoption of an Arbor and Bird Day in the country schools has met with success in the United States, and is well worth a trial here. For the sake of the land we love we need to train the children to love the tree and the bird. To quote the Secretary for Agriculture, Mr. Sterling Morton (1904), "Public sentiment, if properly fostered in the schools, would gain force with the growth and development of our boys and girls, and would become a hundredfold more potent than any law enacted by the State or Congress. I believe such a sentiment can be developed, so strong and so universal that a respectable woman will be ashamed to be seen with the wing of a wild bird on her bonnet, and an honest boy will be ashamed to own that he ever robbed a nest or wantonly took the life of a bird." So may it be.

Conclusion.—The Government is the representative of the State, the guardian of the people's heritage. The individual is too apt to consider his private and immediate gain. The Government alone can watch over the permanent interests of the State, can see to it in good time that our resources are not impoverished, that the individual has the usufruct of the land

and does not skin it, and must be the schoolmaster of the nation in the highest sense.

The scientific method—the method of accurately informed common sense—is the only sane, the only impartial, the only incorruptible and the only efficient method, in government as in everything else. What are the alternatives? Good government carried out by statesmen, based on exact *science*, precise knowledge, and foresight; and bad government carried out by politicians subservient to present interests and personal influences, and based on *nescience*.

So Science is the natural ally of the Government. For in regard to material questions the scientific man of the twentieth century occupies the position of the prophets of old. He alone can say "Thus saith the Lord," for he alone has "waited patiently upon the Lord," and learned His will. Without Science no nation can keep its place in the van. For "Science is the golden guiding star of practice; without science there can only be a blind groping in the region of undefined possibilities."

On behalf of the Hon. Treasurer, Mr. J. R. Garland, who was unable to be present, the Secretary submitted the Financial Statement for the past year, and then moved that its consideration be deferred for a month, as a series of altogether unusual circumstances had combined to prevent the Auditors from carrying out their duties at the appointed time.

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

PRESIDENT: A. H. S. Lucas, M.A., B.Sc.

MEMBERS OF COUNCIL (to fill six vacancies): Prof. T. W. E. David, B.A., F.R.S., Henry Deane, M.A., F.L.S., M. Inst. C.E., W. S. Dun, James R. Garland, M.A., Prof. W. A. Haswell, D.Sc., F.R.S., J. H. Maiden, F.L.S., etc.

AUDITORS: Messrs. Duncan Carson and Edward G. W. Palmer, J.P.

The Meeting then adjourned to April 29th, at 8 o'clock.

WEDNESDAY, APRIL 29TH, 1908.

The Adjourned Annual General Meeting of March 25th, 1908, was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, April 29th, 1908.

Mr. A. H. S. Lucas, M.A., B.Sc., President, in the Chair.

The Secretary, on behalf of Mr. J. R. Garland, M.A., Hon. Treasurer, presented the balance sheet for the year 1907, duly certified by the Auditors; and he moved that it be received and adopted, which was carried unanimously.

The President said that the Society had now to say farewell to Mr. Garland in his official capacity as Hon. Treasurer, and that it did so with very great regret. Mr. Garland's business-like management of the Society's finances, his unfailing courtesy, and his disinterested efforts to advance its welfare entitled him to the hearty thanks of the Members. The news of a steady improvement in Mr. Garland's health would be received with great satisfaction.

On the motion of Mr. Hedley, it was resolved, with acclamation, that a record of the Society"s appreciation of Mr. Garland's valuable services should be entered on the Minutes; and that the sincere thanks of the Members, together with their hearty congratulations on his prospective restoration to health, should be tendered to Mr. Garland.

On the motion of Mr. J. H. Campbell it was resolved that the best thanks of the Society should be conveyed to the Honorary Auditors, Messrs. Duncan Carson and E. G. W. Palmer for their kindness and co-operation in carrying out the annual audit.

On the conclusion of the formal business of the Meeting, a very hearty vote of thanks to the President for his able address, dealing with a subject of so much importance to the welfare of the community—the right relations of Science and the Government—was carried with acclamation, on the motion of Mr. R. H. Cambage.

The Linnean Society of New South Wales.

GENERAL ACCOUNT.

Balance Sheet at 31st December, 1907.

Liabilities.

	£	s.	d.
Capital: Amount received from Sir William Macleay during his life-time	14,000	0	0
Further Sum bequeathed by his Will £6,000, less Probate Duty, £300 ...	5,700	0	0
	£19,700	0	0
Income Account at 31st Dec., 1907 ...	85	16	10
	£19,785	16	10

Assets.

	£	s.	d.	£	s.	d.
Investments: Loans on Mortgage	17,700	0	0			
Fixed Deposit Commercial Banking Co. of Sydney	2,000	0	0			
				19,700	0	0
Cash: At Bank—Current Account	81	12	10			
In hands of Secretary ..	4	4	0			
				85	16	10
				£19,785	16	10

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Dr. INCOME ACCOUNT, year ended 31st December, 1907. Cr.

	£	s.	d.	£	s.	d.
To Salaries and Wages ...				473	3	4
,, Printing (Publications) ...	302	4	7			
,, Illustrations	112	14	1			
				414	18	8
,, Ground Rent	64	0	0			
,, Rates	18	10	5			
,, Insurance	8	2	7			
	90	13	0			
Less charged to Bacteriology Account	21	0	0			
				69	13	0
,, Renovating Caretaker's House				28	11	0
,, Bank Charges	1	2	1			
,, Postage, Telegrams, Advertising, and Petties ...	42	7	0			
,, Telephone Rent	5	0	0			
,, Accountancy Fee	5	5	0			
,, Printing (sundries), Stationery, &c....	4	12	0			
,, Iron Safe	6	5	0			
				64	11	1
				1,050	17	1
,, Balance to next year ...				85	16	10
				£1,136	13	11

	£	s.	d.	£	s.	d.
By Balance at 31st Dec., 1906				74	3	3
,, Subscriptions—						
Arrears—£27 6 0						
1907— 98 14 0						
1908— 2 2 0						
	128	2	0			
,, Entrance Fees	12	12	0			
,, Interest on Investments ...	795	14	5			
,, Sales (including 100 copies of Proceedings purchased by Government)... ...	126	2	3			
				1,062	10	8
				£1,136	13	11

BACTERIOLOGY ACCOUNT.

Balance Sheet at 31st December, 1907.

Liabilities.	£	s.	d.	Assets.	£	s.	d.
Capital: Amount bequeathed by Sir William Macleay, £12,000, less Probate Duty £600	11,400	0	0	Investments: Loans on Mortgage ...	13,350	0	0
Accumulated Interest ordered by Council to be added to Capital	900	0	0	Cash in Bank, Current Account	423	1	9
Further Amount ordered by Council to be added to Capital	700	0	0				
Interest invested	350	0	0				
	13,350	0	0				
Income Account at 31st December, 1907	423	1	9				
	£13,773	1	9		£13,773	1	9

Dr. INCOME ACCOUNT, year ended 31st December, 1907. Cr.

	£	s.	d.	£	s.	d.		£	s.	d.
To Salary and Wages	405	0	0				By Balance at 31st Dec., 1906	303	1	5
,, Petty Cash (Bacteriologist)	6	0	0				,, Interest on Investments	559	6	3
,, Colouring Walls of Laboratory, etc.	6	9	6							
,, Insurance	0	16	5							
,, One-fourth of Ground Rent, Rates, and Insurance on Hall	21	0	0							
				439	5	11				
,, Balance to next year ...				423	1	9				
				£862	7	8		£862	7	8

LINNEAN MACLEAY FELLOWSHIPS' ACCOUNT

Balance Sheet at 31st December, 1907.

Liabilities.				£	s.	d.	Assets.	£	s.	d.	£	s.	d.
Capital: Amount bequeathed by Sir William Macleay, £35,000, less £1,750 Probate Duty...				33,250	0	0	Investments: Loan on Mortgage	33,250	0	0			
Balance from Income Account capitalised in terms of bequest or available for such purpose—							Inscribed Funded Stock at 4%, due August, 1909 ...	1,020	0	0			
On 31st Dec., 1904	£1,020	9	9				Fixed Deposits, Commercial Banking Co. of Sydney ...	2,038	0	0			
On 31st Dec., 1905	1,048	18	6								36,308	0	0
On 31st Dec , 1906	989	2	9				Cash in Bank, Current Account				1,057	16	11
On 31st Dec., 1907	1,057	5	11										
				4,115	16	11							
				£37,365	16	11					£37,365	16	11

Dr. INCOME ACCOUNT, year ended 31st December, 1907. Cr.

	£	s.	d.		£	s.	d.
To Salaries of Linnean Macleay Fellows (two)	700	0	0	By Interest on Investments	1,757	5	11
,, Amount transferred to Capital Account	1,057	5	11				
	£1,757	5	11		£1,757	5	11

Audited and found correct, and Securities produced to us.

Duncan Carson }
E. G. W. Palmer } Auditors.

30th March, 1908.

J. R. Garland, Hon. Treasurer.

ORDINARY MONTHLY MEETING.

Mr. A. H. Lucas, M.A., B.Sc., President, in the Chair.

Mr. H. E. Finckh, Raglan Street, Mosman, was elected an Ordinary Member of the Society.

The Donations and Exchanges received since the previous Monthly Meeting (November 27, 1907), amounting to 26 Vols., 329 Parts or Nos., 116 Bulletins, 10 Reports, and 80 Pamphlets, received from 118 Societies, &c., and eight Individuals, were laid upon the table.

NOTES ON THE NATIVE FLORA OF NEW SOUTH WALES.

By R. H. Cambage, F.L.S.

Part vi. Deepwater to Torrington and Emmaville.

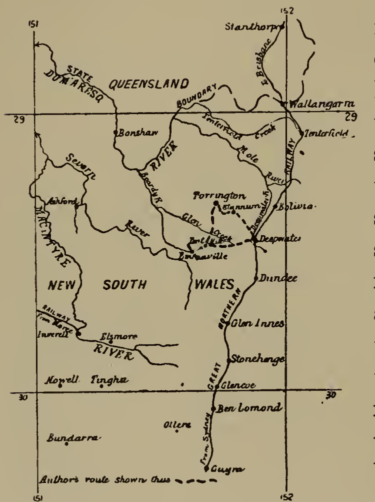
(Plates i.-ii.)

(Continued from These Proceedings, 1906, p.452).

For purposes of a general classification, the flora of New South Wales may be considered under four sections, which may be roughly described as severally characterising the Coastal Area, the Mountain Area, the Western Slopes, and the Interior. The locality dealt with in this paper falls within the north-western part of the Mountain Area, west of the Great Dividing Range (Text fig.1) and consequently contains some plants which ascend the valleys from the Western Slopes. The presence of some Coastal and Interior plants is also referred to and discussed in relation to geological and climatic influences. The material for this paper was obtained during two short visits to the locality in July and September, 1907, and as the flowers were late owing to the dry spring, many species would necessarily be overlooked, and the list must therefore be regarded as incomplete.

The average annual rainfall in this part of New England is approximately 34 inches, while the general elevation above sea-level varies from about 3,000 to 3,500 feet, or about 4,000 feet around Torrington. Although the rainfall is considerable, it is much less than that on the coast to the eastward, though greater than that of the Western Slopes, which again exceeds that of the Interior. The aspect is chiefly a western one, but owing to the extent and height of the country around

Torrington, parts of the eastern faces are sheltered from western influence, and afford suitable conditions for the growth of some coastal plants. The question of aspect, whether east or west, plays an important part in regulating the distribution of the native flora in this State, and a western aspect in the Mountain Area implies an absence of brush or jungle.



The district is full of interest to one who studies the various influences which operate on the distribution of plant life, for here are found coastal species which flourish on the Triassic sandstone around Sydney, and which at Torrington have sought out a somewhat similar soil derived from a decomposing granite; and although the altitude is so much higher than that of the coast, the temperature of this elevated plateau is modified by the warmth of the more northern latitude. Within this area, also, though generally selecting a different geological formation, are species which belong to the Interior, some even extending into South Australia.

The principal geological formations supporting the flora described may be summarised under the names of blue granite, acid granite (denoting an abundance of silica) and indurated claystone formation. The blue granite occurs chiefly between Deepwater and Stannum, also between Deepwater and Tent Hill. The acid granite produces the flora between Stannum and Torrington, while the indurated claystone is found around Emmaville. The flora of the acid granite area is profuse compared with that of the more open blue granite country, though the latter produces a much better soil. These igneous rocks have been very fully described by Messrs. E. C. Andrews, B.A., and J. C. H. Mingaye, F.I.C., F.C.S.* Some figures representing constituents of these rocks in other localities, taken from the paper by Messrs. Andrews and Mingaye are most instructive.

	Blue Granite.	*Acid Granite.*
Silica (SiO_2)	65·36 ...	75·78
Alumina (Al_2O_3)	16·37 ...	12·42
Ferric oxide (Fe_2O_3)	1·80 ...	0·55
Ferrous oxide (FeO)	2·68 ...	1·08
Magnesia (MgO)	1·81 ...	0·50
Lime (CaO)	3·82 ...	1·06
Soda (Na_2O)	3·40 ...	3·20
Potash (K_2O)	3·75 ...	4·60

It will be seen that the acid granite has a much higher percentage of silica, but the blue granite possesses a greater proportion of those ingredients which produce good soil.

Deepwater to Stannum.

For a few miles along the road from Deepwater to Stannum the flora is sparse, much of the country having been cleared, especially within the beautiful broad valley through which the Deepwater River flows, but such trees as *Eucalyptus tereticornis* Sm., *E. nova-anglica* Deane & Maiden, *E. conica* Deane & Maiden, (*E. Baueriana* var. *conica* Maiden), *E. viminalis* Labill., *Angophora subvelutina* F.v.M. (Apple), *A. intermedia* DC. (Apple), and *Casuarina Luehmanni* R. T. Baker (Bull Oak), may be seen.

The interest in regard to distribution attaches chiefly to *Eucalyptus conica* and *Casuarina Luehmanni.* The former species occurs principally on the Western Slopes, extending slightly into the Interior, and going almost as far south as the Murrumbidgee. Its exact southern limit is not known to me. South of the Lachlan it is usually found below an altitude of 1,000 feet, owing to its objection to extreme cold; but in coming northwards to warmer latitudes, it is found gradually ascending the valleys,

* Records Geological Survey N. S. Wales, 1907, Vol. viii.

until near Deepwater it grows at an elevation of about 3,200 feet above sea-level. The species is one which prefers river-flats to hills, and from the localities it frequents on northern New England, it can generally be traced along the valleys to the lower country on the Western Slopes. Mr. Andrews has drawn my attention to the fact that it is a lover of the blue granite.

The occurrence of *Casuarina Luehmanni* at Deepwater is of greater interest than that of *Eucalyptus conica*, as the former is a more typical Interior tree, and continues southerly across the north-western part of Victoria into South Australia. Specimens of this Casuarina have also been collected 7 miles beyond Wallangarra in Queensland by Mr. E. C. Andrews, and it is common on the watershed of the Upper Hunter and Goulburn Rivers, having crossed the lower portion of the Liverpool Range from the west. Its size around Deepwater quite equals that attained in the western districts.

It has been noticed that many plants which belong to the Western Slopes and which are restricted to comparatively low levels in the south, appear to ascend very considerably on western New England. This great difference is probably to some extent due to the very cold influence in the south, which radiates from the snow-clad heights of Kosciusko, whose altitude exceeds 7,000 feet. If a similar mountain area of equal height existed in the north of this State, it would be likely to prevent the ascent of many western species to their present elevations. If, on the other hand, the local conditions were the same throughout the Mountain Area, the upper limit of the plants of the Western Slope would rise with greater regularity along a more even grade. It is probable the diminished effect in the north of the cool southerly wind exercises some important influence in the matter, as although the elevation is greatest in the south, the land mass which exceeds, say, 3,000 feet, is greater in extent in the north.

Around Stannum and Torrington.

The country around Stannum and Torrington, which ranges from 3,400 to about 4,000 feet, consists chiefly of hills composed of acid granite, often known as tin-granite, from its association with valuable tin deposits. Quartz is so abundant that the disintegration of this coarse granite results in the production of a soil as sandy as that derived from the weathering of the Triassic sandstone near Sydney and on the Blue Mountains. The effect of geological influence on the vegetation is very apparent on this particular area, for many Sydney species are thriving here, imparting to the locality much of the appearance of a typical sandstone flora. Appended is a list of plants noticed on this acid granite formation extending from Stannum to Torrington:—

RANUNCULACEÆ: *Clematis glycinoides* DC., *Ranunculus lappaceus* Sm. (Buttercup).

DILLENIACEÆ: *Hibbertia stricta* R.Br., *H. vestita* A. Cunn., *H. linearis* R.Br., *H. diffusa* R.Br. (a shapely little shrub about 3-4 feet high, growing among the acid granite rocks, and flowering in November).

VIOLARIEÆ: *Viola betonicæfolia* Sm., *V. hederacea* Labill.

PITTOSPOREÆ: *Billardiera scandens* Sm. (a twining plant).

POLYGALEÆ: *Comesperma sylvestre* Lindl.

STERCULIACEÆ: *Sterculia diversifolia* G. Don, (Currajong) on andesite formation.

GERANIACEÆ: *Oxalis corniculata* L.

RUTACEÆ: *Zieria lævigata* Sm., *Boronia ledifolia* J. Gay var. *pinnata*, *B. microphylla* Sieb., *Phebalium glandulosum* Hk., *P. rotundifolium* A. Cunn., *Correa speciosa* Andr., (Native Fuchsia).

OLACINEÆ: *Olax stricta* R.Br.

CELASTRINEÆ *Celastrus Cunninghamii* F.v.M.

STACKHOUSIEÆ: *Stackhousia linariæfolia* A. Cunn.

RHAMNEÆ: *Cryptandra amara* Sm.

SAPINDACEÆ: *Dodonæa viscosa* L., and var. *attenuata* (Hop Bush).

LEGUMINOSÆ: *Mirbelia speciosa* Sieb., with most beautiful purplish flowers; *M. pungens* A. Cunn., *Gompholobium* sp., *Jacksonia scoparia* R.Br., (Dogwood); *Daviesia latifolia* R.Br., often called Hopbush, covered in September with racemes of attractive orange-yellow flowers; *D. ulicina* Sm., *D. acicularis* Sm., *D. genistifolia* A. Cunn., *Aotus villosa* Sm., *Pultenæa foliolosa* A. Cunn., *P.* sp. (No.1621), probably new species; *Dillwynia ericifolia* Sm. var. *phylicoides* Benth., *D. juniperina* Sieb., *Bossiæa microphylla* Sm., *B. Scortechinii* F.v.M., prostrate, with dark yellow flowers; *Hovea linearis* R.Br., *H. longifolia* R.Br., *Indigofera australis* Willd., *Glycine clandestina* Wendl., *Hardenbergia monophylla* Benth., (False Sarsaparilla, a twining plant with beautiful purple flowers); *Acacia lanigera* A. Cunn., var. *venulosa*; *A. juniperina* Willd., *A. penninervis* Sieb., *A. neriifolia* A. Cunn., *A. linifolia* Willd., *A. lunata* Sieb., *A. viscidula* A. Cunn., *A. implexa* Benth., *A. longifolia* Willd., *A. spectabilis* A. Cunn., *A. decurrens* Willd., *A. Murrayana* F.v.M., ? *A.* sp. (Nos. 1622 and 1622A).

ROSACEÆ : *Rubus* sp.

CRASSULACEÆ : *Tillæa verticillaris* DC.

DROSERACEÆ : *Drosera peltata* Sm.

HALORAGEÆ : *Haloragis* sp.

MYRTACEÆ : *Calythrix tetragona* Labill., *Thryptomene ciliata* F.v.M., *Bæckea* sp., *Leptospermum flavescens* Sm., *L. arachnoideum* Sm., *L. stellatum* Cav. (a rough brown scaly barked Tea-tree), *L. myrsinoides* Schl., *Callistemon lanceolatus* DC. (?), along banks of small creeks; *C. pityoides* Miq., *Angophora intermedia* DC., (Apple Tree; not noticed on the acid granite); *Eucalyptus capitellata* Sm. (Brown Stringybark), *E. macrorrhyncha* F.v.M. (Red Stringybark); *E. melliodora* A. Cunn., (Yellow Box or Yellow Jacket); *E. hemiphloia* F.v.M., (Box, near Stannum; not on acid granite); *E. viminalis* Labill., (White Gum, or Manna Gum; not on the acid granite); *E. tereticornis* Sm., (Forest Red Gum); *E. Banksii* Maiden, (on small round hill just south of 14-mile post); *E. Bridgesiana* R. T. Baker (White Peppermint, one of the trees recognised by Baron von Mueller as *E. Stuartiana* F.v.M.), *E. eugenioides* Sieb. (White Stringybark); *E. rubida* Deane & Maiden (*E. Gunnii* var. *rubida* Maiden, a White Gum); *E. Andrewsi* Maiden (Blackbutt); *E. Deanei* Maiden (Brown

Gum); *E. Bancrofti* Maiden (*E. tereticornis* var. *brevifolia* Benth.; Brittle or Cabbage Gum).

UMBELLIFERÆ: *Xanthosia* sp., *Actinotus Helianthi* Labill. (Flannel Flower).

ARALIACEÆ: *Panax sambucifolius* Sieb.

LORANTHACEÆ: *Loranthus pendulus* Sieb. (Mistletoe).

RUBIACEÆ: *Pomax umbellata* Sol., *Asperula oligantha* F.v.M., *Galium umbrosum* Sol.?

COMPOSITÆ: *Olearia chrysophylla* A. Cunn., *O. ramulosa* Labill. (sometimes locally called Wild May); *O. ramosissima* Benth., *O.* sp., *Brachycome* sp., *Craspedia Richea* Cass. (Billy Buttons); *Cassinia aculeata* R.Br., *C. lævis* R.Br., *Helichrysum scorpioides* Labill., *H. bracteatum* Willd.(Everlasting Flower); *H. apiculatum* DC., *H. obcordatum* F.v.M., *Helipterum anthemoides* DC.

STYLIDIEÆ: *Stylidium laricifolium* Rich.(a Trigger-flower), *S. graminifolium* Sw.(the common Trigger Flower).

GOODENIACEÆ: *Goodenia geniculata* R.Br., *G. rotundifolia* R.Br., *G. bellidifolia* Sm., *Dampiera stricta* R.Br.

CAMPANULACEÆ: *Wahlenbergia gracilis* DC.(Blue Bell).

EPACRIDEÆ: *Styphelia viridis* Andr.(Five Corners); *S. læta* R.Br.(?), *Melichrus urceolatus* R.Br., *M. rotatus* R.Br., *Brachyloma daphnoides* Benth.(flowers sweet-scented); *Lissanthe strigosa* R.Br., *Leucopogon lanceolatus* R.Br., *L. microphyllus* R.Br. var. *pilibundus* Benth.; *L. melaleucoides* A. Cunn., *L. muticus* R.Br., *L. neo-anglicus* F.v.M., *Monotoca scoparia* R.Br., *Epacris microphylla* R.Br.

JASMINEÆ: *Notelæa linearis* Benth.

SOLANEÆ: *Solanum parvifolium* R.Br.(Prickly Apples).

SCROPHULARINEÆ: *Veronica Derwentia* Andr., *Euphrasia Brownii* F.v.M., *E. scabra* R.Br.

LABIATÆ: *Plectranthus parviflorus* Willd.(small succulent plant with blue flowers, on flat rocks); *Prostanthera empetrifolia* Sieb., *P.* sp.(No.1718, probably a new species), *P.* sp., *Ajuga australis* R.Br.

LAURINEÆ: *Cassytha pubescens* R.Br.

PROTEACEÆ: *Petrophila sessilis* Sieb., *Conospermum taxifolium* Sm., *Persoonia cornifolia* A. Cunn., *P. sericea* A. Cunn., *P. tenuifolia* R.Br., *P.* sp., *Grevillea trinervis* R.Br., *G. linearis* R.Br., *Hakea microcarpa* R.Br., *H. dactyloides* Cav., *Lomatia silaifolia* R.Br., *Banksia collina* R.Br., *B. integrifolia* L.f.(White Honeysuckle).

THYMELEÆ: *Pimelea linifolia* Sm.

EUPHORBIACEÆ: *Poranthera corymbosa* Brongn., *Phyllanthus thymoides* Sieb.

URTICEÆ: *Urtica incisa* Poir.(Nettle).

CASUARINEÆ: *Casuarina suberosa* Ott. & Dietr.(Black Oak).

SANTALACEÆ: *Choretrum spicatum* F.v.M., *Exocarpus cupressiformis* Labill.(Native Cherry), *E. stricta* R.Br.

CONIFERÆ: *Callitris calcarata* R.Br.(Black Pine).

ORCHIDEÆ: *Dendrobium speciosum* Sm.(Rock Lily), *Dipodium punctatum* R.Br., *Thelymitra media* R.Br., *Diuris pedunculata* R.Br.(on wet flats), *D. abbreviata* F.v.M., *Caladenia carnea* R.Br. var. *alba*; *Glossodia major* R.Br.(Blue Orchid).

IRIDEÆ: *Patersonia sericea* R.Br.(Wild Iris).

AMARYLLIDEÆ: *Hæmodorum planifolium* R.Br.

LILIACEÆ: *Eustrephus latifolius* R.Br., *Wurmbea dioica* R.Br., *Tricoryne elatior* R.Br., *Stypandra glauca* R.Br.(covered in September with beautiful bright blue flowers).

JUNCACEÆ: *Xerotes longifolia* R.Br., *Xanthorrhœa* sp.(Grass Tree), *Luzula campestris* DC.

CYPERACEÆ: *Cladium glomeratum* R.Br., *Gahnia* sp., *Caustis pentandra* R.Br.

GRAMINEÆ: *Themeda Forskalii* Hack.(*Anthistiria ciliata* L., Kangaroo Grass); *Dichelachne sciurea* Hook.

FILICES: *Davallia pyxidata* Cav.(Hare's-Foot Fern); *Adiantum Aethiopicum* L.(Maidenhair Fern), *Cheilanthes tenuifolia* Sw., *Pteris aquilina* Linn.(Bracken); *Blechnum cartilagineum* Sw., *Asplenium flabellifolium* Cav., *Polypodium punctatum* Thunb., *P. serpens* Forst.

Although *Sterculia diversifolia* was found growing close to Stannum, it was on an andesite formation, and was not noticed on the granite. This species is also rare on the purely sandstone soils around Sydney and on the Blue Mountains. The fact of its occurrence at an elevation of about 3,400 feet in this Mountain Area, while at the same time it flourishes in the dry Interior near Cobar, etc., furnishes evidence of its adaptability to environment. Its home, however, is usually below an altitude of 2,000 feet in New South Wales.

The widely distributed *Correa speciosa* (sometimes called Wild Fuchsia) was noticed at intervals on the granite, and displayed the usual variation in the colour of its long tubular flowers, some being creamy-white, while others were red with green tips.

An interesting species of Pultenæa (Nos. 1621 and 1621A) was found growing in the swampy land or wet flats, and flowering at the end of September. The plants usually consist of a single stem, though sometimes branching, up to about 2 feet, terminating in a dense head of bright yellow florets. This appears to be a new species.

The locality has a plentiful supply of Wattles, thirteen species of Acacia being noticed. Although the plant identified as *A. Murrayana* was flowering in July, no pods were procurable in September to assist in the determination of this Acacia which seems to be rare in New South Wales. *A. viscidula* is a spreading shrub about 3-4 feet high, and occurs among the flat granite rocks. An Acacia (No. 1622) about 10-12 feet high was seen on the granite formation, having reddish-brown stems, long narrow 1-nerved phyllodia, and very (young) long narrow pods.

Eucalyptus capitellata is common around Torrington, and has very large coarse leaves. This species is found on Mount Lofty in South Australia, and continues intermittently through Victoria and along the eastern part of New South Wales to the locality under discussion.

Casuarina Luehmanni comes from the drier parts of South Australia and Victoria, through the interior of this State; and it is of interest to note that these two species have arrived, by totally different routes, at a spot which is climat ca y suitable to both. This affords another instance of the gradual adaptability of plants.

The geological conditions required by these two trees are, however, quite distinct, and *C. Luehmanni* is never associated with *Eucalyptus capitellata*, though they may occur on their respective formations only a few miles apart.

The buds of *Eucalyptus macrorrhyncha* were noticed to resemble those of *E. capitellata*, and there was an absence of the suddenly tapering pointed opercula so common on the southern parts of the Western Slopes.

The occurrence of *E. melliodora* (Yellow Box) in this locality is not surprising, for its versatility in withstanding both heat and cold has often been noticed. It, however, prefers a western to an eastern influence in this State.

Both *E. viminalis* and *E. rubida* (White Gums) were seen near Stannum; and in the absence of their distinctive "sucker" leaves, which are narrow-lanceolate and orbicular respectively, these trees look very similar in the forest. Although they are often found growing side by side on basalt and other formations, such was not the case here, for while *E. viminalis* flourished on the andesite, it appeared to be absent from this particular sandy granite formation. *E. rubida*, however, was well distributed over the granite area, but not noticed on the andesite.

E. Andrewsi, the Blackbutt of northern New England, is plentiful on the granite, but seems absent from the andesite around Stannum. This tree appears to be one of the principal Eucalypts found on this class of acid granite, and is also one of the largest. Although it occurs practically all over New England, and comes south on to the high range which separates the waters of the Manning from those of the Hunter, and has been collected by Mr. Andrews near Copeland, there is so far no record of its having crossed to the southern side of the Hunter and Goulburn valleys. The species may therefore be useful in connection with any research into the relative ages of the Hunter valley and certain members of the genus Eucalyptus. Though *E. Andrewsi* is of comparatively large size west of the Main

Divide, it attains its greatest dimensions along the eastern margin of New England under a coastal, as opposed to a westerly influence. This species occurs at Maryland and Stanthorpe in Queensland, according to Mr. Andrews.

Another interesting Eucalypt occurring abundantly between Stanthorpe and Torrington is *E. Deanei*, locally called Brown Gum. This is another coastal form which extends as far south as Picton Lakes, where it is known as Blue Gum, giving rise to the name of the creek which flows from the lake. It is found on various tributaries of the Hawkesbury and Hunter, and gradually ascends the eastern face of the New England plateau, till towards the north it crosses to the western watershed. Its noble and stately proportions, as seen along the Burragorang valley in the south, where the combined conditions of warmth, shelter and moisture all contribute to a luxurious growth, are missing in this north-western area. Though in the north-west it is still comparatively large, its exposure in a more elevated climate has resulted in diminished stature, and probably also in its being coated with the brown flaky bark which has suggested the local name for the species.

E. tereticornis, the Forest Red Gum so widely known over the Coastal and Mountain Areas and Western Slopes, is distributed over both the andesite and granite formations around Stannum.

E. Bancrofti was not only restricted to the granite area, but was practically confined to the rocky and higher parts, only following to lower levels while attended by the influence of the acid granite. It appears open to question whether this is a distinct species or merely a variety of *E. tereticornis.** That it has strong affinities to the latter is beyond doubt, but after carefully observing both trees in various localities I am disposed to regard the former as sufficiently distinct to warrant its having specific rank. It seems possible that *E. Bancrofti* may have developed in some way by environment over long ages as a form of *E. tereticornis*, and by constantly selecting these somewhat elevated hard

See 'The Forest Flora of New South Wales,' Part xi. By J. H. Maiden.

acid granite areas, has gradually assumed its present character. Its usually shorter, paler and more orbicular leaves are generally distinct from those of *E. tereticornis*, though the variation in form and size is considerable; while the subcylindrical operculum is a very marked feature of *E. Bancrofti*. The timber is much inferior to, and more brittle than, that of *E. tereticornis*, and of a deeper red colour, being little paler when freshly cut than the timber of *E. squamosa* Deane & Maiden. A fairly constant distinctive feature in the fruits of the two species may be noticed in the valves, for while those of *E. tereticornis* are plainly continuous on the edge of the domed rim, those of *E. Bancrofti* have the appearance of being placed inside the rim, and are usually longer and paler. In the forest, however, there seems to be no difficulty whatever in separating the two trees by the bark alone, for that of *E. Bancrofti* is never in long flakes, but breaks off in very short pieces, settling around the base of the tree in broken fragments, sometimes with almost a powdery appearance and evidently indicating its brittle nature. In its bark (though more of a grey colour), and straggling habit, this tree has sometimes the appearance of *Angophora lanceolata* Cav., a so-called Red Gum growing near Sydney. *E. Bancrofti* will sometimes descend to the base of the hills and associate with *E. tereticornis*, though retaining its distinctive characters. In one instance this was noticed where two young trees, one of each species, were growing only a foot apart. *E. Bancrofti* occurs in Queensland, and although in New South Wales its home is on the tin-granites of northern New England and its western slopes, it has been recorded by Mr. Maiden from Port Macquarie, whilst its most definite southern limit known to me is Murrurundi.

Many of the trees of *E. eugenioides* were noticed to be in full flower early in July.

Olearia ramosissima was also in bloom, the small bushes being covered with a profusion of pale blue flowers which were eagerly sought after by the local residents for table decorations. *O. ramulosa*, a plant which around Sydney is often known as Snow-bush, from the mass of white flowers it bears, was in a much less advanced stage, scarcely any flowers of this species being seen in July. Around the Inverell district this plant is sometimes known as Wild May.

Melichrus urceolatus is a very common little plant on the granite area, though it is by no means confined to that formation, and was met with frequently throughout.

Leucopogon lanceolatus showed scarcely any signs of flowering early in July, and *L. melaleucoides* was just beginning to open into flower. *L. microphyllus* var. *pilibundus* ranges from about 2-3 feet high, and was absolutely covered with masses of snow-white blossoms which were freely used for decorative purposes. This Leucopogon might fitly be called a Snowbush, for its clusters of pure white, little, bearded flowers are so dense as to exactly represent a plant just visited by a snowstorm. It was still flowering at the end of September. The leaves, which are about 4 lines long, have small recurved points, so that if the hand be passed upward among the branches, the small resisting hooks are distinctly felt.

Prostanthera empetrifolia was restricted to the damp swampy areas, and its reddish-purple flowers were just opening at the end of September. This species has slender stems which are often supported by the adjacent plants; and though its height seemed commonly about 2-4 feet, it was found in one instance to reach 6 feet while resting on its stronger neighbours.

A second Prostanthera (No.1718), which is probably a new species, occurs almost exclusively in the slight depressions where a little soil can accumulate on the dry, almost bare acid granite rocks. Here the plants flourish in clusters about 3 feet high, being covered in September with a most attractive display of purplish-blue flowers. The leaves when crushed emit a strong odour, a feature common in the genus, accounting for the local name of Turpentine for this species.

Hakea microcarpa was noticed on swampy land, a situation that it often selects on New England; while *H. dactyloides* sought out the sandy areas as it does around Sydney and on the Blue Mountains.

Banksia integrifolia, White Honeysuckle, is typical of this sandy granite formation, and was noticed up to 30-40 feet high. As regards geographical distribution this is a most interesting species. In the Sydney district it appears to be almost entirely restricted within a narrow strip along the sea-shore, seldom extending back from the ocean or salt estuaries more than a few miles. It does not appear to be common on the Blue Mountains, though it occurs there, sometimes in a stunted form. In going inland from the North Coast, however, it seems to altogether disregard its shore-loving tastes, and gradually works its way up to the New England plateau, using these sandy granite areas as stepping stones, until it crosses the Great Dividing Range to the locality now described. At an elevation of 3,600 feet, and quite removed from ocean-influence, it is growing as luxuriantly as those ornamental representatives at Kurnell and Narrabeen. It would therefore seem that the distribution of this species is to a greater extent governed by the chemical constituents in the soil than by the consideration of either climate or aspect. The juvenile foliage was noticed around Torrington to be truncated and serrated similar to that growing at Narrabeen, while the mature leaves were practically entire. *B. collina* was found as shrubs about 3-5 feet high in wet flats at Torrington.

Another tree typical of this granite area is *Casuarina suberosa* (Black Oak), and it occurs abundantly at elevations exceeding 3,600 feet. Cones were collected up to 1½ inches long.

Dendrobium speciosum (Rock Lily) seems rare, only a few plants being seen in the cleft of a large granite rock; but even these were scarcely expected in a locality so far removed from coastal influence.

Davallia pyxidata (Hare's-Foot Fern) also came somewhat as a surprise for the same reason, but this species was more plentiful than the Rock Lily.

In These Proceedings for 1906,(p.63) Mr. J. H. Maiden, F.L.S., has described the flora of Howell, south of Inverell, where the formation is also an acid granite, perhaps containing a slightly higher percentage of silica than the rocks at Torrington. After allowing for the greater westerly influence and lower altitude of Howell, which averages about 1,000 feet less than Torrington, a most interesting and instructive comparison of these two floras can be made, showing how important is the geological factor in regulating the distribution of our native plants.

Torrington to Emmaville.

The road from Torrington to Emmaville, which is southerly about 16 miles, soon passes out of the acid granite, and enters an area of andesite and what is locally known as blue granite. The absolute change of the flora after leaving the acid granite is most remarkable, and it seems no exaggeration to estimate that quite 80 per cent. of the plants are left behind. Amongst those noticed during a hurried drive before Tent Hill was reached at 12 miles were :—

Sterculia diversifolia, *Jacksonia scoparia* (Dogwood), *Angophora subvelutina*, *Eucalyptus viminalis*, *E. albens* Miq. (White Box); *E. nova-anglica* (Red or Black Peppermint); *E. dealbata* A. Cunn., *E. tereticornis*, *E. macrorrhyncha*, *E. melliodora*, *Casuarina Cunninghamiana* (River Oak, on Glen Creek), and *Xanthorrhœa* sp. (Grass-Tree).

It was of interest to notice that *Sterculia diversifolia* and *Eucalyptus viminalis* appeared immediately the andesite was reached.

E. nova-anglica occurs on the better soil in the valleys, and near Glen Creek. The species is one which is typical of good, fairly damp soils, and is therefore a well known tree in the settled districts of New England. (For previous remarks see These Proceedings, 1904, p.795).

E. albens is the White or Grey Box tree which practically defines the east and west limits of the area referred to by me as the Western Slopes; and although south of the Murrumbidgee it is rarely found at an elevation exceeding 1,300 feet above sea-level, it climbs to 3,000 feet around Emmaville, the highest point observed being on the Bald Nob, which reaches about 3,200 feet. It is of interest to find that this tree manages to ascend almost to the New England Plateau, but this it accomplishes by creeping up the sides of the valleys where it secures shelter from coastal influence, for its great desideratum is a western aspect. North of Emmaville it follows up the valley of the Beardy River and Glen Creek, gradually establishing itself at such high levels as to come within some of the winter snow-storms. It advances towards Glen Innes along the valley of the MacIntyre River above Inverell, where the basaltic formation suits it so admirably, and is the principal tree in giving a characteristic appearance to the local flora.

Reflecting on the qualities which a plant possesses for resisting extremes of temperature and moisture, the thought is suggested that possibly in some instances after thousands of years of gradual adaptation to opposite conditions, extreme forms are evolved which in time may be regarded as separate species. Something of this kind may explain the great similarity which exists between *E. albens* of the west and *E. hemiphloia* F.v.M., a common Box tree along the coast. It is still a matter of opinion among botanists whether these are two distinct species, or one a variety of the other; but it seems highly probable, considering the close affinities between them, that both had a common origin, and have developed their present characteristics owing to the various influences of environment.

A gum tree often associated with *E. albens* in rocky situations is *E. dealbata* A. Cunn. (*E. tereticornis* var. *dealbata* Deane & Maiden). This is a tree with strong affinities to *E. tereticornis*, and may perhaps be justly regarded as only a variety of that species. In these Proceedings for 1900 (p.712) I have suggested that *E. dealbata* may perhaps be regarded as a form of *E. tereticornis* which grows chiefly on ridges, and incline to the opinion that it may be considered as a variety, although characteristic differences are referred to. During the intervening years a close study of the habit and distribution of these trees satisfies me that there are fairly constant differences between them sufficient to make it desirable that *E. dealbata* should rank as a species. The chief botanical differences appear to be in the truncate and usually sessile fruit of *E. dealbata*, and the pedicellate domed fruit of *E. tereticornis*. In the forest one is often assisted in separating the two species by the very glaucous foliage and buds of the former, and often by its drooping habit. Its timber is also inferior to that of *E. tereticornis*. *E. dealbata* undoubtedly seems to favour a western influence, and elevated or ridgy land; and a knowledge of its habits is often unconsciously used as an assistance in its identification. Around Emmaville the two trees are growing side by side, but there is rarely any difficulty in separating them by a general inspection. Probably this is another instance of two closely allied trees having had a common origin, and, owing to certain conditions of environment, have gradually developed differences which may perhaps now be regarded as sufficient to entitle each to specific rank. It is noteworthy that there is probably no species of Eucalyptus with more forms possessing features which just barely bestow the right to specific rank than *E. tereticornis*.

It may be pertinent to point out that in considering the relationship of species and varieties among native plants, it is customary for the botanist to regard the form which happens to have been first discovered and described as the species or type, and those which may have been found later as varieties, without any reference to the question as to which of them may naturally be more closely related to the original form. It is therefore highly probable that some of the botanist's so-called species may be merely later forms which have been evolved from an older stock, though the latter now happens to be styled a variety. In New South Wales, therefore, the botanist's varieties are generally found in localities remote from Port Jackson, whence many of the types came.

Just north of Tent Hill, on the fairly open hillside among *E. dealbata* and *E. albens*, *Jacksonia scoparia* was very abundant, being quite a feature in the landscape.

The trees of *Casuarina Cunninghamiana* along the banks of Glen Creek were the only River Oaks noticed within the area described, and the species would probably be more abundant at lower levels.

Around Emmaville.

The plants observed around Emmaville in July were:—*Hibbertia linearis* R.Br., *H. serpyllifolia* R.Br., *Billardiera scandens* Sm., *Sterculia diversifolia*(Currajong), *Boronia ledifolia*, *B. microphylla*(?), *Dodonæa viscosa*, *Gompholobium* sp., *Jacksonia scoparia*, *Daviesia genistifolia*, *D. latifolia*, *Pultenæa microphylla* Sieb., *Dillwynia ericifolia* Sm. var. *phylicoides* Benth., *Bossiæa buxifolia* A. Cunn., *Hovea linearis*, *Indigofera australis*, *Hardenbergia monophylla*, *Acacia decurrens*, *A. linifolia*, *A. implexa*, *A. spectabilis*, *A. neriifolia*, *A. penninervis*, *A. lanigera* var. *venulosa*, *A. Dawsoni* R. T. Baker, *Kunzea capitata* Reichb., *Melaleuca thymifolia* Sm., *Angophora subvelutina*, *A. intermedia*, *Eucalyptus tereticornis*, *E. dealbata*, *E. eugenioides*, *E. melliodora*, *E. Banksii*, *E. macrorrhyncha*, *E. Andrewsi*, *E. crebra* F.v.M.(Narrow-leaved Ironbark); *E.Caleyi* Maiden (Drooping Ironbark), *E. conica*(Fuzzy Box or Apple-Box), *E. albens*, *E. nova-anglica*(near Tent Hill) *E. Bridgesiana*, *Loranthus* sp., *Pomax umbellata*, *Olearia ramosissima*, *O.ramulosa*, *Brachycome* sp.(Wild Daisy), *Cassinia* sp., *Helichrysum apiculatum*, *Wahlenbergia gracilis*(Blue Bell), *Melichrus urceolatus*, *Brachyloma daphnoides*, *Lissanthe strigosa*, *Leucopogon collinus* R.Br.(on low ridge about 1 mile north-west of Emmaville), *Monotoca scoparia* R.Br., *Notelæa microcarpa* R.Br.(known as Ginggie near Attunga); *Solanum parvifolium*, *Prostanthera nivea* A. Cunn., *Cassytha* sp., *Persoonia cornifolia*(Geebung), *P. sericea*(?), *P.* sp., *Phyllanthus thymoides*, *Casuarina suberosa*, *C. Luehmanni*, *C. paludosa* Sieb.(?), *Exocarpus cupressiformis*, *Callitris calcarata*(Black Pine), *Stypandra glauca*, *Xanthorrhœa* sp., *Themeda Forskalii*(Kangaroo Grass), *Cheilanthes tenuifolia* (a small fern among the rocks).

Acacia Dawsoni R. T. Baker was described in 1897, from specimens collected near Rylstone, and has been only once recorded since, the second locality being at Abercrombie, about 100 miles south (These Proceedings, 1906, p.714). Its discovery at Emmaville, some 250 miles northerly from Rylstone, extends its range considerably, but an interesting fact in regard to its distribution is that Emmaville is in the same plant-zone as Rylstone or just on the border-land of the Mountain Area and the Western Slopes, so that its occurrence at these two fairly distant spots is less remarkable than might appear at first sight. It is growing about 3 miles northerly from Emmaville on the track to Bald Nob; and the plants, which are scatterred over several acres, average about one foot high. The elevation of the locality is nearly 3,000 feet above sea-level, being about 1,000 feet higher than Rylstone, but owing to the difference of latitude, the change in climate is only equal to that produced by a few hundred feet.

Eucalyptus Banksii occurs on the hills easterly from Emmaville, and by the casual observer, might easily be confused with *E. Bridgesiana* (White Peppermint), but its clustering, sessile buds and fruits, as well as its more strictly opposite juvenile foliage and smoother twigs, enable it to be readily separated from that species.

In describing *E. Banksii* in These Proceedings (1904, p.774) Mr. Maiden pointed out its similarity to *E. Stuartiana* (*E. Bridgesiana*), and *E. Cambagei* Deane & Maiden. This resemblance in the forest was very striking both at Emmaville and Torrington (a new locality for the species), but its affinities with *E. goniocalyx* F.v.M., were not pronounced, as the latter is more of a smooth-barked gum-tree.

E. Caleyi is an Ironbark which was noticed near the Bald Nob, a few miles northerly from Emmaville, and is a conspicuous tree owing to its drooping glaucous foliage (Plate i.). Its timber, though good, does not appear to be eagerly sought after owing to its hardness, and its severity on the saw when being cut in the mill. It evidently prefers a western to an eastern influence.

In a few instances a tree was noticed in a group of Ironbarks, with an almost smooth, brown box-bark, but in other respects with all the characteristics of *E. Caleyi*. The same feature has been observed at Copeton, and Mr. Andrews has reported it to me from other localities. It is remarkable that amongst so many of our Ironbark forests, a tree occurs at intervals having decided affinities with the local Ironbark, but generally showing some transit to the local Box, which in this case is *E. albens;* and the occurrence naturally suggests hybridization. In some instances the fruits, timber, and bark are of an intermediate character; but so far as my brief observations have gone, it would appear that the particular trees under discussion have nearly all the features of *E. Caleyi* without the usual rough bark. Few bushmen would be induced to consider the tree to be the same as the Ironbark, without working the timber.

E. crebra, the Narrow-leaved Ironbark, is fairly common around Emmaville at altitudes up to 3,000 feet, but the width of the leaves is variable. Although it grows with *E. Caleyi*, the two species are easily distinguished by the general contrast between the dark-coloured foliage of the former, and the glaucous, often drooping appearance of the latter (Plate ii.).

Only a little of *Casuarina Luehmanni* (Bull Oak) was seen, and this was about two miles southerly from Emmaville, in company with other western plants. *C. inophloia* F.v.M., the oak tree with a semi-fibrous bark, was not noticed near Emmaville, but it occurs about ten miles away, near the Severn River on the Inverell Road.

Tent Hill to Deepwater.

From Tent Hill to Deepwater is 14 miles easterly. The geological formation for many miles is blue granite, then sandy slates, with the exception of some basalt near the 4-mile post. Much of the country has been cleared, but the flora on the blue granite is always sparse compared with that of the acid granite. The following plants were noticed by the roadside :—*Hibbertia linearis*, *Sterculia diversifolia*, *Jacksonia scoparia*, *Daviesia latifolia*, *Hardenbergia monophylla*, *Acacia linifolia*, *A. implexa*, *A. decurrens*, *Angophora intermedia*, *A. subvelutina*, *Eucalyptus melliodora*, *E. nova-anglica*, *E. Bridgesiana*, *E. tereticornis*, *E. albens*, *E. conica*, *E. viminalis* (first seen between the 8- and 9-mile posts from Deepwater), *E. eugenioides* (at about 3 miles from Deepwater), *Helichrysum apiculatum*, *Melichrus urceolatus*, *Lissanthe strigosa*, *Pimelea* sp., and *Casuarina Luehmanni.*

Two well-known New England trees, viz., *Eucalyptus coriacea* A. Cunn.(White Ash of the north, or Snow Gum of Kosciusko) and *E. stellulata* Sieb.(Black Ash or Black Sally), seem absent from the locality examined, but had there been any extent of basaltic soil both species might have been expected.

Among the various features connected with the flora of the area described, perhaps the most notable observed was the remarkable way in which a large number of Sydney plants had crossed the Main Dividing Range, and acclimatised themselves at an elevation approaching 4,000 feet above sea-level, either chiefly owing to their having discovered a suitable geological formation with a fair rainfall, and some shelter from the cold and drying effects of westerly gales, or that the westerly influence becomes less as northern latitudes are approached.

Other matters of extreme interest are the richness of the acid granite flora, and the exclusiveness of some species for their favoured geological formations.

I am much indebted to Messrs. J. H. Maiden, F.L.S., and E. Betche for assistance in identifying some of the plants.

My thanks are due to Mr. E. C. Andrews, B.A., for assisting me to complete my collections, and for useful hints in regard to the influence of the local geological formations with which he is familiar.

I have also to thank Miss Daisy Hawkins of Torrington for sending flowers which were not procurable at the time of my visit.

EXPLANATION OF PLATES.

Plate i.

Eucalyptus Caleyi Maiden, Drooping Ironbark.

Plate ii.

Eucalyptus crebra F.v.M., Narrow-leaved Ironbank, on the right; *E. Caleyi* Maiden, Drooping Ironbark, on the left.

NOTE ON THE BREEDING HABITS OF THE RED BELLIED NEWT (*MOLGE PYRRHOGASTRA* Boie).

By Edgar R. Waite, F.L.S., Curator, Canterbury Museum, Christchurch, N.Z.

On August 31st, 1904, I exhibited before the Society living examples of the Asiatic Red-bellied Newt, (*Molge pyrrhogastra* Boie)* and though I kept them, in Sydney, until my removal in April last year, they showed no signs of breeding.

At the breeding season last year, the Newts were exhibited at the New Zealand International Exhibition, but they were not then suitably housed for breeding purposes.

This season, however, they were returned to the tank in which I kept them in Sydney, and with the exception of the exigencies of climate, they are under precisely similar conditions.

The first eggs were laid on October 10th, and hatched on December 12th; subsequent eggs also required about sixty days for incubation, the temperature of the water ranging from 55° to 65° F. The tank is well supplied with plants, including *Vallisneria*, *Anacharis* and *Myriophyllum*, but in every instance the first-named was selected. The procedure does not appear to differ from that of the Crested Newt of Britain (*Molge cristata* Laur.), as detailed by Rusconi and Bell,† for though I formerly kept both adults and tadpoles of this species, I never actually bred it.

The Red-bellied Newt, as watched in my vivarium, usually employs a terminal floating portion of a leaf of *Vallisneria* and folds it upon itself, the leaf being often cracked in the process. The leaf is glued in this position, and the single egg, placed

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* These Proceedings, 1904, xxix., p.557.

† "British Reptiles," 1839, p.122.

within the fold, is similarly secured. More rarely an egg is placed between two leaves where they cross each other, the two being glued together. Occasionally a detached portion of a leaf is used, and fixed against the wall of the tank, always, however, at the surface of the water. If removed from the plant an egg sinks, but the primary object of the attachment appears to be protection, for I have intentionally detached some eggs and they have developed equally well on the bottom.

The larvæ have grown rapidly since they were hatched, ten days ago, but if their subsequent development is as slow as that of *Molge cristata*, as recorded by Higginbottom,* it will be fully three years before they are mature, even if I am successful in rearing them.

*Ann. Mag. Nat. Hist. (2), xii., 1853, p.374.

WEDNESDAY, APRIL 29TH, 1908.

The Ordinary Monthly Meeting of the Society was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, April 29th, 1908.

Mr. A. H. S. Lucas, M.A., B.Sc., President, in the Chair.

Mr. W. G. HALL, Public School, Millfield, N. S.W., and Mr. H. M. GILES, Zoological Gardens, South Perth, W.A., were elected Ordinary Members of the Society.

The President announced that, under the provisions of Rule xxv., the Council had elected Mr. HENRY DEANE, M.A. F.L.S.,&c., Mr. J. H. MAIDEN, F.L.S., &c., Dr. T. STORIE DIXSON, and Mr. THOMAS STEEL, F.C.S., F.L.S., &c., to be VICE-PRESIDENTS for the current Session.

A letter from the Department of Public Health, Sydney, embodying a request from the Natural History Branch of the British Museum for additional specimens of blood-sucking insects, was read to the Meeting. Contributions should be divided into two portions, and despatched simultaneously, one to The Director, British Museum (Natural History), and the other to The Quick Professor of Biology, New Museums, Cambridge. It was also asked that duplicates of specimens which had already been sent to the British Museum might be sent to the Quick Professor of Biology at Cambridge. The President commended the matter to the notice of Members who were in a position to respond to this deserving appeal for material which would be put to good use; and Dr. Chapman emphasised the importance of addressing contributions sent to Cambridge to "The Quick Professor of Biology."

The President said that this year (1908) would afford an opportunity for celebrating the jubilee of the Theory of Natural Selection, as propounded by Charles Darwin and Alfred Russel Wallace in 1858; and that next year would be the jubilee year of the publication of the "Origin of Species," and the centenary of Charles Darwin's birth; and he thought that the chance of signalising the occasion by sending an appropriate communication from the Society to Dr. Wallace, as the surviving veteran, should not be lost sight of.

On the motion of Professor Wilson it was resolved that the question of suitably commemorating the approaching interesting anniversaries referred to by the President be remitted to the Council for the arrangement of details.

The Donations and Exchanges received since the previous Monthly Meeting, amounting to 16 Vols., 63 Parts or Nos., 9 Bulletins, 1 Report, 20 Pamphlets, and 3 Maps, received from 16 Societies, &c., and two Individuals, were laid upon the table.

A REVISION OF THE *THYNNIDÆ* OF AUSTRALIA.

[*Hymenoptera.*]

PART II.

BY ROWLAND E. TURNER, F.E.S.

(Continued from these Proceedings, 1907, p.290.)

Subfamily THYNNINÆ *(continued)*.

Genus THYNNUS Fab.

Thynnus Fab., Syst. Ent. p.360, n.113, 1775.

The species which I retain in this genus are very diverse in appearance and structure, but I have thought it best in the present state of our knowledge to use subgenera, rather than to create an excessive number of genera, many of which might have to be sunk when further material becomes available. I have also been unable to examine the mouth-parts of several of the species which might have thrown more light on the natural arrangement.

The structure being so varied, I shall only mention the characters which serve to distinguish the genus from other Australian genera of the family.

♂. The hypopygium is always abnormal, but never in the form of a long and strongly recurved acute spine as in *Rhagigaster* and the allied genera. The head is never as strongly hollowed beneath, or as strongly bearded on the sides as in *Tachynomyia*; nor is the abdomen as strongly petiolate as in *Ariphron*. The maxillary palpi of the last two genera are also strongly elongate, which alone will distinguish them from all species of *Thynnus* except the subgenus *Zeleboria*.

♀. The maxillary palpi are rudimentary, consisting of two, or more rarely of three joints; and the second segment of the abdomen is differentiated, more or less transversely carinated.

I have been compelled to use the mouth-parts to a considerable extent in the subdivision of the genus, although I am aware of the inconvenience entailed owing to the difficulty of study without dissection, which cannot always be resorted to. But I have found that the characters used by Ashmead, the hypopygium and clypeus are far too variable to be any guide except for specific distinctions. I have thought it best to sink *Thynnoides*, though the structure of the anterior coxæ in the male and the pygidium and maxillary palpi (3-jointed) of the female may warrant its retention when more material is available.

Table of Subgenera of the Genus Thynnus Fab.

i. ♂. Labrum strongly narrowed posteriorly.
- A. Joints of the antennæ strongly arcuate beneath.
  - *a*. Second recurrent nervure received by the third cubital cell at some distance from the base. Hypopygium prominent, not emarginate.
    (♀. Second abdominal segment rugose, with a transverse carina at the base and at the apex. Pygidium simple). *Phymatothynnus.*
  - *b*. Second recurrent nervure received very near the base of the third cubital cell. Hypopygium short and emarginate.
    (♀. Second abdominal segment with one carina or more. Pygidium simple. Thorax very coarsely sculptured). *Psammothynnus* Ashm.
- B. Joints of the antennæ not strongly arcuate beneath.
  - *a*. Second recurrent nervure received by the third cubital cell at some distance from the base.
    - a^2. Abdomen flattened, the segments not constricted.
      - a^3. The three apical joints of the maxillary palpi elongate. *Zeleboria* Sauss.
      - b^3. The joints of the maxillary palpi slender and subequal. *Glaphyrothynnus.*
    - b^2. Abdomen not much flattened, the mouth-parts variable. *Lophocheilus* Guér.
  - *b*. Second recurrent nervure received close to the base of the third cubital cell.
    - a^2. Apical joint of the maxillary palpi rudimentary. *Catocheilus* Guér.
    - b^2. Apical joint of the maxillary palpi normal.
      - a^3. Labrum strongly bilobed. *Agriomyia* Guér.

b^3. Labrum not strongly bilobed, usually truncate. *Aeolothynnus* Ashm.

ii. Labrum broad and full, scarcely narrowed posteriorly.

A. Antennæ slender at the apex.

(♀. Pygidium with the truncation broadly ovate; not constricted before or on the truncation). *Macrothynnus.*

B. Antennæ of almost even thickness throughout.

(♀. Pygidium constricted before or more rarely on the truncation). *Thynnus.*

Key to the Species of Thynnus.

♂♂. i. Labrum strongly narrowed posteriorly.

A. The joints of the antennæ strongly arcuate beneath.

a. Hypopygium not emarginate.

a^2. Hypopygium with an apical spine.

a^3. Postscutellum yellow, legs ferruginous. *aratus* 2

b^3. Wholly black. *monilicornis* Sm. 1

b^2. Hypopygium without an apical spine. *nitidus* Sm. 4

b. Hypopygium short and emarginate.

a^2. Clypeus with a carina. *depressus* Westw. 5

b^2. Clypeus without a carina. *fulvopilosus* Sm 6

B. The joints of the antennæ not strongly arcuate beneath.

a. Second recurrent nervure received by the third cubital cell at some distance from the base.

a^2. Abdomen flattened, the segments not constricted.

a^3. The three apical joints of the maxillary palpi elongate.

a^4. The second cubital cell shorter than the third on the radial nervure.

a^5. Hypopygium without an apical spine.

a^6. Antennæ short and stout. *leucostictus* 18

b^6. Antennæ slender. *ada* 12

b^5. Hypopygium with an apical spine.

a^6. Hypopygium with a strong spine on each side near the base. *agnatus* 13

b^6. Hypopygium with an apical spine only.

a^7. Hypopygium rounded at the apex.

a^8. Wholly black; the antennæ long and slender. *longicornis* 19

b^8. The sides of the abdomen spotted with white; the antennæ rather short. *sexmaculatus* Sm. 7

b^7. Hypopygium truncate at the apex.

a^8. Abdomen spotted with yellow on the sides.

a^9. Hypopygium broad, the sides almost parallel. *trivialis* Sm. 9

b^9. Hypopygium sharply narrowed near the base, narrowly truncate at the apex. *proximus* 8

b^8. Abdomen wholly black. *nitidulus* 10

c^7. Hypopygium triangular.

a^8. Abdomen black *politus* 14

b^8. Abdomen light ferruginous-red. *cryptoides* Sm. 11

b^4. The second cubital cell as long or longer than the third on the radial nervure.

a^5. Posterior femora with a large tubercle beneath.

a^6. Abdomen black. *calcaratus* Sm. 15

b^6. Second and third segments of the abdomen dark ferruginous *femoratus* 16

b^5. Posterior femora without a tubercle; the abdomen ferruginous. *volatilis* Sm. 17

b^3. The three apical joints of the maxillary palpi not elongate.

a^4. Hypopygium strongly emarginate. *xanthorrhoei* Sm. 20

b^4. Hypopygium not emarginate, blunt at the apex.

a^5. Clypeus strongly convex, truncate at the apex.

a^6. Hypopygium with a spine on each side near the base. *sitiens* 26

b^6. Hypopygium entirely without spines.

a^7. Abdomen black and yellow.

a^8. Abdomen black with yellow spots on the sides. *contiguus* 21

b^8. Abdomen black with yellow bands or lunules

a^9. The yellow bands on the abdomen broad.

a^{10}. The yellow bands interrupted in the middle. *trifidus* Westw. 23

b^{10}. Tha yellow bands not interrupted. *flavescens* Sm. 25

b^9. The bands on the abdomen narrow and lunulate *carinatus* Sm. 24

b^7. Abdomen black and ferruginous. *sedulus* Sm. 27

b^5. Clypeus not very strongly convex and slightly emarginate *marginalis* Westw. 22

b^2 The abdomen not much flattened, the segments often constricted.

a^3. The first dorsal segment of the abdomen without a tubercle at the base.

a^4. The hypopygium not triangular or subtriangular,

a^5. The hypopygium broadly produced from the rounded basal prominences.
a^6. Wholly black. *villosus* Guêr. 106
b^6. Not wholly black.
a^7. The legs and mandibles ferruginous *fervens* Sm. 107
b^7. The legs black, the mandibles yellow. *anilitatis* Sm. 108
b^5. The hypopygium narrowly produced from the acute basal prominences, the sides parallel. *froggatti* 123
b^4. The hypopygium triangular or subtriangular, with or without basal prominences.
a^5. Wings hyaline or flavo-hyaline.
a^6. The abdominal segments strongly constricted.
a^7. Abdomen black.
a^8. Abdomen wholly black. *obscurus* Klug. 121
b^8. The two apical abdominal segments red. *mamillatus* 109
b^7. Abdomen ferruginous.
a^8. The ventral segments without tubercles. *petulans* Sm. 118
b^8. Some of the ventral segments with tubercles at the sides.
a^9. Segments 3-5 with tubercles. *wieseri* D.T. 117
b^9. Segments 3-4 with tubercles. *excoriatus* 116
b^6. The abdominal segments not at all or very slightly constricted.
a^7. Abdomen black, without markings.
a^8. Hypopygium unarmed. *tenuatus* Sm. 111
b^8. Hypopygium armed.
a^9. Clypeus with a medium carina, wholly black *ambiguus* 110
b^9. Clypeus without a carina, margined with yellow.
a^{10}. Legs fusco-ferruginous *protervus* Sm. 119
b^{10}. Legs black *kirbyi* 124
b^7. Abdomen marked with yellow.
a^8. Abdomen elongate or fusiform.
a^9. Second ventral segment of the abdomen with a tubercle on each side. *tuberculiventris* Westw. 125
b^9. The ventral segments without tubercles.

a^{10}. Hypopygium elongate-triangular.
a^{11}. Abdomen black with yellow spots on the sides.
a^{12}. Antennæ moderately long.
a^{13}. The anterior angles of the pronotum prominent. *crinitus* 126
b^{13}. The anterior angles of the pronotum not prominent. *immodestus* 130
b^{12}. Antennæ short.
a^{13}. First abdominal segment short.
a^{14}. The spots on the abdomen small *vigilans* Sm. 112
b^{14}. The spots enlarged, forming interrupted bands. *vigilans* Sm. var. *incertus* 112
b^{13}. First abdominal segment long and slender. *cognatus* Sm. 113
b^{11}. Abdomen ferruginous marked with orange.
a^{12}. The posterior margin of the pronotum fulvous.
a^{13}. The clypeus longer than broad. *rufiventris* Guér. 127
b^{13}. The clypeus broader than long. *wallisii* Sm. 128
b^{12}. The pronotum entirely black. *inconstans* Sm. 133
b^{10}. Hypopygium short and broad.
a^{11}. The yellow bands on the abdomen interrupted *senex* Sm. 131
b^{11}. The bands orange and not interrupted. *flavipennis* Sm. 134
b^{8}. Abdomen subconical, truncate at the base.
a^{9}. Clypeus truncate at the apex.
a^{10}. Median segment marked with yellow.
a^{11}. Pronotum black. *hyalinatus* Westw. 137
b^{11}. Pronotum marked with yellow. *apterus* Oliv. 136
b^{10}. Median segment black. *maculosus* Sm. 138
b^{9}. Clypeus strongly rounded at the apex.
a^{10}. Hypopygium not truucate at the apex. *affinis* Guér. 140

b[10]. Hypopygium truncate, the apical spine recurved. *annulatus* Kirby 139

b[5]. Wings dark fuscous.

a[6]. With a spine on each side of the sixth ventral abdominal segment. *purpureipennis* Westw. 115

b[6]. Without a spine on the sixth ventral segment. *lubricus.* 114

b[3]. The first dorsal segment of the abdomen with a tubercle at the base. *oppositus* Sm. 135

b. The second recurrent nervure received by the third cubital cell close to the base.

a[2]. The sixth joint of the maxillary palpi rudimentary. *klugii* Guér. 105

b[2]. The sixth joint of the maxillary palpi normal.

a[3]. The labrum long and narrow, very strongly bilobed.

a[4]. First ventral segment of the abdomen with an acute tubercle.

a[5]. Hypopygium rounded at the apex, with a short spine.

a[6]. The second dorsal segment of the abdomen with a transverse depressed line at the base.

a[7]. The median segment rounded at the sides.

a[8]. The anterior margin of the pronotum yellow.

a[9]. Abdomen black, marked with yellow or white.

a[10]. Abdomen sparsely punctured.

a[11]. Pronotum yellow with a black spot in the middle and on each side. *albomaculatus* Sm. 95

b[11]. Anterior margin only of the pronotum yellow.

a[12]. Front smooth and shining. *rotundiceps* Sm. 89

b[12]. Front punctured.

a[13]. Median segment black. *rotundiceps* Sm. var. *propinquus* Sm. 89

b[13]. Median segment marked with white. *cingulatus.* 90

b[10]. Abdomen closely punctured or rugulose.

a[11]. The sixth abdominal segment with a yellow spot on each side. *jucundus* Sm. 87

b[11]. The sixth abdominal segment wholly black.

a^{12}. Thorax marked with yellow.
a^{13}. Scutellum marked with yellow.
a^{14}. Median segment marked with yellow on the middle and on the sides. *maculatus* Guér. 85
b^{14}. Median segment marked with yellow on the sides only.
a^{15}. Head massive and rounded. *medius* Sm. 88
b^{15}. Head not very massive.
a^{16}. With a yellow spot on the vertex. *maculatus* Guér. var. *odyneroides* Westw. 85
b^{16}. Without a yellow spot on the vertex. *viridus* Sm. 86
b^{13}. Scutellum not marked with yellow. *maculatus* Guêr. var. *variegatus* Klug. 85
b^{12}. Thorax and median segment black, postscutellum white.
a^{13}. Legs black. *luctuosus* Sm. 92
b^{13}. Legs ferruginous. *marginilabris* Guér. 91
b^{9}. Abdomen dark ferruginous, marked with white. *rubellus* Sm. 93
b^{8}. Anterior margin of the pronotum black.
a^{9}. Abdominal segments 2-4 with a yellow spot on each side. *molestus* Sm. 94
b^{9}. Abdomen wholly black. *adelaidæ.* 98
b^{7}. The median segment subtruncate. *suspiciosus* Sm. 96
b^{6}. Second dorsal segment of the abdomen not depressed at the base. *trochanterinus* Westw. 99
b^{5}. Hypopygium triangular with a short apical spine. *albopictus* Sm. 97
b^{4}. The tubercle on the first ventral segment not developed.
a^{5}. Abdomen black and yellow. *irregularis* Sm. 100
b^{5}. Abdomen black with the two apical segments red. *incensus* Sm. 102
b^{3}. The labrum not bilobed or very slightly so, usually short and subtriangular.
a^{4}. Abdomen flattened, the segments not constricted.
a^{5}. Hypopygium without an apical spine.
a^{6}. Abdomen black and yellow. *pygmaeus.* 34
b^{6}. Abdomen marked with ferruginous.

a^7. Mesonotum and median segment marked with
yellow. *rubromaculatus.* 35

b^7. Mesonotum and median segment black.

a^8. Abdomen not marked with yellow, the four
basal segments ferruginous. *innocuus.* 36

b^8. Abdomen with yellow spots on the sides,
the second segment only marked with
ferruginous. *planiventris.* 40

b^5. Hypopygium with an apical spine.

a^6. Hypopygium rounded or triangular. Abdomen
black and yellow.

a^7. Hypopygium triangular. *beatrix.* 39

b^7. Hypopygium rounded. *penetratus* Sm. 38

b^6. Hypopygium truncate at the apex.

a^7. Abdomen black, usually marked with yellow
or white.

a^8. Thorax wholly black, the legs ferruginous.
generosus. 37

b^8. Thorax marked with yellow, the legs black.

a^9. Wings wholly hyaline. *westwoodi* Guér. 28

b^9. Wings hyaline with a fuscous cloud in
the radial cell. *mackayensis.* 43

b^7. Abdomen more or less ferruginous.

a^8. Abdomen ferruginous except at the extreme
base.

a^9. Front without a longitudinal sulcus.
decoratus Sm. 41

b^9. Front with a well marked longitudinal
sulcus. *sodalis.* 42

b^8. The apical segments of the abdomen black.

a^9. Abdomen without yellow lunules.
tenuis. 33

b^9. Abdomen marked with yellow lunules or
spots.

a^{10}. Abdomen marked with lunules.

a^{11}. Without a median frontal sulcus.
pulchellus Klug. 29

b^{11}. With a median frontal sulcus.
pulcherrimus. 30

b^{10}. Abdomen with yellow spots on the
sides. *minutus* Sm. 32

b^4. Abdomen not much flattened, the segments more or
less constricted.

a^{5}. Without spines on the sides of the fifth or sixth ventral segments.

a^{6}. Hypopygium rounded or truncate, with a single spine.

a^{7}. Hypopygium rounded at the apex.

a^{8}. Abdomen black and yellow.

a^{9}. Abdomen broadly banded with yellow. *polybioides.* 44

b^{9}. Abdomen marked with yellow on the sides only. *rostratus.* 58

b^{8}. Abdomen ferruginous marked with white. *combustus* Sm. 60

b^{7}. Hypopygium truncate at the apex.

a^{8}. Hypopygium narrowly truncate; abdomen yellow and ferruginous. *optimus* Sm. 45

b^{8}. Hypopygium broadly truncate; abdomen almost entirely black.

a^{9}. Abdomen marked with yellow on the sides. *dispersus.* 56

b^{9}. Abdomen entirely black.

a^{10}. The sides of the epipygium dilated near the apex. *zelebori* Sauss. 53

b^{10}. The epipygium truncate, the sides not dilated.

a^{11}. The scutellum narrowly truncate at the apex. *truncatus* Sm. 54

b^{11}. The scutellum broadly truncate at the apex.

a^{12}. Legs black. *iridipennis* Sm. 55

b^{12}. Legs ferruginous. *collaris* Guér. 57

b^{6}. Hypopygium tridentate, the apical spine much the longest.

a^{7}. Clypeus rostrate. *arenicolus.* 59

b^{7}. Clypeus not rostrate.

a^{8}. Scutellum not strongly elevated in the middle.

a^{9}. Abdomen slender, the segments not strongly constricted, black or black and yellow.

a^{10}. Abdomen banded with yellow.

a^{11}. The yellow bands not interrupted. *jardinei.* 47

b^{11}. The yellow bands interrupted.

a^{12}. The disc of the mesonotum and scutellum ferruginous. *bembeculus.* 48

b^{12}. The disc of the mesonotum and scutellum black marked with yellow.

a^{13}. Legs light ferruginous.

a^{14}. Scutellum rounded at the apex. *productus.* 49

b^{14}. Scutellum narrowly truncate at the apex. *coloratus.* 50

b^{13}. Legs black and fusco-ferruginous.

a^{14}. Scutellum narrowly truncate at the apex. *conjungens.* 52

b^{14}. Scutellum broadly truncate at the apex. *tasmaniensis* Sauss. 51

b^{10}. Abdomen wholly black. *pavidus* Sm. 61

b^{9}. Abdomen broad, the segments strongly constricted, ferruginous. *gilberti.* 82

b^{8}. Scutellum strongly elevated in the middle.

a^{9}. Abdomen elongate-fusiform, black and yellow.

a^{10}. Abdomen punctured.

a^{11}. Legs ferruginous. *cygnorum.* 67

b^{11}. Legs black and yellow. *bipartitus.* 66

b^{10}. Abdomen finely rugose.

a^{11}. First two abdominal segments shining. *crabroniformis* Sm. 65

b^{11}. Second abdominal segment finely rugose. *crabroniformis* Sm. var. *opaciventris* 65

b^{9}. Abdomen elongate, ferruginous marked with white.

a^{10}. Interantennal prominence not developed. *excellens* Sm. 62

b^{10}. Interantennal prominence broadly V-shaped. *excelsus.* 63

b^{5}. With a spine at the apical angles of the fifth or sixth ventral segment.

a^{6}. The spine on the sixth segment and not on the fifth.

a^{7}. Clypeus rostrate. *eyrensis.* 73

b^{7}. Clypeus not rostrate.

a^8. Abdomen elongate, clypeus not very narrow at the apex.
a^9. Median segment subtruncate.
a^{10}. Thorax coarsely punctured. *sanguinolentus* 79
b^{10}. Thorax finely punctured. *baccatus* Sm. 74
b^9. Median segment rounded.
a^{10}. Abdomen wholly or partly ferruginous.
a^{11}. Abdomen wholly ferruginous. *dimidiatus* Westw. 64
b^{11}. The two apical segments only ferruginous-red.
a^{12}. Abdomen without white marks. *decipiens* Westw. 78
b^{12}. Abdomen marked with white. *illustris* Kirby 75
b^{10}. Abdomen black or black and yellow.
a^{11}. Abdomen marked with yellow.
a^{12}. Median segment coarsely punctured. *cerceroides* Sm. 77
b^{12}. Median segment finely punctured. *ablatus* 76
b^{11}. Abdomen entirely black.
a^{12}. Wings hyaline. *armiger* 80
b^{12}. Wings fuscous. *umbripennis* Sm. 81
b^8. Abdomen broadly fusiform, clypeus narrow at the apex
a^9. Abdomen black. *aterrimus* Sm. 83
b^9. Abdomen marked with creamy yellow. *saundersi* 84
b^6. The fifth ventral segment with a long spine at the apical angles.
a^7. Abdomen elongate fusiform. *clementi* 72
b^7. Abdomen elongate.
a^8. Without a spine at the angles of the sixth ventral segment.
a^9. Head black.
a^{10}. Clypeus yellow and black. *bidentatus* Sm. 70
b^{10}. Clypeus wholly black. *bidentatus* Sm. var. *orientalis* 70
b^9. Head yellow, the vertex only black *doddii* 71
b^8. With a small spine at the apical angles of the sixth segment. *sannæ* 69

ii. Labrum broad and full, scarcely narrowed at the base.
  A. The two or three apical joints of the antennæ not nearly as thick as the others.
    a. The hypopygium ending in a very blunt, strongly recurved process.
      a^2. The clypeus fulvous and truncate at the apex. *friederici* D.T. 143
      b^2. The clypeus black and broadly emarginate at the apex. *poultoni* 144
    b. Hypopygium broadly rounded at the apex.
      a^2. Wings flavo-hyaline; pronotum fulvous. *insignis* Sm. 142
      b^2. Wings fuscous; pronotum black. *simillimus* Sm. 141
  B. The antennæ of almost equal thickness throughout.
    a. Sixth ventral segment of the abdomen with a spine at the apical angles.
      a^2. Median segment vertically truncate posteriorly.
        a^3. Scutellum and postscutellum produced beyond the median segment.
          a^4. Postscutellum very strongly emarginate at the apex. *emarginatus* Fab. 149
          b^4. Postscutellum not strongly emarginate.
            a^5. Head and thorax entirely pale yellow. *ventralis* Sm. 148
            b^5. Thorax marked with black above or beneath.
              a^6. Black and pale yellow *dentatus* Fab. 146
              b^6. Black and bright ferruginous brown. *pulchralis* Sm. 147
        b^3. Postscutellum reaching the truncation of the median segment, but not projecting beyond it.
          a^4. Abdomen marked with pale yellow above. *darwiniensis* 153
          b^4. Abdomen wholly black above.
            a^5. Scutellum with a tubercle at the apex; the wings hyaline. *brenchleyi* Sm. 151
            b^5. Scutellum without a tubercle; the wings fuscous. *ochrocephalus* Sm. 152
      b^2. Median segment obliquely truncate or rounded posteriorly.
        a^3. Median segment obliquely truncate.
          a^4. Hypopygium with five spines.
            a^5. Legs yellow. *zonatus* Guér. 154
            b^5. Legs ferruginous. *elgneri* 155
          b^4. Hypopygium with three spines or less
            a^5. The truncation of the median segment slightly concave. *excavatus* 166
            b^5. The truncation of the median segment not concave.

a^6. Abdomen black.

a^7. Wings dark fuscous, hyaline at the base. *fenestratus* Sm. 167

b^7. Wings fusco-hyaline. *morosus* Sm. 168

b^6. Abdomen barred with yellow.

a^7. Clypeus not depressed.

a^8. The yellow bands on the abdomen broad.

a^9. The basal spines of the hypopygium prominent *vernalis* 159

b^9. The basal spines of the hypopygium not prominent. *anchorites* 160

b^8. The yellow bands on the abdomen narrow.

a^9. Mesonotum marked with yellow. *leachiellus* Westw. 158

b^9. Mesonotum without yellow marks. *campanularis* Sm. 161

b^7. Clypeus depressed. *andreanus* 187

b^3. Median segment more or less rounded.

a^4. Clypeus not very prominent at the base.

a^5. Abdomen marked with yellow. *vestitus* Sm. 157

b^5. Abdomen not marked with yellow.

a^6. Hypopygium tridentate; abdomen black.

a^7. Clypeus yellow. *walkeri* 192

b^7. Wholly black. *nigripes* Guér. 194

b^6. Hypopygium without basal spines, unidentate; the apical abdominal segment red. *crudelis* 196

b^4. Clypeus very prominent at the base.

a^5. Abdomen marked with yellow. *simplex* Sm. 195

b^5. Abdomen wholly black.

a^6. Clypeus black.

a^7. Entirely black; hypopygium without an apical spine. *atrox* 193

b^7. Black, the legs ferruginous; hypopygium with an apical spine. *novaræ* Sauss. 190

b^6. Clypeus yellow.

a^7. Legs black. *carbonarius* Sm. 188

b^7. Legs ferruginous. *pseustes* 191

b. Sixth ventral segment of the abdomen without a spine at the apical angles.

a^2. Abdomen subconical or elongate.

a^3. Median segment truncate.

a^4. Abdomen black beneath.

a^5. Abdomen wholly black.

a^6. Abdomen punctured, without pubescence. *flavilabris* Guér. 169

b^6. Abdomen very finely punctured, with fine pubescence. *picipes* Westw. 170

b^5. Abdomen not wholly black.

a^6. All the dorsal segments of the abdomen orange-brown.

a^7. Wings flavo-hyaline.

a^8. Median segment with golden pile. *shuckardi* Guér. 172

b^8. Median segment with white pile. *guerinii* Westw. 173

b^7. Wings fuscous. *obscuripennis* Guér. 171

b^6. Two or more apical abdominal segments black.

a^7. Abdomen orange-brown above, the two apical segments black. *flaviventris* Guér. 174

b^7. Abdomen black, banded with yellow or obscure ferruginous on the four or five basal segments. *varipes* Sm. 175

b^4. Abdomen marked with yellow above and beneath.

a^5. Thorax entirely black. *seductor* Sm. 164

b^5. Thorax marked with yellow.

a^6. Epipygium punctured. *confusus* Sm. 162

b^6. Epipygium striated. *flavopictus* Sm. 176

b^3. Median segment rounded at the sides.

a^4. Hypopygium rather broadly truncate at the apex, with a spine.

a^5. Abdomen sparsely punctured, broadly banded with yellow. *subinterruptus* Sm. 184

b^5. Abdomen closely punctured, narrowly banded with yellow. *frenchi* 180

b^4. Hypopygium triangular from near the base, with a short spine or none.

a^5. Abdomen banded with yellow.

a^6. Hypopygium without an apical spine. *assimilis* Sm. 179

b^6. Hypopygium with an apical spine.

a^7. Median segment wholly black.

a^8. The yellow bands on the abdomen interrupted. *agilis* Sm. 178

b^8. The yellow bands on the abdomen not interrupted. *insidiator* Sm. 182

b^7. Median segment marked with yellow.

a^8. Median segment oblique. *melleus* Westw. 181
b^8. Median segment abruptly truncate.
irritans Sm. 183
b^5. Abdomen not banded with yellow.
a^6. Abdomen ferruginous red. *basalis* Sm. 185
b^6. Abdomen black. *tuberculifrons* Sm. 186
b^2. Abdomen fusiform or elongate-fusiform.
a^3. Clypeus not emarginate at the apex.
a^4. First ventral segment of the abdomen with a tubercle at the apex.
a^5. Abdomen black, with a broad yellow band on the fourth segment. *unifasciatus* Sm. 201
b^5. Abdomen wholly black.
a^6. Abdominal segments margined with white pubescence. *impetuosus* Sm. 202
b^6. Abdomen without pubescence. *waterhousei.* 205
b^4. First ventral abdominal segment without a tubercle at the apex.
a^5. Second ventral segment of the abdomen with a tubercle at the base. *melanotus.* 203
b^6. Second ventral segment without a tubercle.
a^7. Abdomen with broadly interrupted orange bands.
a^8. The abdominal segments strongly constricted. *constrictus* Sm. 200
b^8. The abdominal segments not much constricted.
a^9. Median segment and scutellum black.
modestus Sm. 199
b^9. Median segment and scutellum marked with orange.
a^{10}. Pronotum marked with orange on the anterior margin only.
frauenfeldianus Sauss. 198
b^{10}. Posterior margin of the pronotum broadly marked with orange.
nubilipennis Sm. 197
b^7. Abdomen wholly black or black and ferruginous brown.
a^8. Clypeus black; abdomen elongate-fusiform.
moechus. 189
b^8. Clypeus yellow or margined with white at the sides.

a^9. Clypeus yellow, the abdomen broadly fusiform.
a^{10}. Abdomen black. *binghami.* 204
b^{10}. Abdominal segments margined with dull ferruginous-brown. *ultimus.* 206
b^9. Clypeus margined with white at the sides; abdomen elongate-fusiform.
a^{10}. Mesopleuræ red. *pugionatus* Guér. 210
b^{10}. Mesopleuræ black. *gracilis* Westw. 211
b^3. Clypeus emarginate at the apex.
a^4. Legs ferruginous; wings flavohyaline.
a^5. Abdomen sparsely punctured. *fulvipes* Guér. 207
b^5. Abdomen closely punctured. *fumipennis* Westw. 208
b^4. Legs black; wings hyaline. *senilis* Erichs. 209

♀♀. i. Fifth ventral segment punctured.
A. Tarsal ungues bifid.
a. Second dorsal segment of the abdomen with less than four transverse carinæ.
a^2. Thorax punctured; the second dorsal segment of the abdomen rugose with a transverse carina at the base and at the apex.
a^3. Head strongly rounded at the posterior angles. *aratus.* 2
b^3. Head almost rectangular. *monilicornis* Sm. 1
b^2. Thorax coarsely rugose.
a^3. Pronotum without a carina. *depressus* Westw. 5
b^3. Pronotum with a median carina. *fulvopilosus* Sm. 6
b. Second dorsal segment of the abdomen with four or more transverse carinæ.
a^2. Pronotum without a carina.
a^3. Pygidium not contracted.
a^4. Head about as long as broad. *cryptoides* Sm. 11
b^4. Head broader than long.
a^5. Head rounded at the sides. *trivialis* Sm. 9
b^5. Head not rounded at the sides. *nitidulus.* 10
b^3. Pygidium contracted.
a^4. Second dorsal segment of the abdomen with six transverse carinæ. *proximus.* 8
b^4. Second dorsal segment of the abdomen with less than six transverse carinæ.
a^5. Head large and convex. *attenuatus* Sm. 103
b^5. Head flattened.
a^6. Pronotum with a median sulcus on the anterior portion.

a^7. Head narrowed posteriorly.
a^8. Pronotum broader than long. *maculatus* Guér. 85
b^8. Pronotum longer than broad. *laevifrons* Sm. 101
b^7. Head broad and rounded. *luctuosus* Sm.
b^6. Pronotum without a sulcus.
a^7. Head strongly narrowed posteriorly. *medius* Sm. 88
b^7. Head broad and rounded. *rotundiceps* Sm. 89
b^2. Pronotum with a median carina. *sannœ.* 69
B. Tarsal ungues simple.
a. Epipygium not contracted.
a^2. Pygidium not truncate.
a^3. Anterior angles of the pronotum tuberculate. *politus.* 14
b^3. Anterior angles of the pronotum not tuberculate. *femoratus.* 16
b^2, Pygidium vertically truncate.
a^3. Pygidium half as long again as broad. *xanthorrhoei* Sm. 20
b^3. Pygidium more than twice as long as bɹoad. *marginalis* Westw. 22
b. Epipygium contracted.
a^2 Epipygium recurved at the apex.
a^3. Pronotum slightly raised in the middle of the anterior margin. *flavescens* Sm. 25
b^3. Pronotum not raised on the anterior margin. *carinatus* Sm. 24
b^2. Epipygium not recurved at the apex.
a^3. Pronotum without a carina or tubercle.
a^4. Pronotum as long as broad.
a^5. Pronotum with a deep median sulcus on the anterior margin. *westwoodi* Guér. 28
b^5. Pronotum without a sulcus.
a^6. Median segment strongly punctured. *beatrix.* 39
b^6. Median segment almost smooth; the angles of the pronotum prominent.
a^7. Head strongly narrowed posteriorly. *pulcherrimus* 30
b^7. Head rounded. *generosus* 37
b^4. Pronotum much broader than long.
a^5. The raised carina before the apex of the first abdominal segment not emarginate.
a^6. Pronotum not flattened.
a^7. Pronotum with a median sulcus on the anterior margin.

a^8. Head strongly convex. *puchellus* Klug. 29
b^8. Head flattened. *mackayensis* 43
b^7. Pronotum without a sulcus.
a^8. Head not narrowed posteriorly. *pavidus* Sm. 61
b^8. Head narrowed posteriorly. *armiger* 80
b^6. Pronotum flattened.
a^7. Head strongly excavated on each side. *sulcatus* Sm. 46
b^7. Head not excavated.
a^8. Head narrowed posteriorly. *gilberti* 82
b^8. Head not narrowed posteriorly.
a^9. Pronotum emarginate. *adelaidæ*
b^9. Pronotum not emarginate. *iridipennis* Sm. 55
b^5. The raised carina before the apex of the first abdominal segment emarginate.
a^6. Pronotum narrowed posteriorly. *ablatus* 76
b^6. Pronotum not narrowed posteriorly.
a^7. Head convex, narrowed anteriorly. *sanguinolentus* 79
b^7. Head flattened, narrowed posteriorly. *cerceroides* Sm. 77
b^3. Pronotum with a median carina or tubercle.
a^4. Head rounded at the sides.
a^5. Head broad and flat.
a^6. Pronotum narrowed posteriorly. *crabroniformis* Sm. var. *opaciventris* 65
b^6. Pronotum not narrowed posteriorly. *coloratus* 50
b^5. Head narrowed into a neck posteriorly. *doddii* 71
b^4. Head not rounded at the sides.
a^5. Head broader than long. *quadratus* Sm. 68
b^5. Head longer than broad.
a^6. Head strongly narrowed posteriorly. *bipartitus* 66
b^6. Head not narrowed posteriorly.
a^7. Head excavated on the sides. *zelebori* Sauss. 53
b^7. Head not excavated on the sides.
a^8. Pronotum broader than long. *tasmaniensis* Sauss. 51
b^8. Pronotum longer than broad. *conjungens* 52

ii. Fifth ventral segment striated or rugose.
A. Pygidium not sharply contracted before the truncation or on the truncation.
a. Pygidium very narrow, the sides parallel. *villosus* Guér. 106
b. Pygidium broader, usually longitudinally striated.
a^2. Pygidium not notched at the sides before the apex.

a^3. Pygidium longer than broad, the sides parallel or nearly so.

a^4. First abdominal segment obliquely striated. *lubricus* 114

b^4. First abdominal segment without oblique striae.

a^5. Fifth ventral segment rugose.

a^6. Epipygium slightly widened to the apex and broadly truncate. *purpureipennis* Westw. 115

b^6. Epipygium not widened to the apex.

a^7. Legs bright ferruginous.

a^8. Head ferruginous. *vigilans* Sm. 112

b^8. Head black. *froggatti* 123

b^7. Legs fusco-ferruginous.

a^8. Head opaque and delicately punctured. *obscurus* Klug. 121

b^8. Head shining and almost smooth. *laeviceps* Sm. 122

b^5. Fifth ventral segment longitudinally striated.

a^6. Abdomen black. *ambiguus* 110

b^6. Abdomen marked with yellow.

a^7. Pygidium narrowed to the apex. *excoriatus* 116

b^7. Pygidium not narrowed to the apex.

a^8. Second abdominal segment wholly yellow. *inconstans* Sm. 133

b^8. Second abdominal segment spotted with yellow.

a^9. Second abdominal segment ferruginous. *immodestus* 130

b^9. Second abdominal segment black. *klugii* Guér. 105

b^3. Pygidium ovate.

a^4. Second abdominal segment transversely rugose-striate. *friederici* D.T. 143

b^4. Second abdominal segment with transverse carinae.

a^5. The whole of the first dorsal segment of the abdomen transversely striated. *dilatatus* Sm. 145

b^5. The first abdominal segment not striated on its whole length.

a^6. The first abdominal segment transversely striated at the apex. *simillimus* Sm. 141

b^6. The first abdominal segment not striated. *insignis* Sm. 142

b^2. Pygidium notched on each side near the apex, the sides produced into short spines.

a^3. Clypeus not pointed.
a^4. Head black.
a^5. Front of the head yellow; the thorax ferruginous. *flavifrons* Sm. 120
b^5. Head and thorax entirely black. *protervus* Sm. 119
b^4. Head ferruginous.
a^5. Pronotum black. *connectens* Sm. 132
b^5. Pronotum ferruginous. *flavipennis* Sm. 134
b^3. Clypeus pointed.
a^4. Fifth ventral segment rugose.
a^5. The spines on the sides of the pygidium very small. *rufiventris* Guér. 127
b^5. The spines on the sides of the pygidium well developed. *crinitus*. 126
b^4. Fifth ventral segment of the abdomen striated.
a^5. Head rather small, strongly rounded at the posterior angles. *kirbyi* 124
b^5. Head large, less strongly rounded posteriorly.
a^6. Abdomen almost entirely yellow, with a few black marks.
a^7. Median segment black. *wallisii* Sm. 128
b^7. Median segment yellow or ferruginous. *annulatus* Kirby 139
b^6. Abdomen black or fusco-ferruginous, marked with yellow. *apterus* Oliv. 136

B. Pygidium contracted either at the base of the truncation or near the middle of the truncation.
a. Pygidium narrow, constricted on the truncation before the apex.
a^2. Front depressed and slightly concave on each side. *ultimus* 206
b^2. Front without depressions.
a^3. Second abdominal segment with five transverse carinæ; head broader than long.
a^4. Legs black. *waterhousei* 205
b^4. Legs ferruginous.
a^5. Head black. *fumipennis* Westw. 208
b^5. Head ferruginous. *fulvipes* Guér. 207
b^3. Second abdominal segment with six carinæ; head as long as broad.
a^4. Abdomen sparsely and rather deeply punctured. *gracilis* Westw. 211
b^4. Abdomen sparsely and finely punctured. *pugionatus* Guér. 210

b. Pygidium constricted at the base of the truncation.
a[2]. Second abdominal segment with less than seven transverse carinæ.
a[3]. Pygidium widened to the apex.
a[4]. Second abdominal segment with six carinæ. *nubilipennis* Sm. 197
b[4]. Second abdominal segment with five carinæ. *frauenfeldianus* Sauss. 198
b[3]. Pygidium scarcely, if at all, widened to the apex.
a[4]. Second abdominal segment with five carinæ. *irritans* Sm. 183
b[4]. Second abdominal segment with three or four carinæ near the base, the apical area delicately transversely striated.
a[5]. Pygidium lanceolate.
a[6]. Pronotum with a faint median carina. *tuberculifrons* Sm. 186
b[6]. Pronotum without a carina.
a[7]. Head nearly rectangular, as long as broad. *insidiator* Sm. 182
b[7]. Head broader than long.
a[8]. Head nearly rectangular. *basalis* Sm. 185
b[8]. Head considerably narrowed posteriorly. *melleus* Westw. 181
b[5]. Pygidium elongate-ovate.
a[6]. Fifth ventral segment longitudinally striated. *flavofasciatus* Sm. 177
b[6]. Fifth ventral segment of the abdomen rugose. *flavopictus* Sm. 176
b[2]. Second abdominal segment with seven or more transverse carinæ.
a[3]. First abdominal segment with oblique striæ.
a[4]. Head not excavated on the front; black and yellow. *andreanus* 187
b[4]. Head excavated on each side; wholly black.
a[5]. The carinæ on the second abdominal segment straight. *carbonarius* Sm. 188
b[5]. The carinæ at the base of the second segment strongly arched. *moechus* 189
b[3]. First abdominal segment without oblique striæ.
a[4]. Epipygium expanding into lobes at the apex.
a[5]. The epipygium pointed, the lobes not membranous *pseustes* 191

b^5. Epipygium truncate, the lobes membranous.
a^6. Head deeply excavated on the sides. *sulcifrons* Sm. 163
b^6. Head not excavated.
a^7. First abdominal segment with several strong transverse carinæ. *fenestratus* Sm. 167
b^7. First abdominal segment with one or two carinæ only close to the apex.
a^8. Fifth ventral segment transversely rugose. *shuckardi* Guêr. 172
b^8. Fifth ventral segment longitudinally rugose. *guerinii* Westw. 173
b^4. Epipygium without lobes at the apex.
a^5. The head excavated in front on each side.
a^6. The concave spaces extending to the vertex. *leachiellus* Westw. 158
b^6. The concave spaces not extending to the vertex.
a^7. The median segment and the first abdominal segment covered with long pubescence. *brenchleyi* Sm. 151
b^7. A tuft of long hairs in the middle of the first abdominal segment.
a^8. The truncation of the pygidium ovate. *ventralis* Sm. 148
b^8. The truncation of the pygidium lanceolate ovate.
a^9. The second abdominal segment with nine or ten rather low and slightly irregular carinæ. *dentatus* Fab. 146
b^9. The second abdominal segment with eight or nine strong and regular carinæ. *pulchralis* Sm. 147
b^5. The head not excavated.
a^6. The front flattened and subconcave. *sabulosus* 156
b^6. The front convex.
a^7. Fifth ventral segment of the abdomen longitudinally striated.
a^8. The truncation of the pygidium ovate.
a^9. The anterior margin of the pronotum straight.
a^{10}. Pronotum and abdomen marked with yellow.
a^{11}. Head black; pronotum slightly concave. *excavatus* 166

b^{11}. Head yellow in front; pronotum not concave. *vernalis* 159
b^{10}. Pronotum ferruginous-red, abdomen black. *picticollis* 165
b^{9}. Pronotum broadly emarginate anteriorly. *novaræ* Sauss. 190
b^{8}. The truncation of the pygidium not ovate, widened to the apex. *modestus* Sm. 199
b^{7}. Fifth ventral segment of the abdomen transversely rugose. *seductor* Sm. 164

Subgenus i. PHYMATOTHYNNUS, n.subgen.

♂. Antennæ about as long as the head, thorax and median segment combined, the six or seven apical joints strongly arcuate beneath. Clypeus narrowly produced and truncate at the apex; labrum very small and short, truncate and strongly ciliated anteriorly, strongly narrowed posteriorly; first joint of the maxillary palpi very short, the three apical joints rather slender, fourth joint the longest; first joint of the labial palpi nearly as long as the three apical joints combined, and the labium has a few long recurved hairs at the apex. Abdominal segments depressed at the base and the hypopygium prominent.

♀. Head only slightly convex. The second abdominal segment has a transverse carina near the base and another at the apex; the intervening space transversely rugose; fifth ventral segment punctured. Pygidium simple, not contracted or truncate. Tarsal ungues bidentate; the basal joint of the anterior tarsi not produced at the apex.

Type *Thynnus monilicornis* Sm.

The mouth-parts of the male closely resemble those of *Lophocheilus villosus* Guér., from which the antennæ separate it. The female is quite different and shows some resemblance to *Tachynomyia.*

1. T. (PHYMATOTHYNNUS) MONILICORNIS Sm.

Thynnus (*Agriomyia*) *monilicornis* Sm., Cat. Hym. B.M. vii. p.39, n.104, 1859(♂♀).

♂. Clypeus short, narrowly produced and truncate anteriorly, with a small tubercle before the apex; the interantennal carina transverse, narrowly emarginate anteriorly. Head and thorax closely punctured; the scutellum rather long, broadly rounded at the apex. Median segment rounded, very finely and shallowly punctured. Abdomen elongate-fusiform, shining, closely and very shallowly punctured; the apical margins of the segments depressed, with a raised mark on each side before the apex. Hypopygium small, much narrower at the base than at the apex, where it is truncate, with a small spine. Length 11-12 mm.

♀. Head broader anteriorly than long, narrowed posteriorly, sparsely punctured, the front produced into two minute tubercles between the antennæ. Thorax and median segment rather sparsely punctured; the pronotum much longer than broad; the median segment obliquely truncate posteriorly. First abdominal segment truncate anteriorly, sparsely punctured; the second segment with a transverse carina near the base and another near the apex, the intervening space coarsely transversely rugose, the apical margin raised, forming a third carina; the third segment with a transverse impressed line near the base, very finely punctured at the base, more coarsely and sparsely at the apex; the remaining segments finely punctured. Pygidium simple, with a low, longitudinal carina. Length 6-9 mm.

Hab.—Melbourne (French); Tasmania (Simson; ♂♀ in cop.); Bombala, N. S.W. (Froggatt; ♂♀ in cop.).

Smith's types, which are lost, were smaller. The female from Tasmania is coloured as in Smith's description, but the specimen from Bombala is much darker, the head and thorax being black; it is also more deeply punctured, but I do not think the differences are of specific value, though they may prove to be so when a longer series is available for comparison.

2. T. (PHYMATOTHYNNUS) ARATUS, n.sp.

♂. Clypeus finely rugulose, narrowly truncate at the apex; the antennæ longer than the head and thorax, the seven apical joints depressed at the base and apex beneath and subarcuate. Head and thorax closely and finely punctured; the median segment rounded, very finely rugulose. Abdomen sparsely and shallowly punctured, fusiform; first segment with a sulcus from the base not reaching the apex; segments 2-5 strongly depressed at the base, the apical margin narrowly depressed, with a raised mark before the apex, faint in the middle and emarginate. Hypopygium with parallel sides, triangular at the apex, with a very short spine. Black, with thin cinereous pubescence; mandibles except at apex, apex of clypeus, two small spots between the antennæ, a narrow interrupted line on the anterior margin of pronotum and postscutellum yellow; tibiæ and tarsi, and femora at the apex ferruginous. Wings fusco-hyaline, nervures black. Length 17 mm.

♀. Head much broader than long, rounded at the posterior angles, closely punctured, a short longitudinal sulcus on the front which is produced on each side of it between the antennæ into a small tubercle; clypeus with a carina from the base to the apex. Thorax and median segment punctured; pronotum rectangular broader than long; median segment obliquely truncate posteriorly, the surface of the truncation very minutely and closely punctured. Abdomen punctured, most closely on the fourth and fifth segments; second segment with a transverse carina near the base and the apical margin raised, the intervening space coarsely, transversely rugose. Fifth ventral segment strongly punctured. Pygidium simple, rugose, with a low longitudinal carina. Black; the antennæ, the legs and the apex of the pygidium ferruginous. Length 10 mm.

Hab.—Victoria (French; ♂♀); Mittagong, N. S.W. (Froggatt; ♂♀ in cop.).

3. T. (Phymatothynnus) distinctus Guér.

Lophocheilus distinctus Guér., Mag. de Zool. xii. p.12, P.103, figs.14-15(♂).

I have not seen the type of this insect, and am unable to recognise it from the description, which is very poor. It seems to be near *T. nitidus* Sm., which may possibly have to be sunk as a synonym, but at present I think it best to keep them separate.

Hab.—Australia.

4. T. (Phymatothynnus) nitidus Sm.

Thynnus (*Agriomyia*) *nitidus* Sm., Cat. Hym. B.M. vii. p.30, n.77, 1859(♂).

♂. Clypeus short and broad, not much produced, rather narrowly truncate anteriorly, finely punctured, opaque, the apical margin shining, a longitudinal carina reaching from the base to very near the apex. Head and thorax finely punctured with thin grey pubescence, fulvous on the front of the head; head a little broader than the pronotum. Anterior margin of the pronotum elevated, with a deep groove behind it. Median segment rounded, rather short, very finely and closely punctured. Abdomen very flat, narrow at the base, gradually widened to the fourth and fifth segments, which are the broadest; shallowly punctured and shining, a faint depressed transverse line near the base of segments 2-4. Hypopygium very small, rounded and unarmed.

Hab.—Adelaide, S.A.; Perth, W.A.

♀. Unknown.

The antennæ are as long as the thorax and median segment combined, and of almost equal thickness throughout. The inter-antennal prominence is bilobed.

Subgenus Psammothynnus Ashm.

Psammothynnus Ashm., Canad. Ent. xxxv. 1903.

♂. Joints of the antennæ strongly arcuate beneath, shorter and stouter than in *Phymatothynnus*, the palpi stout, the three apical joints of the maxillary palpi not slender or elongate. Abdomen flattened, the segments not constricted; hypopygium short and not prominent, strongly emarginate, with an appendage of long, stiff hairs on each side. Second recurrent nervure received by the third cubital cell near the base.

♀. Thorax strongly rugose; second abdominal segment with very few transverse carinæ; pygidium simple, not contracted or truncate.

Type *Thynnus* (*Agriomyia*) *depressus* Westw.

5. T. (PSAMMOTHYNNUS) DEPRESSUS Westw.

Thynnus (*Agriomyia*) *depressus* Westw., Arc. Ent. ii. 2, p.107, P.74, figs.5-6, 1844(♂♀).

Zeleboria depressa Sauss., Reise d. Nov. ii. 1, Hym. p.131, 1867.

Psammothynnus depressus Ashm., Canad. Ent. xxxv. 1903(♂♀).

?*Thynnus trisulcatus* Sm., Cat. Hym. B.M. vii. p.45, n.129, 1859(♀).

Hab.—S.W. Australia.

I think I am correct in sinking the name *trisulcatus*, but have not had any opportunity of comparing a series of specimens. There is no carina on the pronotum of the female of this species as in *T. fulvopilosus.*

6. T. (PSAMMOTHYNNUS) FULVOPILOSUS Sm.

Thynnus fulvopilosus Sm., Descr. n.sp. Hym. p.160, 1879(♂♀).

Rhagigaster rugosus Sm., Descr. n.sp. Hym. p.176, 1879(♀; nec ♂).

♂. This is very near *T. depressus* Westw. The pronotum is covered with long fulvous hairs, but I can see no other appreciable difference.

♀. Head subquadrate, broader than long, slightly convex, finely reticulate with sparse and large punctures. Thorax and median segment coarsely punctured; the pronotum rectangular, broader than long, narrower than the head, the anterior margin straight and very slightly produced at the angles, a short, delicate longitudinal carina on the middle of the segment. Median segment nearly as long as the pronotum, obliquely truncate posteriorly. Abdomen opaque, with a few scattered and shallow punctures; basal segment vertically truncate anteriorly, with a deep transverse groove before the apical margin; second segment with three strong transverse carinæ, the apical margin also slightly raised. Pygidium rather narrow, gradually broadened from base to apex, with a median longitudinal carina and the margins a little elevated. Length 6 mm.

Hab.—Adelaide, S.A. (Smith).

The female is very similar to that of *T. depressus*, but differs in the sculpture of the abdomen, especially of the second segment. It will probably prove to be a geographical variety of that species.

Subgenus Zeleboria Sauss.

♂. The males may be distinguished by the three terminal joints of the maxillary palpi being long and slender as in *Tachynomyia*, from which they may easily be distinguished by the form of the head which is not deeply hollowed beneath or bearded on the sides. The first joint of the maxillary palpi is very short; the first joint of the labial palpi is long; and the labrum is small, truncate at the apex, and very sharply narrowed posteriorly. The abdomen is flattened and subpetiolate.

♀. The females show no good distinguishing characters. The fifth ventral segment is punctured, and the pygidium usually not contracted or truncate, but in one species it is elongate and contracted. In the typical group the tarsal ungues are bidentate. The carinæ on the second abdominal segment vary in number, but do not exceed six in any of the species.

Type *Thynnus* (*Agriomyia*) *sexmaculatus* Sm.

Ashmead gives *T. carinatus* Sm., as the type of the genus, but as *T. sexmaculatus* is given first by Saussure, I retain it as the type, and place *T. carinatus* in another subgenus. When the sexes are better known the group may require further division.

7. T. (Zeleboria) sexmaculatus Sm.

Thynnus (*Agriomyia*) *sexmaculatus* Sm., Cat. Hym. B.M. vii. p.32, n.81, 1859(♂).

Zeleboria sexmaculata (Sm.) Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.131, 1867.

♂. Clypeus short, rather broadly truncate at the apex. Pronotum not shortened, the anterior margin only very slightly raised at the sides. Median segment slender. The hypopygium is very similar to that of *T. trivialis*, but rather longer and narrower, and rounded at the apex; the sides are nearly parallel and it is twice as long as broad. I have seen only the type.

♀. Unknown.

In this and in the allied species *T. trivialis* and *T. proximus* the second cubital cell is much shorter than the third; and the three terminal joints of the maxillary palpi are elongate, but not as much so as in the genus *Tachynomyia*.

Hab.—Sydney (Smith).

8. T. (Zeleboria) proximus, n.sp.

♂. Clypeus a little advanced, rather broadly truncate at the apex, finely punctured; head shallowly punctured on the occiput, finely punctured-rugulose on the front, thinly clothed with fulvous pubescence. Thorax finely and closely punctured; median segment rounded, as broad at the base as long, delicately reticulate. Abdomen subpetiolate, fusiform, shining, the two apical segments punctured. Hypopygium broad at the base, subtriangular, narrowly truncate at the apex, with a strong apical spine. Black; mandibles, anterior margin of clypeus, two minute spots between the antennæ, anterior margin of the prothorax narrowly interrupted in the middle, a minute spot on each side before the tegulæ, a narrow, longitudinal spot on the scutellum, a transverse line on the postscutellum and a spot on each side of the second and third abdominal segments yellow; femora, tibiæ, tarsi and tegulæ ferruginous. Wings hyaline tinted with yellow, nervures fuscous. Length 11-14 mm.

In another specimen the spots on the third abdominal segment and on the scutellum are absent.

♀. Head strongly narrowed posteriorly, only half as wide on the posterior as on the anterior margin, flat above, flattened and slightly concave on the sides, eyes situated on the sides; the whole head shining, with a few scattered punctures and a short longitudinal sulcus between the antennæ. Thorax and median segment sparsely punctured; pronotum nearly square, with a faint median sulcus from the anterior margin to the centre; median segment broadened from the base, obliquely truncate posteriorly. First abdominal segment truncate anteriorly, apical margin depressed, giving an appearance of a transverse carina before the apex; second segment with six strong transverse carinæ, including the recurved apical margin; the remaining segments smooth on the basal half, shallowly punctured on the apical half. Pygidium lanceolate, very much contracted, slightly broadened towards the apex by the expansion of the margins of the hypopygium which form marginal carinæ, leaving the epipygium as a central carina. Dark fuscous; head, pronotum and legs dark ferruginous; second abdominal segment and pygidium fusco-ferruginous. Length 7-9 mm.

Hab.—Leura, N. S.W. (Froggatt; ♂♀ in cop.). Types in Coll. Froggatt.

The male is very near *T. sexmaculatus* Sm., but the shape of the hypopygium and of the median segment is different.

9. T. (ZELEBORIA) TRIVIALIS Sm.

Thynnus (*Agriomyia*) *trivialis* Sm., Cat. Hym. B.M. vii. p.38, n.101, 1859(♂♀).

Aelurus fulvifrons Sm., Cat. Hym. B.M. vii. p.56, n.12, 1859(♂♀).

Thynnus impatiens Sm., Descr. n.sp. Hym. p.168, n.29, 1879(♂).

The male differs from that of *T. proximus* in having the pronotum shorter, with the anterior margin strongly raised; hypopygium narrower at the base, sides almost parallel, truncate at the apex, with a short apical spine. The posterior margin of the pronotum is yellow and there is a yellow spot on each side of the second, third, and fourth abdominal segments.

♀. Head much broader than long, narrowed posteriorly and strongly rounded at the angles, shining and sparsely punctured. Thorax and abdomen finely rugose; pronotum as long as broad, anterior angles prominent and subtuberculate; first abdominal segment rather broadly depressed on the apical margin, carina before the depression straight and transverse; second segment with five transverse carinæ; pygidium rather small, not contracted, rounded at the apex, with an obscure longitudinal carina; fifth ventral segment punctured. Fuscous; head, second abdominal segment and pygidium fusco-ferruginous; mandibles, antennæ, legs and apical margin of the abdominal segments rufo-testaceous. Length 6 mm.

Hab—Lower Plenty (Bakewell); Victoria (French); Champion Bay, W.A. (Smith).

The types of *T. trivialis* and *T. fulvifrons* were in Bakewell's Collection and appear to be lost.

10. T. (Zeleboria) nitidulus, n.sp.

♂. Clypeus short and narrowly truncate at the apex; antennæ as long as the head and thorax; head narrowed behind eyes. Head and thorax closely and finely punctured; anterior margin of pronotum slightly raised at the sides; median segments slender, finely transversely rugulose. Abdomen subpetiolate, elongate fusiform, smooth and shining, with a few very minute punctures; first segment with a deep sulcus from the base to the middle. Hypopygium small, the sides parallel, truncate at the apex, with a short spine. Black; with sparse grey pubescence on the head and thorax; mandibles except at the apex, a narrow, interrupted line on anterior margin of pronotum and a transverse line on postscutellum yellow; legs except the coxæ and trochanters ferruginous. Wings hyaline, slightly iridescent, nervures black. Length 11-14 mm.

♀. Head broader anteriorly than long, very strongly rounded at the posterior angles, shining and very sparsely punctured, with a deep median sulcus between the antennæ. Thorax and median segment finely punctured; pronotum narrower than head, nearly square, with a median sulcus from the anterior margin not reaching beyond the middle. Abdomen finely punctured-rugulose; first segment depressed at the apex, leaving a straight carina before the depression, the extreme apical margin slightly raised; second segment with five strongly raised transverse carinæ, including the raised apical margin. Pygidium small, not constricted, epipygium with a faint longitudinal carina. Fifth ventral segment punctured. Black; head, legs and pygidium ferruginous; thorax and median segment fusco-ferruginous. Length 9 mm.

Hab.—Melbourne (French).

The labrum of the male is small, truncate anteriorly and fringed with long hairs. The first joint of the maxillary palpi is about half as long as the second, the three apical joints are slender, the fourth being much the longest. The first joint of the labial palpi is nearly as long as the three apical joints combined. The claspers are slender at the apex.

11. T. (Zeleboria) cryptoides Sm.

Thynnus (*Agriomyia*) *cryptoides* Sm., Cat. Hym. B.M. vii. p.33, n.84, 1859(♂).

♂. Clypeus rather short, narrowly truncate at the apex; the interantennal prominence bilobed. Head and thorax finely and closely punctured; median segment slender, very finely transversely striated and shining. Abdomen subpetiolate, elongate fusiform, shining, with a few small scattered punctures. Hypopygium subtruncate at the apex, slightly produced at the apical angles with a central spine.

♀. Head a little broader than long, slightly rounded at the posterior angles, moderately convex, shining, very finely and sparsely punctured. Thorax and median segment rather closely punctured, pronotum rectangular, much broader than long, with a longitudinal sulcus from the anterior margin reaching beyond the middle; median segment obliquely truncate posteriorly. Abdomen vertically truncate at the base, closely and shallowly punctured; first segment with the apical margin slightly raised and a transverse carina before it; second segment with four transverse carinæ including the raised apical margin. Pygidium simple, with a low, longitudinal carina. Entirely light castaneous-brown. Length 6 mm.

Hab.—River Plenty (Smith); Melbourne (Bakewell; ♂♀ in cop.); Gosford, N. S.W. (Froggatt; ♂♀ in cop.).

Type of ♀ in Oxford University Museum.

12. T. (Zeleboria) ada, n.sp.

♂. Slender; clypeus rather short, broadly truncate anteriorly, finely and closely punctured, pubescent. Head finely and closely punctured, with a faint median impressed line from between the antennæ halfway to the anterior ocellus. Pronotum depressed, the anterior margin raised; shining, with fine and very shallow punctures. Mesonotum and scutellum closely punctured, the scutellum rather broadly subtruncate at the apex. Median segment slender, much longer than broad, shining, very shallowly punctured, with a short, median, impressed longitudinal line from the base. Abdomen subpetiolate, slender, flattened above and beneath, broadest at the third and fourth segments, shining, sparsely and very shallowly punctured, the two apical segments more strongly punctured, with thin, long, cinereous pubescence on the sides. Hypopygium small, prominent, rounded at the apex, without a spine. Black; anterior margin of the clypeus, a small spot at the base of each antenna, anterior margin of the pronotum, narrowly interrupted in the middle, a short line on each side of the posterior margin before the tegulæ, a small spot on the mesopleuræ, a spot on the scutellum and a transverse line on the postscutellum, yellow. Legs dark fusco-ferruginous. Wings hyaline, faintly tinted with yellow, nervures black. Length 10-12 mm.

Hab.—Roebourne, N. W. Australia (C. French).

The anterior margin of the labrum is nearly straight, ciliate; the labrum is strongly narrowed posteriorly. The three apical joints of the maxillary palpi are very long. The second cubital cell is much shorter than the third.

13. T. (Zeleboria) agnatus, n.sp.

♂. Clypeus depressed at the base, a little convex in the centre, rather narrow and slightly emarginate at the apex, with very fine, thin pubescence. Antennæ not longer than the thorax and median segment combined. Head finely punctured, a little narrowed posteriorly, interantennal carinæ oblique and divided by a sulcus. Pronotum very delicately punctured, the anterior margin slightly raised; mesonotum and scutellum rather more strongly punctured. Median segment as long as the mesonotum and scutellum combined, very minutely punctured, with short grey pubescence. Abdomen subpetiolate, fusiform, very finely and shallowly punctured; beneath more strongly punctured and clothed with long cinereous pubescence; first ventral segment with a carina at the base and an oblique triangular truncation at the apex. First dorsal segment with a longitudinal sulcus not reaching the apex; second and third segments with a slightly depressed transverse line near the base. Hypopygium broad at the base, with a spine on each side, thence rather narrowly produced, slightly emarginate at the apex on each side of the apical spine. Black; mandibles except at the apex, clypeus, interior margin of the eyes, a small spot at the base of each antenna, anterior margin of the pronotum and posterior margin of the sides, tegulæ, a small spot on the mesonotum, a large one on the mesopleuræ, a small spot on the centre of the scutellum and one at each of the anterior angles, a very small spot on each side of the median segment near the apex and coxæ beneath yellow; legs ferruginous, stained with fuscous on the tibiæ and tarsi; abdominal segments 1-4 with a broad creamy-white transverse band on each side near the apical margin. Wings long, hyaline, a fuscous band occupying the whole of the radial and third cubital and part of the second cubital and second discoidal cells; nervures fuscous. The three apical joints of the maxillary palpi are slender and elongate, and there is a tuft of very long hairs on the labium.

Hab.—Kuranda, near Cairns, Q. (Turner).

14. T. (Zeleboria) politus, n.sp.

♂. Head and thorax punctured-rugose, with thin cinereous pubescence, clypeus slightly advanced, finely and closely punctured, truncate anteriorly; head rather small, a straight transverse carina between the antennæ. Antennæ longer than the head and thorax combined. Scutellum sparsely punctured, narrowly truncate at the apex. Median segment rather long and slender, delicately reticulate. Abdomen slender, subpetiolate, flattened beneath, shining; segments 2-5 with a slight, impressed, transverse line near the base, first segment with a short longitudinal sulca from the base, epipygium pointed, hypopygium narrowly rounded at the apex, with a short apical spine not projecting much beyond the epipygium. Black; a spot on each side of the vertex, tegulæ, femora, tibiæ and tarsi ferruginous; an interrupted line on the anterior margin of the pronotum and a spot on the postscutellum whitish-yellow. Wings hyaline, nervures fuscous, stigma ferruginous. Length 10 mm.

♀. Head suborbicular, slightly convex above, shining; pronotum broader than long, with a median sulcus reaching from the anterior nearly to the posterior margin, anterior angles produced into blunt spines; sparsely punctured. Median segment very short, obliquely truncate posteriorly, finely punctured. Abdomen shining, very sparsely punctured; first segment depressed on the apical margin, leaving a transverse carina just before the apex; second segment with three prominent transverse carinæ and the apical margin slightly recurved, forming a fourth less prominent carina; third segment with an impressed transverse line near the base; pygidium oblique, rather narrow, the sides nearly parallel, narrowly rounded at the apex. Tarsal ungues simple. Fuscous; head and second abdominal segment ferruginous; legs fusco-ferruginous. Length 6 mm.

Hab.—Cowra, N. S.W. (Froggatt). Types in Coll. Froggatt.

15. T. (Zeleboria) calcaratus Sm.

Thynnus (*Agriomyia*) *calcaratus* Sm., Cat. Hym. B.M. vii. p.40, n.105, 1859(♂).

I have not seen this species. It is evidently closely allied to *T. femoratus* as described above, but is much smaller, and has the median segment smooth at the base and the abdomen entirely black. These differences, together with a slight difference in the position of the tubercle on the posterior femora, are, I think, sufficient to justify separation.

Hab.—Lower Plenty (Bakewell).

16. T. (Zeleboria) femoratus, n.sp.

♂. Clypeus advanced, rather narrowly truncate anteriorly, convex, finely and closely punctured; head concave beneath, finely and very closely punctured; with cinereous pubescence, long on the sides. Thorax very closely punctured; median segment long, finely punctured. Abdomen elongate, flattened beneath, sparsely punctured, shining; a short median sulcus from the base of the first segment and a slightly depressed transverse line near the base of segments 2-5, the two apical segments with long thin pubescence and more strongly punctured. Hypopygium subtriangular, with a small apical spine, not projecting very far beyond the epipygium. Claspers very long and slender. Posterior femora armed with a large acute tubercle near the base beneath. Opaque black; mandibles, anterior margin of the clypeus, a narrowly interrupted line on the anterior margin of pronotum and a small spot on postscutellum pale yellow; a spot on each side on the occiput, tibiæ, tarsi and femora, second, third and fourth abdominal segments dark ferruginous; base of the femora black, fourth abdominal segment more or less stained with black. Wings hyaline, faintly iridescent, nervures black. Length 12 mm.

♀. Head suborbicular, slightly convex, smooth and shining. Pronotum longer than broad, the sides parallel, shining, sparsely punctured, with a sulcus from the anterior margin to the centre. Median segment broadened from the base, short, obliquely truncate posteriorly, and punctured. Abdomen sparsely punctured, first segment with the apical margin depressed, leaving a transverse carina before the apex. Second segment with two strongly raised transverse carinæ, the apical margin recurved forming a third, less prominent, carina. Pygidium oblique, the sides parallel, not very narrow, rounded at the apex. Fuscous, the head bright ferruginous; pro- and mesothorax, pygidium and legs fusco ferruginous; second abdominal segment bright testaceous, carinæ fusco-ferruginous; the segments beneath at the sides pale testaceous. Length 6 mm.

Hab.— Bombala, N. S. W. (Froggatt). Types in Coll. Froggatt.

The male is very near *T. calcaratus* Sm., but that insect is black except the yellow mandibles and margin of the clypeus and the ferruginous tibiæ and tarsi. The tubercle on the posterior femora is in the middle in *T. calcaratus*, not near the base as in the present species. The type of *T. calcaratus* appears to be lost, probably owing to Smith's extremely careless habits as to marking type-specimens.

17. T. (Zeleboria) volatilis Sm.

Thynnus (*Agriomyia*) *volatilis* Sm., Cat. Hym. B.M. vii. p.33, n.85, 1859(♂).

♂. Clypeus narrowly produced and truncate anteriorly. Head and thorax finely rugose; pronotum shining and finely rugulose; scutellum with an obscure carina from base to apex. Median segment slender, delicately transversely rugulose, almost smooth at the base. Abdomen subpetiolate, elongate-fusiform, shining and sparsely punctured. Hypopygium triangular, narrowly truncate at the apex, with a small apical spine. Head and pronotum with long, thin, fulvous pubescence, longest on the sides of the head.

Hab.—Australia (Smith); Adelaide(?).

Nearest to *T. cryptoides* Sm., but differs much in sculpture and in the shape of the hypopygium.

18. T. (Zeleboria) leucostictus, n.sp.

♂. Clypeus narrowly advanced in the middle and truncate at the apex, closely and finely punctured, extreme apex smooth and shining, with a delicate carina from base to centre. Antennæ shorter than head and thorax combined. Head finely rugose, interantennal carina not developed. Thorax finely punctured, scutellum subtriangular, truncate at the apex. Median segment very closely and minutely punctured; with grey pubescence, thickest on the sides. Abdomen slender, elongate-fusiform, shining and almost smooth. Hypopygium small and narrow, subtriangular at the apex. Black; a spot on each side of the vertex, tegulæ and legs except coxæ and trochanters ferruginous; a spot on each side of second, third and fourth abdominal segments creamy-white. Wings hyaline, nervures fuscous. Length 10 mm.

Hab.—Yass, N. S.W. (Froggatt). Type in Coll. Froggatt.

The antennæ are shorter and stouter than in other species of the group.

19. T. (Zeleboria ?) longicornis, n.sp.

♂. Clypeus narrowly subtruncate at the apex, densely covered with silver pubescence. Head very finely and closely punctured, broadly emarginate posteriorly, interantennal prominence deeply emarginate at apex; antennæ long and slender, as long as the abdomen. Thorax finely and closely punctured; anterior margin of pronotum strongly raised; scutellum with a depressed transverse row of large punctures at base, narrowly rounded at apex. Median segment long and rather slender, finely punctured at base, delicately transversely rugulose at apex, with an obscure sulca from the base to the middle. Abdomen subpetiolate, elongate, flattened, smooth and shining; the two apical segments coarsely punctured. Hypopygium rounded, with a slightly recurved apical spine. Entirely black. Wings hyaline, faintly tinged with fuscous, nervures fuscous. Length 18 mm. Exp. al. 28 mm.

Hab.—N.W. Australia (French).

This species approaches *Tachynomyia*, but I think it is most naturally placed here.

Subgenus Glaphyrothynnus, n.subgen.

Zeleboria Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.131, 1867 (partim); Ashm., Canad. Ent. xxxv. 1903.

♂. Labrum strongly rounded anteriorly, broadly truncate posteriorly and connected with the basal portion by a narrow petiole. Maxillæ very broad at the base; maxillary palpi rather short and very slender, first joint as long as or longer than the others; labial palpi slender, second joint almost as long as first. Abdomen flattened, the segments not constricted ; hypopygium usually without an apical spine, blunt or emarginate. The second recurrent nervure is received by the third cubital cell at some distance from the base.

♀. Tarsal ungues simple; fifth ventral segment punctured; second abdominal segment usually with three transverse carinæ;

pygidium variable, broad and vertically truncate or contracted and recurved at apex.

Type *Thynnus xanthorrhoei* Sm.

20. T. (Glaphyrothynnus) xanthorrhoei Sm.

Thynnus xanthorrhoei Sm., Cat. Hym. B.M. vii. p.28, n.70, 1859(♂).

Thynnus planifrons Sm , *l.c.* p.46, n.134, 1859(♀).

?*Thynnus plebejus* Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.123, n.11, 1867(♀).

Zeleboria xanthorrhoei Sauss., Stett. Ent. Zeit. xxx. p.60, n.10, 1869(♂♀).

♂. Hypopygium deeply and broadly emarginate at the apex.

♀. Pygidium rather broad, vertically truncate posteriorly and longitudinally rugose-striate.

Hab.--Sydney.

21. T. (Glaphyrothynnus) contiguus, n.sp.

♂. Clypeus large, convex, very broadly truncate at apex, with a short carina at base; interantennal prominence very widely V-shaped. Head and thorax finely and closely punctured, scutellum subtriangular, rather narrowly truncate at apex. Median segment rounded, very finely and closely punctured. Abdomen elongate, subpetiolate, flattened, shining, shallowly and closely punctured; first segment with a deep sulcus from base not reaching apex; segments 2-4 slightly depressed at base; segments 1-4 depressed narrowly on apical margin, with a raised mark emarginate posteriorly before apex. Epipygium broadly truncate at apex; hypopygium small, rounded at apex, without a spine. Black; mandibles, clypeus except a median line on basal half, margins of eyes as high as base of antennæ, a line on each side of vertex, margins of pronotum, narrowly interrupted on anterior margin, tegulæ, a large curved mark on mesopleuræ beneath anterior wings, a spot above base of intermediate coxæ, a small spot on scutellum, postscutellum, a large spot on each side of median segment at apex and a small spot on each side of abdominal segments 2-5 yellow. Legs, except coxæ and trochanters, and a minute spot at summit of the eyes ferruginous. Wings hyaline, nervures fuscous. Length 14 mm.

Hab.—Shoalhaven, N. S.W. Type in Coll. Froggatt.

Nearest to *T. xanthorrhoei* Sm., but is slenderer and the divisions between the abdominal segments are more strongly marked.

22. T. (Glaphyrothynnus) marginalis Westw.

Thynnus (Agriomyia) marginalis Westw., Arc. Ent. ii. 2, p.120, P.76, fig.3, 1844(♂).

♂. Clypeus broad and large, convex, with a median longitudinal carina, emarginate at apex. Head rugose. Abdomen rather narrow at base, gradually widened to fourth and fifth segments which are the broadest.

Allied to *T. trifidus* Westw.

♀. Head nearly twice as broad as long, slightly narrowed and rounded posteriorly, shining, finely and shallowly punctured. Thorax shining, finely punctured; pronotum much broader than long; mesonotum very small; median segment short, obliquely truncate posteriorly, sparsely and very finely punctured. Abdomen much broader than thorax, smooth and shining; apical margin of first segment recurved, with a broad depressed area before it; second segment with three transverse carinæ, including the recurved apical margin; third and fourth segments with a raised, curved, punctured mark on each side close to apical margin; pygidium elongate-ovate, the margins elevated at base. Black; antennæ, mandibles and legs dull rufo-testaceous; sides and apical margin of abdominal segments testaceous. Length 9 mm.

Hab.—Albany, W.A. (Brewer); Perth, W.A. (Walker).

Types (♂♀) in Oxford University Museum.

23. T. (Glaphyrothynnus) trifidus Westw.

Thynnus (Agriomyia) trifidus Westw., Arc. Ent. ii. 2, p.119, P.77, fig.4, 1844(♂).

Zeleboria imitatrix Sauss., Reise d. Nov. ii. 1, Hym. p.132, n.3, 1867(♂).

Thynnus imitator Schulz, Spolia Hymenopterologica, p.161, 1906(♂).

I have not seen the type of Saussure's species, but I think his name applies to this form. The maxillary palpi of *T. trifidus*, however, do not seem to differ from those of *T. carinatus*, but I have not been able to dissect the mouth of either species.

Hab.—Albany, W.A. (Westwood).

24. T. (Glaphyrothynnus) carinatus Sm.

Thynnus carinatus Sm., Cat. Hym. B.M. vii. p.29, n.73, 1859(♂).

Zeleboria carinata Sauss., Reise d. Nov. ii. 1, Hym. p.131, n.1, 1867(♂♀).

Zeleboria fusiformis Sauss., *l.c.* p.132, n.2, 1867(♂).

Saussure's descriptions of the sexes of this variable species are sufficient. It is very nearly allied to *T. trifidus* Westw.

Hab.—Stradbroke Isl. (Boreham); Liverpool, N.S.W. (Froggatt; ♂♀ in cop.); Adelaide, S.A. (British Museum, from F. Waterhouse).

25. T. (Glaphyrothynnus) flavescens Sm.

Thynnus (Agriomyia) flavescens Sm., Cat. Hym. B.M. vii. p.68, 1859(♂♀).

♂. Clypeus strongly convex, broadly truncate at apex, sparsely punctured, with a carina from base to apex. Head closely punctured; interantennal carina narrowly V-shaped, produced at apex into a minute tubercle at base of clypeus. Thorax shining and rather sparsely punctured; scutellum large and broadly rounded at apex. Median segment finely and closely punctured. Abdomen elongate, flattened above and beneath, very minutely punctured, apical margins of the segments very narrowly depressed. Hypopygium short, unarmed.

♀. Head much broader than long, rounded posteriorly, smooth and shining. Thorax sparsely punctured; pronotum much broader than long, subconcave above, slightly narrowed posteriorly, the anterior margin straight with a slight elevation in the middle. Median segment closely and finely punctured, short and obliquely truncate posteriorly. Abdomen smooth, with a few scattered punctures; apical margin of first segment not elevated; second segment with three transverse carinæ, including the raised apical margin; third and fourth segments with a raised curved mark on each side. Pygidium very narrow, the sides parallel, a few delicate longitudinal striæ near base, apex slightly recurved.

Hab.—Adelaide, S.A. (Smith).

Very near *T. trifidus* Westw., and *T. carinatus* Sm.

26. T. (GLAPHYROTHYNNUS) SITIENS, n.sp.

♂. Clypeus strongly convex, rather broadly truncate at apex, sparsely punctured, with a delicate carina from base reaching beyond centre. Head rugose, interantennal carina very broadly V-shaped. Thorax sparsely and rather finely punctured, shining; median segment very minutely punctured. Abdomen elongate, slender, shining and very finely punctured; first segment with a very short sulcus at the base; second segment depressed at base; hypopygium narrow, unarmed at apex, with a short, slender spine on each side near base. Black; mandibles, apex and sides of clypeus, margins of eyes as high as base of antennæ, interantennal carina, margins of pronotum narrowly interrupted on anterior margin, tegulæ, a curved mark on the mesopleuræ beneath the anterior wings and a spot above intermediate coxæ, a spot on mesonotum, a spot on centre of scutellum, postscutellum, a narrow curved mark close to apical margin on each side of second and third abdominal segments, a spot on each side of fourth and fifth segments and a line on anterior coxæ and femora beneath yellow; tibiæ and tarsi and a small spot on each side of vertex ferruginous. Wings hyaline, nervures black. Length 9 mm.

Hab.—Western Australia (Du Boulay). Type in Brit. Mus.

27. T. (GLAPHYROTHYNNUS ?) SEDULUS Sm.

Thynnus (*Agriomyia*) *sedulus* Sm., Cat. Hym. B.M. vii. p.35, n.90, 1859(♂).

♂. Clypeus large, broadly produced and truncate at apex, very strongly convex at base, deeply punctured, with a short carina at base. Head punctured on vertex, rugose on front, inter-antennal carina short and broadly V-shaped. Thorax and median segment closely punctured, scutellum rather narrowly truncate at apex; median segment depressed and shining at apex. Abdomen subpetiolate, fusiform, shining and sparsely punctured; second segment depressed at base; segments 2-5 with a slightly raised, curved mark before the depressed apical margin; sides of the segments with long scattered hairs. Hypopygium very short, subtruncate at apex, with a tuft of long curved hairs on each side.

Hab.—Swan River, W.A. (Smith).

I have seen only the type.

Subgenus AEOLOTHYNNUS Ashm.

Aeolothynnus Ashm., Canad. Ent. xxxv. 1903.

♂. Second recurrent nervure received by the third cubital cell very near base; labrum usually short and truncate anteriorly, in a few species long and slightly emarginate at apex; palpi usually rather stout, first joint of the maxillary palpi short, maxillæ more or less bearded on outer margin. Hypopygium very variable, never with more than three spines. Antennæ of even thickness throughout, usually short.

♀. Tarsal ungues simple (except in *Aeol. sannæ*). Second abdominal segment never with more than five transverse carinæ; fifth ventral segment punctured; pygidium contracted, usually with parallel sides.

Type, *Thynnus* (*Agriomyia*) *cerceroides* Sm.

Ashmead gives *Aeol. multiguttatus* Ashm., as the type of his genus, but, as he has not given any description of that species, his name cannot stand. I have therefore selected a species which answers to the generic characters given by him as the type.

28. T. (AEOLOTHYNNUS) WESTWOODI Guér.

Agriomyia westwoodi Guér., Mag. de Zool. xii. p.4, 1842(♂).
Thynnus intricatus Sm., Cat. Hym. B.M. vii. p.30, n.75, 1859(♂).
Thynnus longiceps Sm., Cat. Hym. B.M. vii. p.46, n.132, 1859(♀).
Thynnus nanus Sm., Descr. n.sp. Hym. p.171, n.35, 1879(♂).

♂. Clypeus produced in middle and narrowly truncate at apex; head and thorax closely and finely punctured; pronotum narrower than head, with the anterior margin raised; median segment very finely punctured, smooth at the extreme base, a feeble longitudinal sulcus from base not reaching middle. Abdomen elongate-fusiform, shining and shallowly punctured, and flattened; first segment with a strong sulcus from base not reaching apex; second segment depressed at base, segments 2-5 with apical margin narrowly depressed. Hypopygium small, narrowly produced and truncate at apex, with a short apical spine.

♀. Head as broad anteriorly as long, very much narrowed posteriorly, and very slightly convex. Head, thorax and median segment smooth and shining; pronotum with a short and deep sulcus from anterior margin not reaching middle, much narrower than head, quadrate, the posterior angles slightly raised. Mesonotum very small, rounded and raised. Median segment almost pointed at base, broadened and oblique posteriorly. Abdomen shining with a few sparse punctures; first segment with a raised carina, slightly emarginate in middle; second segment with four transverse carinæ, including the raised apical margin; three following segments with a raised curved mark on each side. Epipygium lanceolate, sides of hypopygium curved upwards forming a groove in which the epipygium rests.

Colour as in Smith's description of *T. longiceps*. Length 5 mm.

Hab.—Tasmania (Lea); Victoria (French); Mittagong, N.S.W. (Froggatt; ♂♀ in cop.).

29. T. (Aeolothynnus) pulchellus Klug.

Thynnus pulchellus Klug, Physik. Abh. Akad. Wiss. Berlin, p.20, n.13, 1840 [1842] (♂).

Thynnus multipictus Sm., Descr. n.sp. Hym. p.160, n.7, 1879 (♂).

♂. Abdomen slender, flattened beneath, the segments not constricted. Hypopygium small, narrow at base, slightly widened to apex where it is truncate with a short apical spine. Colour very variable.

♀. Head subglobose, nearly as long as broad, strongly rounded posteriorly, depressed at base of mandibles, smooth and shining. Thorax and abdomen smooth; pronotum narrower than head, much broader than long, with a depression on middle of anterior margin; median segment very short, obliquely truncate posteriorly. First abdominal segment with the apical margin depressed, and a raised curved mark emarginate in middle just before it; second segment with four transverse carinæ, including the raised apical margin. A raised curved mark, sparsely punctured on each side of third and fourth segments. Pygidium lanceolate, the sides parallel, with a tuft of fulvous hairs on each side before apex. Head and thorax fusco-ferruginous; legs testaceous-brown; abdomen castaneous. Length 4-5 mm.

Hab.—Melbourne to Sydney (♂♀ in cop.).

30. T. (Aeolothynnus) pulcherrimus, n.sp.

♂. Clypeus short, narrowly truncate at apex. Head finely and closely punctured, interantennal prominence not very strongly developed, transverse at apex and divided by a longitudinal sulcus, which extends on the front towards anterior ocellus. Thorax shining, more finely punctured than head; median segment almost smooth, obscurely transversely striated. Abdomen elongate, almost smooth; first segment narrow at base, shorter than in *T. pulchellus*, with a very deep median sulcus from base almost reaching apex; second segment depressed at base. Hypopygium narrow, with almost parallel sides, the apical spine short. Black; mandibles, clypeus, two large spots between antennæ, margins of eyes narrowly interrupted at summit, margins of pronotum, a large quadrate spot on mesonotum, a large spot on scutellum, a transverse line on postscutellum, a large mark almost interrupted in middle on mesopleuræ beneath anterior wings, another beneath and behind posterior wings, a spot on each side at apex of median segment, and a mark on each side at apex of each abdominal segment except the seventh, produced transversely and lunulate on segments 3-6, yellow; a spot on each side of vertex, second and third abdominal segments and legs ferruginous. Wings hyaline, nervures testaceous-brown. Length 9 mm.

♀. Head smooth and shining, much broader anteriorly than long, strongly narrowed posteriorly and slightly convex. Pronotum almost square, with a fine median sulcus from anterior margin to centre. Mesonotum longer than broad, median segment obliquely truncate posteriorly. Abdomen almost smooth, much broader than thorax; first segment narrowly depressed on apical margin; second segment with four transverse carinæ including the raised apical margin. Pygidium narrow, elongate, slightly widened in middle. Head and thorax ferruginous-brown, the median segment black, abdomen and legs testaceous, coxæ, trochanters, and femora fuscous. Length 6 mm.

Hab.—Wattle Flat, N.S.W. (Froggatt; ♂♀ in cop.).

Types in Coll. Froggatt.

The male is very near *T. pulchellus* Klug, almost the only points of difference being the presence of a frontal sulcus and the shape of the basal abdominal segment. The female is quite different, and the correctness of the pairing may be relied upon.

31. T. (Aeolothynnus) quadricarinatus Sauss.

Thynnus quadricarinatus Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.124, n.13, 1867(♀).

I am unable to identify this species, but it seems from the description to be allied to the pulchellus-group.

Hab.—Sydney (Saussure).

32. T. (Aoelothynnus) minutus Sm.

Thynnus (Agriomyia) minutus Sm., Cat. Hym. B.M. vii. p.35, n.92, 1859(♂).

♂. Clypeus produced and very narrowly truncate at apex; interantennal prominence long, bilobed, the lobes separated by a narrow sulcus. Head and thorax finely and closely punctured; median segment shining, very delicately transversely striated, smooth at base. Abdomen slender, shallowly punctured; first segment with a sulcus from base not reaching apex; second segment depressed at base; segments 2-5 with a rather strongly raised curved mark on each side before the depressed apical margin. Hypopygium narrow, truncate at apex, with a small spine, the sides nearly parallel.

Hab.—N.W. Coast of Australia (B.M.).

33. T. (Aeolothynnus) tenuis, n.sp.

♂. Clypeus narrowly produced and truncate at apex. Head very finely rugose, opaque; interantennal prominence small, emarginate at apex. Thorax finely punctured, median segment very delicately punctured. Abdomen elongate, shining, first segment with a deep sulcus from base not reaching apex; segments 1-5 with a raised curved mark on each side before the narrowly depressed apical margin. Hypopygium short, with a fairly strong apical spine, angles at base of spine slightly produced. Black; mandibles and a line on postscutellum whitish; margins of pronotum obscure testaceous; second and third abdominal segments ferruginous; femora fusco-ferruginous; tibiæ and tarsi testaceous. Wings hyaline, iridescent, nervures fusco-ferruginous. Length 6 mm.

Hab —Mackay, Q. (Turner).

Nearest to *T. minutus* Sm.

34. T. (Aeolothynnus) pygmaeus, n.sp.

♂. Clypeus subtriangular, rather short and very narrowly truncate at apex, with a carina from base not reaching apex. Head closely and rather strongly punctured, the interantennal carina V-shaped. Thorax and median segment shining and more finely punctured; pronotum short; scutellum large and broad. Abdomen subpetiolate, very flat, shining and very delicately punctured. Hypopygium small, without an apical spine. Antennæ very short. Black; mandibles, clypeus except at base, margins of eyes narrowly interrupted at summit and on outer margin, interantennal carina, margins of pronotum, tegulæ, a large curved mark on mesopleuræ beneath anterior wings and a spot above base of intermediate coxæ, a spot on scutellum, postscutellum, a large irregular spot on each side of median segment near apex, and a narrow curved mark, broadest on the sides, on each side of abdominal segments 2-5 close to apical margin yellow. Tarsi, tibiæ and apex of femora pale ferruginous. Wings hyaline, iridescent, nervures pale ferruginous. Length 5 mm.

Hab.—Victoria (French).

35. T. (Aeolothynnus) rubromaculatus, n.sp.

♂. Clypeus narrowly produced and truncate at apex, with a delicate carina from near base almost reaching apex. Head and thorax punctured; interantennal carina very broadly V-shaped; scutellum large. Median segment very closely and finely punctured. Abdomen subpetiolate, flat, minutely punctured. Hypopygium small and narrow, without an apical spine. Black; mandibles, sides of the clypeus, interantennal carina, margins of eyes narrowly interrupted at summit, margins of pronotum, tegulæ, two large spots on mesopleuræ, a quadrate spot on mesonotum, scutellum except at base, postscutellum, a longitudinal mark on apical portion of median segment and a round spot on each side of it, and a narrow curved band, broadest on sides, close to apical margin of abdominal segments 2-5 yellow. Apex of first abdominal segment and the whole of second and third segments and legs light ferruginous. Wings hyaline, iridescent, nervures fuscous, stigma testaceous. Length 6-7 mm.

Hab.—Victoria (French); Wattle Flat, N.S.W. (Froggatt).

The scutellum is rather narrower at the apex than in *T. pygmæus*, to which it is nearly allied.

36. T. (Aeolothynnus) innocuus, n.sp.

♂. Clypeus short and not much produced, broadly truncate at apex, with a delicate carina from base not quite reaching apex. Head finely rugose, interantennal carina not developed. Thorax finely and closely punctured; anterior margin of pronotum broadly and slightly emarginate; scutellum rather long, truncate at apex, with an obscure median carina. Median segment very delicately transversely striated. Abdomen short, subpetiolate, shining and shallowly punctured. Hypopygium narrow, truncate at apex and unarmed. Black; mandibles at base and post-scutellum pale yellow; margins of pronotum obscurely testaceous; mandibles at apex, anterior margin and a small spot on centre of clypeus, a spot on each side of vertex, abdomen except the two apical dorsal segments, and legs except coxæ and trochanters ferruginous. Wings hyaline, iridescent, nervures fusco-ferruginous. Length 7 mm.

Hab.—Perth, W.A. Type in Brit. Mus.

37. T. (AEOLOTHYNNUS) GENEROSUS, n.sp.

♂. Clypeus short, narrowly truncate at apex and shallowly punctured. Head finely rugose, interantennal prominence represented only by a small tubercle at base of each antenna, a very delicate, longitudinal, shining carina between antennæ reaching half-way to anterior ocellus. Thorax closely and finely punctured; anterior margin of pronotum straight and very slightly raised; scutellum more strongly punctured, with a faint carina from centre to apex, where it is narrowly truncate. Median segment delicately transversely striated, as broad at base as long. Abdomen elongate-fusiform, shining and shallowly punctured, the segments not constricted; first segment with a sulcus from base nearly reaching apex; second segment depressed at base. Hypopygium truncate at apex, with a small spine. Black; anterior margin of clypeus, a spot at base of mandibles, a minute spot at base of antennæ, anterior margin of pronotum narrowly interrupted, base of tegulæ, a spot on each side of first abdominal segment, and a narrow, curved, transverse mark on each side before apical margin of the four following segments creamy-white; a spot on each side of vertex and legs ferruginous. Wings hyaline, nervures black, stigma fusco-ferruginous. Length 9 mm.

♀. Head smooth and shining, rather broader anteriorly than long, narrowed and rounded posteriorly. Thorax and median segment almost smooth, pronotum as broad as long, with a short and obscure longitudinal sulcus from anterior margin, anterior angles slightly prominent. Mesonotum longer than broad; median segment rather slender, obliquely truncate posteriorly the angles at the base of the truncation rounded. Abdomen shining and sparsely punctured; second segment with four transverse carinæ, including the raised apical margin; first, third, fourth and fifth segments with a raised, strongly rounded mark on each side before apical margin. Fifth ventral segment punctured. Pygidium lanceolate, slightly widened at apex. Entirely lightly ferruginous-brown. Length 6 mm.

Hab.—Adelaide, S.A.

Types in Brit. Mus.

38. T. (Aeolothynnus) penetratus Sm.

Thynnus penetratus Sm., Descr. n.sp. Hym. p.158, n.1,1879(♂).

♂. Clypeus very narrowly truncate at apex, with a delicate carina from base to beyond centre. Head and thorax very finely and closely punctured; scutellum narrowly rounded at apex. Median segment very delicately punctured-rugulose, smooth and shining at base. Abdomen elongate-fusiform, shining and very minutely punctured, flattened. Hypopygium broadly rounded at apex, with a minute spine.

Hab.—Swan River, W.A. (Smith).

Allied to *T. westwoodi* Guér., but the hypopygium is very different, and the scutellum is rounded at the apex, not truncate.

39. T. (Aeolothynnus) beatrix, n.sp.

♂. Clypeus very narrowly truncate at apex, with a delicate carina from base not reaching apex, finely and closely punctured. Head and thorax very closely punctured; interantennal prominence only represented by a short carina above base of each antenna; scutellum rather long, subtriangular, truncate at apex. Median segment rounded, very delicately transversely striated. Abdomen shining and shallowly punctured, fusiform and flattened; second segment depressed at base; epipygium rugose. Hypopygium subtriangular, rounded at apex, with a very short spine.

Black; anterior margin of clypeus, margins of eyes as high as base of antennæ, a spot at base of mandibles, anterior margin of pronotum narrowly interrupted, tegulæ, a small spot on post-scutellum and a narrow curved line on each side of second, third and fourth abdominal segments just before apical margin white, anterior legs fuscous. Wings hyaline, nervures black. Length 10-12 mm.

♀. Head broader anteriorly than long, narrowed and rounded posteriorly, smooth and shining, with a few minute and scattered punctures, a short sulcus between the antennæ; clypeus with a carina from base. Thorax and median segment rather shallowly punctured; pronotum longer than broad; mesonotum small; median segment obliquely truncate posteriorly. Abdomen shining, rather sparsely punctured, first segment with the apical margin slightly raised, broadly depressed before apex, leaving a strong carina curved at the sides before the depression; second segment with four transverse carinæ, including the raised apical margin. Pygidium lanceolate, slightly widened at apex. Fifth ventral segment punctured. Black; head, second abdominal segment, pygidium and legs fusco-ferruginous; the depressed apical portion of the first abdominal segment testaceous. Length 7-10 mm.

Hab.—Woodford, N.S.W. (Waterhouse; ♂♀ in cop.), Leura; Mittagong, N.S.W. (Froggatt; ♂♀ in cop.).

The antennæ of the male are rather longer than in *T. pulchellus.*

40. T. (Aeolothynnus) planiventris, n.sp.

♂. Clypeus narrowly produced and truncate at apex, with a carina from base not quite reaching apex; interantennal carinæ oblique, not meeting at apex. Head and thorax very closely punctured; anterior margin of pronotum straight and slightly raised; median segment delicately rugulose at base, very finely transversely striated at apex. Abdomen subpetiolate, fusiform, flattened above and beneath, almost smooth; first segment with a very short sulcus from base; second segment depressed at base. Hypopygium small, a little broader at apex than at base, subtruncate at apex, the angles a little produced, but not forming spines, apical spine blunt. Black; mandibles at base, extreme apex of clypeus and of interantennal carinæ, anterior margin of pronotum narrowly interrupted, a spot on scutellum, post-scutellum and a large spot on each side of abdominal segments 2-6 pale yellow; a spot on each side of vertex, tegulæ, a large spot at base of second abdominal segment and legs, except coxæ and trochanters ferruginous. Wings hyaline, nervures black. Length 8 mm.

Hab.—Western Australia (Du Boulay). Type in Brit. Mus.

41. T. (Aeolothynnus) decoratus Sm.

Thynnus decoratus Sm., Descr. n.sp. Hym. p.159, n.5, 1879(♂).

♂. Clypeus short and broad, with a small tubercle in centre, narrowly truncate at apex. Head and thorax shining, finely and closely punctured; interantennal carina broadly V-shaped, interrupted at apex by a smooth longitudinal line. Anterior margin of pronotum raised and slightly emarginate; scutellum rather long and truncate at apex. Median segment very delicately transversely striated, almost smooth at base. Abdomen flattened, fusiform, very delicately punctured and shining; first segment with a sulcus from base reaching nearly to apex; second segment depressed at base; segments 2-5 depressed on apical margin, with a raised curved mark narrowly emarginate posteriorly before apex. Hypopygium ending in three spines, the central spines strong, those at the apical angles very short.

Hab.—Adelaide, S.A. (Smith).

42. T. (Aeolothynnus) sodalis, n.sp.

♂. Clypeus very narrowly truncate at apex, very finely punctured. Head and thorax shining, rather closely punctured, interantennal prominence bilobed, the lobes long and separated by a narrow frontal sulcus; pronotum short, anterior margin raised, broadly but slightly emarginate; scutellum rather broadly subtruncate at apex. Median segment shining, very delicately transversely striated. Abdomen flattened, fusiform, very minutely punctured; basal segment short, second segment depressed at base; apical margin of the segments depressed, with a raised curved mark on each side. Hypopygium short and small, truncate at apex, with a short spine. Black; vertex, apex of scutellum, legs except coxæ and trochanters, and abdomen except a spot at base of first segment light ferruginous; clypeus, interantennal prominence, margins of eyes interrupted at summit, margins of pronotum, a spot on mesonotum, tegulæ and a line above them, a large curved mark on mesopleuræ, a spot on scutellum, postscutellum, a large spot on median segment, almost divided in middle, a spot on each side near apex, and a spot at apex of coxæ yellow. Length 6 mm.

Hab.—Adelaide, S.A. (F. Waterhouse). Type in Brit. Mus.

Near *T. decoratus* Sm., but the basal abdominal segment is shorter and without the deep longitudinal sulca. The hypopygium and interantennal prominence also differ.

43. T. (Aeolothynnus) mackayensis, n.sp.

♂. Clypeus moderately advanced and rather narrowly truncate at apex; interantennal prominence bilobed, divided by a short longitudinal sulcus. Head and thorax very closely and finely punctured, scutellum short. Median segment rounded, depressed at apex, very finely punctured, smooth at base. Abdomen subpetiolate, slender, fourth segment the broadest; basal segment shining, long and narrow, gradually widened to apex, with a sulcus from base nearly reaching apex; second segment shining, minutely punctured; the remaining segments subopaque, very finely and closely punctured. Hypopygium not very broad, sides almost parallel, rounded at apex, with a short apical spine. Black; mandibles, clypeus, inner margin of eyes broadly, a small spot at base of each antenna, anterior margin of pronotum narrowly interrupted, a small mark on posterior margin before base of wing, a spot in centre and a smaller one at each of anterior angles of scutellum, postscutellum, a spot on mesopleuræ, apical half of median segment interrupted by a narrow black line, a spot on each side of first and third abdominal segments near apical angles, and a transverse band on second segment yellow; a spot on each side of vertex ferruginous. Wings hyaline, radial cell subfuscous, nervures fuscous. Length 11 mm.

♀. Head broader anteriorly than long, very strongly narrowed posteriorly, shining, very minutely punctured, a short longitudinal sulcus between antennæ. Pronotum subquadrate, very delicately and closely punctured, a row of large setigerous punctures along anterior margin. Median segment more sparsely punctured, obliquely truncate posteriorly. First abdominal segment with a raised curved mark on each side before the broadly depressed apical margin; second segment with four transverse carinæ, including the raised apical margin; the three following segments sparsely punctured, with the apical margin narrowly depressed. Pygidium deflexed, narrowly ovate, with a tuft of golden hairs on each side springing from beneath epipygium. Black; head ferruginous; legs, second abdominal segment and pygidium fusco-ferruginous. Length 7 mm.

Hab.—Mackay, Q. (Turner; ♂♀ in cop.).

The colour in the male is most variable, the yellow markings in some specimens being almost entirely absent, and in others more extensive than in the type.

44. T. (Aeolothynnus) polybioides, n.sp.

♂. Clypeus rather strongly convex, produced, and broadly truncate at the apex. Head and thorax finely and closely punctured; the anterior margin of the pronotum straight and rather strongly raised; the scutellum sparsely punctured. Median segment rounded, very finely and shallowly punctured, smooth at the extreme base. Abdomen slightly fusiform, the segments not much constricted, segments 2-4 with a lightly impressed transverse line near the base, the apical margin narrowly depressed. Hypopygium truncate at the apex, with an apical spine. Black; the mandibles, clypeus, a minute spot at the base of each antenna, the margins of the pronotum broadly, narrowly interrupted in the middle on the anterior margin, a large spot on the mesopleuræ below the anterior wings and a smaller one above the base of the posterior coxæ, the tegulæ, a quadrate spot on the mesonotum, a large spot in the middle and a small one at each of the anterior angles of the scutellum, the postscutellum, a broad curved mark on each side of the median segment, a broad band narrowly emarginate posteriorly on the second abdominal segment, an interrupted band on the first, third and fourth segments, a large spot on each side of the fifth, a triangular spot at the apex of the first ventral segment and a band emarginate posteriorly on ventral segments 2-4 yellow; the legs ferruginous. Wings hyaline, nervures fusco-ferruginous. Length 10 mm.

Hab.—S. Australia; Wimmera, Vic. (French). Type in Brit. Mus.

45. T. (Aeolothynnus) optimus Sm.

Thynnus optimus Sm., Cat. Hym. B.M. vii. p.29, n.74, 1859(♂).

♂. Clypeus moderately produced, rather broadly truncate at apex, narrowly truncate at base. Head and thorax finely and closely punctured; interantennal prominence emarginate and not much developed; scutellum sparsely punctured; median segment almost smooth, much longer than broad. Abdomen elongate, flattened; segments 2-5 with a very faint transverse line near base and the apical margin slightly depressed, most broadly so in middle; hypopygium narrowly truncate at apex, with an apical spine.

Hab.—Swan River, W.A. (Smith).

46. T. (Aeolothynnus) sulcatus Sm.

Thynnus sulcatus Sm., Cat. Hym. B.M. vii. p.42, n.117, 1859(♀).

♀. Head a little broader anteriorly than long, slightly narrowed posteriorly, smooth and shining, the front broadly prominent, with a deep depression on each side, vertex sparsely punctured. Pronotum much broader than long, subrectangular. Second abdominal segment with four transverse carinæ, including the recurved apical margin. Pygidium lanceolate, sides of the hypopygium expanding a little towards apex.

Hab.—Swan River.

A specimen, apparently the type, in the British Museum is in very bad condition and does not admit of any detailed description.

47. T. (Aeolothynnus) jardinei, n.sp.

♂. Clypeus short, produced anteriorly and rather broadly truncate at apex. Head and thorax very finely and closely punctured; anterior margin of pronotum raised and straight; scutellum broadly truncate at apex. Median segment shining, rounded, and more sparsely punctured. Abdomen elongate, slender; segments 2-5 with an impressed line near base above and beneath, apical margin depressed, with a raised mark slightly emarginate in middle just before it; ventral segments 3-5 subtuberculate at apical angles. Hypopygium ending in an elongate triangular spine with a short spine on each side of base. Black; mandibles except extreme apex, clypeus, a large spot between antennæ, margins of pronotum, united in middle, tegulæ and a small spot above them, a quadrate spot on mesonotum, a large spot on scutellum and a small one at each of its basal angles, postscutellum, mesopleuræ, apex and sides of median segment, a broad transverse band close to apical margin of the first five abdominal segments above and beneath, narrower on fourth and fifth segments beneath, sixth dorsal segment and legs yellow; scape of antennæ and epipygium fulvous. Wings iridescent hyaline, nervures black, stigma ferruginous. Length 9 mm.

Hab.—Cape York, Q. (Turner).

48. T. (Aeolothynnus) bembeculus, n.sp.

♂. Clypeus broad and short, rather narrowly produced and truncate at apex. Head finely punctured-rugose. Thorax and median segment finely and closely punctured; pronotum short and depressed, anterior margin not elevated; scutellum rather prominent, with a depressed transverse row of punctures at base; median segment rounded, much broader than long. Abdomen elongate, depressed at apex, apical margin of segments 2-5 very narrowly depressed, the same segments with a feebly impressed, transverse line near base. Hypopygium triangular, produced into an acute spine. Black, with white pubescence on head and thorax; clypeus, mandibles except at apex, two short oblique lines between antennæ, margins of pronotum narrowly, tegulæ and an oblique line above them, a longitudinal median line on posterior half of mesonotum, a spot in middle and one at each of the anterior angles of scutellum, a transverse line on postscutellum and an oblique spot on each side of it, a small spot near middle of median segment, a rather larger one at apex and one on each side, three small spots on mesopleuræ, a transverse spot on each side of first abdominal segment and an interrupted narrow band near apical margin of segments 2-6 above and beneath emarginate posteriorly creamy-white; pronotum, disc of mesonotum and scutellum, mesopleuræ and legs ferruginous. Length 9 mm.

Hab.—Cooktown, Q. (Turner).

Taken in October flying with a colony of Bembex.

It seems to be allied to *T. excellens* Sm., but there are many points of difference.

49. T. (Aeolothynnus) productus, n.sp.

♂. Clypeus short, produced and rather broadly truncate anteriorly; interantennal prominence raised on each side into an elevated carina on inner side of scape of antennæ. Head finely punctured-rugose, with grey pubescence on front. Thorax and median segment closely punctured, scutellum broad and short, median segment depressed. Abdomen elongate-fusiform, finely and sparsely punctured, segments 2-5 with a very feebly impressed transverse line near base. Hypopygium produced into an elongate spine, stout at base, with a small spine on each side. Black; mandibles, clypeus, interantennal carinæ, margins of pronotum, tegulæ and a line above them, mesopleuræ in front, a quadrate mark on mesonotum, a transverse spot on scutellum and a small one at each of its basal angles, postscutellum, a spot at apex of median segment and a longitudinal mark on each side of it, a narrow curved band strongly emarginate posteriorly on each side of first abdominal segment, a broader band on segments 2-6 narrowly interrupted in middle and emarginate on apical margin on each side and an interrupted band on segments 2-5 beneath pale yellow; legs, except coxæ and trochanters pale ferruginous. Wings hyaline, nervures black, stigma testaceous. Length 9 mm.

Hab.—N.W. Australia (French).

50. T. (Aeolothynnus) coloratus, n.sp.

♂. Clypeus short, rather broadly truncate at apex and finely punctured. Head finely and closely punctured, interantennal prominence broadly V-shaped. Thorax finely and closely punctured; pronotum with anterior margin raised, obliquely truncate in middle below the raised margin, causing the segment to appear broadly emarginate anteriorly. Median segment much broader than long, rounded, very closely and finely punctured, with a smooth mark on each side at base. Abdomen elongate, finely and shallowly punctured; segments 2-5 with an impressed transverse line near base, and apical margin very narrowly depressed. Hypopygium ending in three acute spines, the central spine much the longest. Black; mandibles, clypeus, an oblique line on each side between antennæ, pronotum with a small black spot on middle and a large one on each side, a quadrate spot on mesonotum, tegulæ, a large spot on mesopleuræ beneath anterior wing and another smaller one behind it, middle of scutellum and a spot at each of anterior angles, a longitudinal mark from apex of median segment reaching beyond middle, with a large spot on each side at apex, a narrowly interrupted transverse band near apex of the six basal abdominal segments above and a spot at apex of coxæ bright yellow; legs, except coxæ and trochanters pale ferruginous marked with yellow. Wings hyaline, nervures fuscous. Length 9-10 mm.

♀. Head small, smooth and shining, rather broader anteriorly than long, much narrowed posteriorly; with a deep and large excavation on each side from eye to base of antennæ, reaching much higher than eye. Thorax very narrow; pronotum much longer than broad, with a strong, longitudinal, median carina. Median segment very short, obliquely truncate from just behind mesonotum. Abdomen smooth, much broader than thorax;

apical margin of first segment depressed, with a transverse carina before it; second segment with four transverse carinæ, including the raised apical margin; segments 3-5 with a feebly raised, curved mark on each side before apical margin. Pygidium very narrow, deflexed posteriorly and very slightly widened to apex. Pale ferruginous-brown, posterior half of pronotum, mesonotum, dorsal segments of abdomen, except the raised marks and carinæ, and tibiæ pale testaceous-yellow. Length 4-5 mm.

Hab.—Mackay, Q. (Turner; ♂♀ in cop.).

51. T. (Aeolothynnus) tasmaniensis Sauss.

Thynnus (*Agriomyia*) *tasmaniensis* Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.119, n.6, 1867(♂).

♂. Saussure's description is sufficient. All specimens I have seen from the mainland have yellow marks on the fifth segment of the abdomen as well as on the four basal segments.

♀. Head subquadrate, very slightly narrowed behind eyes, smooth and shining, with a depression on each side between eye and base of antennæ which are inserted very near together. Thorax and median segment smooth and shining; pronotum a little narrower than head, rather broader than long, depressed anteriorly, centre raised and subtuberculate. Mesonotum very narrow; median segment broadened from base, obliquely truncate posteriorly, angles at base of truncation rounded, surface of the truncation delicately punctured. First abdominal segment raised on apical margin, with a groove before it, giving the appearance of a transverse carina before apex; second segment with three transverse carinæ and apical margin raised; segments 3-5 delicately aciculated at base, sparsely punctured at apex, with a slightly raised curved mark on each side before apical margin. Pygidium lanceolate, epipygium very narrow and deflexed to apex, margins of hypopygium reflexed near apex, causing a slight widening of pygidium. Ferruginous; abdomen stained with fuscous-brown. Length 5-6 mm.

Hab.—Tasmania (Saussure); Sydney, N. S.W.

Type of ♀ in Oxford University Museum.

52. T. (Aeolothynnus) conjungens, n.sp.

♂. Very near *T. tasmaniensis* Sauss., from which it differs in having a delicate carina on the basal portion of the clypeus. There is an interrupted yellow band on the fifth and sixth as well as on the four basal abdominal segments; the nervures of the wings are paler. It is also a smaller species. Length 9 mm.

♀. Head smooth and shining, much longer than broad, rounded at posterior angles, sides nearly parallel, eyes rather prominent. Thorax very narrow, almost smooth; pronotum about twice as long as broad, sides nearly parallel, raised and subterculate in middle near posterior margin, with a few setigerous punctures on anterior margin. Median segment very short and narrow, obliquely truncate posteriorly. The abdomen is damaged, but the pygidium does not differ from that of *T. tasmaniensis*, nor apparently does the rest of the abdomen. The colour is entirely testaceous, but the specimen is probably immature. Length 4 mm.

Hab.—Mackay, Q. (Turner; ♂♀ in cop.).

I should have regarded the male merely as a local form of *T. tasmaniensis*, but the shape of the head and thorax of the female is very different.

53. T. (Aeolothynnus) zelebori Sauss.

Thynnus (*Agriomyia*) *zelebori* Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.117, n.2, 1867(♂).

Saussure's description of the male is sufficient.

♀. Head smooth and shining, much longer than broad, the sides strongly compressed and concave, antennæ inserted close together, eyes touching base of mandibles. Thorax and median segment sparsely and finely punctured; pronotum rectangular, a little longer than broad, with a longitudinal sulcus on each side, leaving a raised area in centre, the lateral margins rather irregularly raised. Median segment short, narrow at base, broadened and obliquely truncate posteriorly. Abdomen rather broader than thorax; first segment depressed on apical margin, leaving a curved carina before apex; second segment with five transverse carinæ, including the raised apical margin; the remaining segments sparsely punctured. Pygidium lanceolate, the lateral margins raised and diverging slightly to apex, with a tuft of hairs on each side. Black; head, prothorax and legs ferruginous. Length 7 mm.

Hab.—Sydney (Saussure); Blue Mts., Woodford (Waterhouse); Leura (Froggatt; ♂♀ in cop.).

Allied to *T. truncatus* Sm.

54. T. (Aeolothynnus) truncatus Sm.

Thynnus (*Agriomyia*) *truncatus* Sm., Cat. Hym. B.M. vii. p.38, n.100, 1859(♂).

♂. Clypeus long, rather narrowly truncate anteriorly, punctured, pointed at base and almost touching interantennal prominence, which is rounded at apex and not much developed; a short, delicate longitudinal carina on front, extending onto base of clypeus. Head and thorax closely and finely punctured; anterior margin of pronotum slightly raised, with a groove behind it; scutellum subtriangular, depressed at base, prominent at apex, sparsely punctured, with an almost obsolete median carina from near base to apex. Median segment rounded, very finely punctured, almost smooth at base. Abdomen elongate, shining, almost without punctures; segments 2-5 moderately constricted near base, apical margin narrowly depressed, leaving a raised area emarginate in middle just before margin. Hypopygium truncate at apex, with a short apical spine; sometimes with the angles slightly prominent. Black; margin of clypeus at sides, a spot at base of mandibles, a short narrow line on each side of anterior margin of pronotum, absent in some specimens, and a transverse line on postscutellum creamy-white. Wings hyaline, nervures black. Length 10-11 mm.

Hab.—Lower Plenty (Bakewell); Victoria (French).

The type is lost.

55. T. (Aeolothynnus) iridipennis Sm.

Thynnus (*Agriomyia*) *iridipennis* Sm., Cat. Hym. B.M. vii. p.38, n.99, 1859(♂♀).

Thynnus strangulatus Sm., Descr. n.sp. Hym. p.166, n.22, 1879(♂♀).

♂. Clypeus produced and rather narrowly truncate at apex, strongly punctured, with a short carina from base not reaching centre. Head shining, very closely punctured. Thorax shining, finely and sparsely punctured, anterior margin of pronotum straight and raised; scutellum strongly elevated in centre, oblique anteriorly. Median segment smooth and shining at base, finely punctured at apex. Abdomen elongate, segments constricted at base, the apical margin very narrowly depressed; sparsely punctured and shining. Epipygium narrow at apex, the apical margin slightly raised; hypopygium ending in a slightly recurved apical spine.

♀. Head smooth and shining, with a few punctures on front, a little broader anteriorly than long, narrowed behind eyes, clypeus with a median carina. Thorax finely and sparsely punctured; pronotum nearly twice as broad anteriorly as long, a little narrowed posteriorly. Median segment smooth, oblique from mesonotum. Abdomen almost smooth; second segment with four transverse carinæ, including the raised apical margin. Pygidium narrow, the sides, as far as can be seen, nearly parallel.

Hab.—Adelaide, S.A. (Smith); Lower Plenty, Vic. (Bakewell).

The type of *T. iridipennis* is lost, but a male in the British Museum answers well to the description, and does not differ appreciably from the type of *T. strangulatus*, except in the coloured markings. Smith says that the female of *T. iridipennis* has only two carinæ on the second abdominal segment, but the basal carina in the allied species is so often covered by the apex of the first segment that he might easily have been mistaken. The type of the female of *T. strangulatus* is damaged on the abdomen.

56. T. (Aeolothynnus) dispersus, n.sp.

♂. Clypeus narrowly truncate at apex, smooth, finely punctured at base. Head and thorax closely punctured; anterior margin of pronotum straight and slightly raised; scutellum not much elevated. Median segment shining, almost smooth at base, delicately transversely-rugulose at apex. Abdomen elongate, finely punctured; the segments smooth at base and slightly constricted, apical margin narrowly depressed. Hypopygium subtruncate at apex, angles slightly produced but not forming spines, apical spine acute. Black; clypeus except base and centre, two minute spots between antennæ, margins of pronotum, tegulæ, a spot on scutellum, postscutellum, a small spot on mesopleuræ, another at base of intermediate coxæ, a small spot on each side of first abdominal segment and a transverse spot on each side of the four following segments close to apical angles pale yellow; tibiæ ferruginous. Wings hyaline, iridescent, nervures fuscous, stigma ferruginous. Head and thorax with thin grey pubescence. Length 8 mm.

Hab.—Victoria (French).

Allied to *T. iridipennis* Sm.

57. T. (Aeolothynnus) collaris Guér.

Lophocheilus collaris Guér., Mag. de Zool. xii. p.13, 1842(♂).

?*Tachynomyia nitens* Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.125, n.2, P.4, fig.65, 1867(♂).

♂. Clypeus narrowly produced and truncate at apex. Median segment delicately transversely rugulose. Fourth and fifth abdominal segments the widest; hypopygium elongate, narrowly truncate at apex, with a fairly long apical spine. Saussure mentions a spine on each side of the apical spine, but although I have seen the angles slightly produced in one specimen, they could not be said to form spines. In the specimens I have seen the yellow band on the posterior margin of the pronotum is only developed on the sides. Guérin's description is very poor and I am doubtful as to the correctness of my determination. Length 9 mm.

Hab.—Victoria (French).

A specimen from the Blue Mts., has the wings fusco-hyaline and measures 11 mm.

58. T. (Aeolothynnus) rostratus, n.sp.

♂. Clypeus much produced, truncate at apex, finely punctured, with a delicate, short carina at base, and a shining line from end of carina to apex. Head finely and closely punctured, with a narrow shining line from anterior ocellus to base of clypeus. Thorax and median segment delicately punctured; pronotum narrower than head, with the anterior margin straight and raised; median segment short and obliquely depressed. Abdomen elongate-fusiform, finely and sparsely punctured; segments 2-5 with an impressed transverse line near base, apical margin narrowly depressed, leaving a raised transverse mark before apex. Hypopygium truncate at apex, with a short spine. Black; abdomen piceous; margins of clypeus at sides, two small spots between antennæ, base of the mandibles, margins of pronotum, tegulæ, a small spot on scutellum, a transverse line on postscutellum, and a spot on each side of second, third and fourth abdominal segments pale dull yellow. Legs fusco-ferruginous. Wings hyaline, nervures brown. Length 10 mm.

Hab.—Victoria (French).

59. T. (Aeolothynnus) arenicolus, n.sp.

♂. Clypeus very long, produced into a beak, narrowly truncate at apex, punctured and with an obscure carina from base to apex, strongly convex. Head, thorax and median segment finely and closely punctured; a shallow sulcus reaching from below anterior ocellus to base of clypeus. Median segment rounded, almost smooth at base. Abdomen elongate, very sparsely punctured; segments 2-5 with an impressed transverse line near base; epipygium subtruncate, apical angles prominent. Second and third ventral segments tuberculate at apical angles. Hypopygium ending in a long and stout black spine, with a small white spine on each side at its base. Black; mandibles at base, lateral margins of clypeus, margins of pronotum, tegulæ, a spot on scutellum, postscutellum, a spot on each side near apex of the median segment and a transverse spot on each side of the five basal abdominal segments near apical margin dull testaceous-yellow. Wings hyaline, nervures black, stigma testaceous. Length 8 mm.

Hab.—Killalpanima, S.A., east of Lake Eyre (H. J. Hillier). Type in Brit. Mus.

60. T. (Aeolothynnus) combustus Sm.

Thynnus (*Agriomyia*) *combustus* Sm., Cat. Hym. B.M. p.32, n.83, 1859(♂).

♂. Clypeus very much produced, subtriangular, rather narrowly truncate at apex. A delicate longitudinal carina from a little below anterior ocellus to base of clypeus. Head and thorax closely and finely punctured, pronotum a little narrower than head, the anterior margin elevated; scutellum prominent; median segment short and obliquely depressed, shining and very delicately punctured. Abdomen shining with minute punctures, slender, third segment a little the broadest; segments 2-5 constricted at base, with the apical margin slightly depressed. Hypopygium broadly rounded at apex, with a short apical spine.

Hab.—Adelaide, S.A.

61. T. (Aeolothynnus) pavidus Sm.

Thynnus pavidus Sm., Descr. n.sp. Hym. p.166, 1879(♂♀).

♂. Clypeus broad and short, narrowly produced and truncate anteriorly, closely punctured. Head rugulose; interantennal prominence bilobed, with a very short and delicate median carina. Thorax finely and closely punctured; scutellum rather prominent, with a depressed, transverse row of large punctures at base. Median segment very delicately transversely striated, almost smooth at base, with a longitudinal sulcus from base not quite reaching apex. Abdomen elongate-fusiform, shining, very shallowly punctured; segments 2-5 with a faintly impressed transverse line near base and a slightly raised curved mark on each side before apex. Hypopygium ending in three spines, the central spine long and curving upwards at apex, the other spines short. There is a ferruginous spot on each side of the vertex, otherwise the colour is well described by Smith.

♀. Head a little longer than broad, smooth and shining, strongly convex, the sides compressed anteriorly and concave. Thorax and median segment narrower than head, sparsely punctured; pronotum a little broader than long; median segment oblique from mesonotum. Abdomen sparsely punctured, second segment with four well marked transverse carinæ, including the recurved apical margin. Pygidium narrow, lanceolate, truncate posteriorly, the margins raised. Length 7 mm.

Hab.—S. Australia (Smith).

62. T. (Aeolothynnus) excellens Sm.

Thynnus excellens Sm., Descr. n.sp. Hym. p.163, n.14, 1879(♂).

♂. Clypeus broadly truncate at apex, moderately produced, convex, with a delicate carina from base to middle, broadly connected with the interantennal prominence which is emarginate anteriorly and not much developed. Head delicately rugulose, with a short, fine, longitudinal carina between antennæ. Thorax finely and closely punctured; anterior margin of pronotum straight and slightly raised; scutellum prominent at apex, obliquely depressed from middle to base, with a transverse row of large punctures at extreme base. Median segment rounded, delicately rugulose, almost smooth at base. Abdomen elongate, almost smooth; segments 2-5 depressed at base above and below; hypopygium ending in a long, slightly recurved spine, with a very short spine on each side. Wings hyaline, nervures testaceous at base, black at apex.

Hab.—Swan River, W.A. (Smith).

63. T. (Aeolothynnus) excelsus, n.sp.

♂. Clypeus moderately produced, narrowly truncate at apex, with a delicate carina from base to middle, connected by a narrow carina with the interantennal prominence which is not emarginate.

Head closely and deeply punctured, the carina from the clypeus continued on front, not reaching anterior ocellus; front and clypeus clothed with short white pubescence. Thorax and median segment closely punctured, scutellum prominent at apex, obliquely depressed at base. Abdomen elongate, sparsely and shallowly punctured, segments 2-5 with an impressed transverse line near base; hypopygium with a long apical spine and a short spine on each side. Black; disc of mesonotum, apex of scutellum and the six apical abdominal segments ferruginous; mandibles except at apex, clypeus except the carina, two short oblique lines between antennæ, margins of pronotum, tegulæ, a small spot on mesopleuræ, a longitudinal line from middle of mesonotum to posterior margin and one on each side reaching from tegulæ to angles of scutellum, a spot in middle and one on each side at anterior angles of scutellum, margin of scutellum at sides, postscutellum, a transverse mark in middle of median segment narrowly connected with a spot at apex, a transverse mark on each side of the first five abdominal segments near the apical margin and a spot at apex of femora creamy-white. Length 10 mm.

Hab.—Port Darwin (Walker). Type in Brit. Mus.

Very near *T. excellens* Sm., but the clypeus is much narrower at the apex, the head and thorax are much more strongly sculptured and the abdominal segments are not as strongly depressed at the base. There is much more pubescence on the head and thorax, and the colour differs considerably.

64. T. (AEOLOTHYNNUS) DIMIDIATUS Westw.

Thynnus (*Thynnoides*) *dimidiatus* Westw., Arc. Ent. ii. 2, p.121, P.76, fig.5, 1844(♂).

Thynnus heinricheri D.T., Cat. Hym. viii. 108, 1897.

♂. Anterior margin of pronotum straight, as broad as head; median segment rounded, a little broader than long. Abdomen elongate; hypopygium ending in three long, acute spines, the central spine very long and slightly recurved. Black; abdomen except the basal segment ferruginous.

Hab.—Albany, W.A. (Westwood).

65. T. (AEOLOTHYNNUS) CRABRONIFORMIS Sm.

Thynnus (*Agriomyia*) *crabroniformis* Sm., Cat. Hym. B.M., p.37, n.97, 1859(♂).

♂. The type has the second abdominal segment shining and sparsely punctured; and the median segment is wholly black, differing in these particulars from all the specimens I have taken in the Cairns district, of which I give a description. The species closely resembles a Cerceris.

Var. OPACIVENTRIS, n.var.

♂. Clypeus produced and rather narrowly truncate at apex; coarsely punctured. Head and thorax opaque, punctured rugose, scutellum punctured, short and strongly convex, broadly truncate at apex. Median segment shining, finely and closely punctured, with a smooth patch on each side at base. Abdomen fusiform, very closely punctured, with fine pubescence on apical half of all the segments except the basal and apical; basal segment shining, smooth, with a few large punctures at extreme apex, and with a sulcus from base not reaching apex; segments 2-5 constricted at base. Epipygium rugose, subtruncate at apex, the margin slightly raised, with prominent angles. Hypopygium rather narrow at apex, with a stout apical spine between two small spines. Black; sides of the clypeus, interior margin of eyes broadly, a spot at base of each antenna, anterior margin of pronotum narrowly interrupted, tegulæ, a spot on mesopleuræ, a small spot in the centre and one at each of the anterior angles of scutellum, post-scutellum, a longitudinal spot at apex and a spot on each side of median segment, first abdominal segment, a spot on each side of second, the whole of fifth and sixth segments and the posterior tibiæ and tarsi yellow; first abdominal segment in middle and at apex, antennæ, anterior and intermediate tibiæ and tarsi and apex of posterior tibiæ ferruginous. Wings hyaline, faintly tinged with yellow, nervures ferruginous. Length 10-12 mm.

♀. Clypeus narrowly advanced and with a carina from base. Head finely and sparsely punctured, with a strongly longitudinal sulcus between antennæ, strongly rounded at posterior angles, nearly twice as broad in front as long. Pronotum much narrower than head, almost smooth, narrowed posteriorly, as long as the breadth on the anterior margin, which is straight, the surface flattened, with a longitudinal median carina and the lateral margins slightly raised, the anterior angles subtuberculate and with a few long hairs. Median segment punctured, very short, obliquely truncate posteriorly. Abdomen much broader than thorax, sparsely punctured; first segment with a carina before apex, a fringe of long hairs springing from below carina; second segment with three transverse carinæ and the apical margin raised; the three following segments with a raised curved mark on each side before the depressed apical margin. Pygidium narrow, truncate posteriorly, with a longitudinal median carina not reaching apex, lateral margins raised, a little expanded at apex. Pale ferruginous; the front of head, third and fourth abdominal segments at apex and posterior tibiæ pale yellow; median segment and base of third, fourth and fifth abdominal segments black. Length 6-7 mm.

Hab.—Cairns, Q. (Turner; ♂♀ in cop.).

The type has no definite locality attached, but probably is from a more southern locality than the variety. The colour is utterly unreliable in both sexes of the variety; I have taken a male in which the vertex, mesonotum, third abdominal segment and the base of the fourth alone are black. The clypeus in the variety is a little more produced than in the type.

A variety somewhat intermediate between this form and the type has been named *Thynnus praepes* by Colonel Bingham (MS.). These forms may prove to be distinct species when the females are discovered, but in the meantime it is better to treat them as varieties.

66. T. (Aeolothynnus) bipartitus, n.sp.

♂. Clypeus short, truncate at apex and closely punctured; interantennal prominence not much developed, connected with base of clypeus by a narrow carina. Head, thorax, and median segment finely and closely punctured; scutellum elevated and strongly convex, broadly truncate at apex; median segment rounded, with a smooth area on each side near base. Abdomen shining with a few scattered punctures; segments 2-5 with an impressed transverse line near base; second and third segments more strongly depressed at the base than the others; the apical margin of all the segments narrowly depressed, most broadly in middle. Hypopygium ending in three acute spines, the central spine stout at base and much the longest. Black; base of mandibles, clypeus except a small black spot before apex, margins of pronotum, tegulæ, mesopleuræ in front, a longitudinal spot in middle of posterior half of mesonotum, a spot on each side at anterior angles of scutellum, postscutellum, a curved spot on sides of median segment and a small spot at apex, a spot on each side of first abdominal segment, a narrow transverse band on each side of the five following segments, broadly interrupted on second, narrowly on the others, and a spot on each side of segments 2-5 beneath dull yellow; tibiæ and tarsi ferruginous, the tibiæ marked with pale yellow. Wings hyaline, nervures black, stigma ferruginous. Length 13 mm.

♀. Head sparsely punctured, longer than wide, much narrowed posteriorly, strongly flattened, the antennæ inserted far apart, the front between them bilobed, a smooth and slightly convex area in middle above base of antennæ, eyes situated close to base of mandibles, margins of the head rather broadly expanded below them. Thorax sparsely punctured; pronotum longer than broad, with a strongly raised blunt tubercle in middle, anterior margin straight, with a few large setigerous punctures, the angles subtuberculate. Median segment more closely and finely punctured, obliquely truncate posteriorly. Abdominal segments aciculated at base, very sparsely punctured at apex; first segment truncate anteriorly, the apical margin slightly raised, with a broad groove before it, giving the appearance of a transverse carina before apex; second segment with five strong transverse carinæ, including the raised apical margin. Pygidium narrow, lanceolate, the sides parallel, with a longitudinal carina and with a tuft of golden hairs on each side before apex. Ventral segments very strongly punctured, almost smooth at base. Entirely fuscous. Length 7 mm.

Hab.—Cairns and Mackay, Q. (Turner; ♂♀ in cop.).

67. T. (Aeolothynnus) cygnorum, n.sp.

♂. Clypeus short and truncate at apex; a short, oblique carina on each side above and between the base of the antennæ. Head, thorax and median segment finely and closely punctured; anterior margin of pronotum straight; scutellum elevated and strongly convex, subtriangular, and narrowly truncate at apex. Abdomen elongate, rather sparsely punctured; segments 2-5 with an impressed transverse line near base, the apical margin of the same segments slightly and very narrowly depressed, second and third segments more strongly depressed at base than the others; apical margin of basal segment narrowly depressed, most broadly so in middle. Hypopygium narrowly subtruncate at apex, apical angles slightly produced, apical spine very strong. Black; base of mandibles, clypeus, except a large black spot in centre narrowly continued to base, interantennal carinæ, margins of pronotum, tegulæ, a very small spot in centre of scutellum, a spot on each side of first abdominal segment, a narrow transverse band on each side of the three following segments above and beneath, and on fifth segment above pale dull yellow; legs, except coxæ and trochanters, ferruginous. Wings hyaline, tinged with fuscous, nervures black, stigma ferruginous. Length 12 mm.

Hab.—Champion Bay, W.A. (Du Boulay). Type in Brit. Mus. Closely allied to *T. bipartitus*.

68. T. (Aeolothynnus) quadratus Sm.

Thynnus quadratus Sm., Cat.Hym.B.M.vii.p.42,n.116,1859(♀).

♀. Head subrectangular, much broader than long, almost smooth, and hardly at all convex. Pronotum depressed anteriorly, nearly twice as broad as long, sparsely punctured, with a longitudinal carina from middle to posterior margin and a few long hairs at anterior angles. Median segment closely and finely punctured, almost vertically truncate posteriorly. Abdomen almost smooth; first segment with a raised curved mark on each side before apex; second segment with three transverse carinæ and the apical margin slightly raised. Pygidium very narrow, deflexed and very slightly widened to apex.

Hab.—N.W. Coast of Australia.

The type is in very poor condition.

69. T. (Aeolothynnus) sannæ, n.sp.

♂. Clypeus broad, not very much produced, broadly subtruncate at apex, strongly convex, coarsely punctured and with an obscure carina from base to apex. Thorax and median segment closely and finely punctured; anterior margin of pronotum straight, and not elevated; scutellum sparsely punctured, with a depressed row of deep punctures at its base; median segment rounded and narrowed to apex. Abdomen shining, the segments very finely and shallowly punctured at base, almost smooth at apex; first segment obliquely truncate anteriorly, with a median sulcus from base not reaching apex; segments 2-5 strongly constricted at base, apical margin very narrowly depressed, leaving a slightly raised curved mark, emarginate in middle, before apex; sixth segment at apex and epipygium rugose, epipygium broadly truncate at apex, the apical angles prominent. Ventral segments 2-6 depressed at apex, leaving a carina very broadly emarginate posteriorly before apex, the carina on third and fourth segments forming a small tubercle at each of the apical angles; produced on the sixth segment into a long acute spine and on the sixth into a minute spine on each side. Hypopygium subtruncate at apex, apical angles slightly produced, with a short apical spine. Black, with grey pubescence; margin and sides of clypeus, margins of pronotum narrowly interrupted in centre of anterior margin, a narrow longitudinal mark on disc of mesonotum posteriorly, tegulæ, a small central spot on scutellum and the margin at the sides, a transverse line on postscutellum, a small spot on each side of first abdominal segment and a narrow transverse band on each side of the four following segments creamy-white; fore tibiæ and all the tarsi fusco-ferruginous. Wings hyaline, tinged with yellow, nervures black, stigma ferruginous. Length 14 mm.

♀. Head smooth and shining, strongly convex, narrowed anteriorly, rather broader on posterior margin than long; eyes small and round, situated at some distance from base of mandibles, with which they are connected by a carina, antennæ close together at base, clypeus with a carina from base to apex. Pronotum a little broader than head, broader than long and slightly narrowed posteriorly, opaque, with a longitudinal median carina produced into an acute tubercle posteriorly. Median segment narrow at base, shining, flattened above and smooth, obliquely truncate posteriorly and shallowly punctured. Abdomen shining, very finely and sparsely punctured; first segment slightly depressed on apical margin; second segment with three strong transverse carinæ in middle and several delicate transverse striations before apical margin, which is very slightly raised. Pygidium vertically truncate posteriorly, the sides parallel and slightly raised, truncate at apex, more than twice as long as broad; epipygium very much shorter than hypopygium. Fifth ventral segment rugose. Black; mandibles, antennæ and legs fuscous; abdominal segments testaceous on sides. Length 8 mm.

Hab.—Cape York, Q. (Turner; ♂♀ in cop.).

The labrum of the male is longer than in most of the genus and is moderately bilobed. The female has the tarsal ungues bidentate.

70. T. (Aeolothynnus) bidentatus Sm.

Thynnus (*Agriomyia*) *bidentatus* Sm., Cat. Hym. B.M. vii. p.32, n.82, 1859(♂).

♂. Clypeus not very much produced, rather broadly truncate at apex. Thorax and median segment closely and shallowly punctured, most finely on median segment, which is rounded. Abdomen shining, segments 2-5 divided by an impressed transverse line, the apical margins very narrowly depressed, leaving a raised, curved mark, deeply emarginate in middle, just before apex. Ventral plates of segments 2-5 deeply emarginate, slightly produced at the apical angles of third and fourth segments, produced into a long acute spine at the apical angles of the fifth segment. Hypopygium lanceolate, without an apical spine.

Hab.—Swan River, W.A. (Smith).

Var. ORIENTALIS, n.var.

♂. A delicate longitudinal carina from base of clypeus half way to anterior ocellus. Clypeus entirely black. The yellow marginal bands of the pronotum united and narrowly interrupted in middle; the yellow spots on abdomen much smaller than in the typical form.

This variety is a little larger and more robust than the type, and appears to be constant.

Hab.—Wimmera, Vic. (French).

71. T. (AEOLOTHYNNUS) DODDII, n.sp.

♂. Clypeus not much advanced, broadly and slightly emarginate anteriorly; labrum exposed, feebly bilobed; a faint depressed transverse line on clypeus before apex. Head delicately and very closely punctured; thorax more sparsely punctured, the punctures larger than those on head. Pronotum depressed, the anterior margin raised, a little narrower than head. Scutellum rather broadly truncate at apex; median segment smooth. Abdomen narrow, flattened, the segments of about even width, strongly depressed at base of each segment; second and third segments with a strongly raised mark, emarginate in centre, just before apical margin. Hypopygium subtriangular, narrowly truncate at apex, with a short apical spine. Segments 2-5 strongly produced at apical lateral angles beneath, fifth produced into a long spine on each side. Black; mandibles, except at apex, clypeus, margins of eyes, narrowly interrupted at apex, a broad band above base of antennæ, narrowly interrupted in middle, pronotum with the exception of a small black spot in middle and a transverse line on each side, a large square spot on posterior margin of mesonotum, a curved line above tegulæ, tegulæ, mesopleuræ, a large spot on scutellum, and a spot at the anterior angle on each side, postscutellum, a large horseshoe-shaped mark on each side of and a spot at each basal angle of median segment, an oblique band on each side of abdominal segments 1-6 near apex, the spines on sides of segments and the legs, bright yellow; intermediate and posterior tibiæ and tarsi fusco-ferruginous. Wings hyaline, nervures testaceous Length 9 mm.

♀. Head convex, broad anteriorly, rounded and narrowed to a neck posteriorly, longer than broad. Pronotum rectangular, longer than broad, the lateral margins elevated, the centre much raised, forming a broad longitudinal carina. Mesonotum rather prominent, median segment very short, obliquely truncate posteriorly. Sides of the thorax and median segment vertical. Abdomen much broader than median segment, all the segments, except second and sixth, depressed on apical margin and in centre, leaving a rounded raised area on each side before apex; second segment with the apical margin raised forming a transverse carina, another transverse carina near base, the intervening space very finely transversely striate. Pygidium lanceolate, obliquely truncate towards apex, where it is very slightly dilated. The whole insect smooth and shining, without punctures. Rufo-testaceous; head, except mandibles and antennæ, the third, fourth and fifth abdominal segments piceous; thorax and median segments fusco-ferruginous. Length 4 mm.

Hab.—Townsville, Q. (F. P. Dodd). Type in the British Museum.

72. T. (Aeolothynnus) clementi, n.sp.

♂. Clypeus short, rather broadly truncate at apex, punctured. Head very closely punctured, with grey pubescence on front. Thorax finely and very closely punctured, rather broad; pronotum as broad as head, the anterior margin scarcely raised; scutellum strongly convex, broadly truncate at apex, more sparsely punctured. Median segment broad and short, very finely and closely punctured, smooth at extreme base. Abdomen shallowly punctured, shorter and broader than in most of the allied species; segments 2-5 slightly constricted at base; third and fourth ventral segments with the apical angles prominent, fifth ventral segment with a very long and acute spine on each side at apical angles. Epipygium truncate at apex; hypopygium ending in three spines, those at the apical angles very short. Black; clypeus, a spot at base of mandibles, margins of pronotum, a large spot on mesopleuræ, tegulæ, a spot near posterior margin of mesonotum, a spot on middle and one at each of anterior angles of scutellum, a spot on each side at base of median segment near middle and one on each side on the extreme margin not far from apex, a narrowly interrupted band near apex of first abdominal segment, a broader transverse spot on each side of segments 2-5 above, a smaller spot on each side of segments 2-4 beneath, undersurface of spines of fifth segment, and a mark at apex of anterior femora pale dull yellow; tibiæ and tarsi fusco-ferruginous. Wings hyaline, nervures black. Length 14 mm.

Hab.—Nickol Bay, W.A. (Clement). Type in Brit. Mus.

73. T. (Aeolothynnus) eyrensis, n.sp.

♂. Clypeus produced and strongly narrowed anteriorly, forming an elongate beak, narrowly truncate at apex, with a median, longitudinal carina on apical portion, depressed at base and punctured. Labrum prominent and almost pointed at apex. Head rather small, very finely rugulose. Thorax and median segment very finely and closely punctured, pronotum broadly emarginate anteriorly, rather long and quite as broad as head. Scutellum rather narrowly truncate at apex; median segment subtriangular, very narrow at apex, with a depression on each side near basal angles. Abdomen elongate, first segment oblique, not quite as wide at apex as second; segments 2-4 with a depressed transverse line near base, and the apical margin very narrowly depressed. Beneath there is a raised plate on segments 2-6, strongly emarginate and produced at apical angles, forming acute spines on segments 4-6. Hypopygium broad and short, with an apical spine and an acute, slender spine on each side close to apex. Black; clypeus, internal margin of eyes broadly to above base of antennæ, a spot on each side above base of antennæ, pronotum, a square spot on mesonotum, tegulæ and a curved line above them, mesopleuræ, a spot in middle of scutellum and a small spot at each of anterior angles, a transverse line on postscutellum, sides of median segment, a longitudinal spot on each side at base and a small spot at apex, a broad transverse band on middle of each abdominal segment, the prominent ventral plates beneath and the seventh segment dull cream colour. A large, slightly depressed spot on each side of clypeus near apex and a narrowly interrupted transverse line crossing clypeus from base of mandibles dark brown. A transverse line on sides of pronotum and a small spot in middle, and a broad irregular mark on mesopleuræ black. Legs pale yellow, trochanters and tarsi fuscous, femora at base and tibiæ beneath ferruginous-brown. Wings hyaline, nervures black, stigma testaceous. Length 8 mm.

Hab.—Killalpanima, S.A , 100 miles east of Lake Eyre.

Type in Brit. Mus. (H. J. Hillier).

74. T. (Aeolothynnus) baccatus Sm.

Thynnus (*Agriomyia*) *baccatus* Sm., Trans. Ent. Soc. London, 1868, p.236(♂).

♂. Clypeus broad, slightly produced and truncated at apex where it is not very broad, finely punctured. Head, thorax and median segment very finely and closely punctured; anterior margin of pronotum straight, not elevated; mesothorax rather broad; median segment short, obliquely truncate posteriorly. Abdomen rather strongly punctured, second segment the broadest; segments 2-5 strongly depressed at base above and beneath, segments 3-5 subtuberculate beneath near apical angles; sixth ventral segment with a short spine on each side at apical angles. Hypopygium broad, terminating in three spines, the central spine long and stout. Wings hyaline, nervures black, stigma fuscous.

Hab.—Champion Bay, W.A. (Du Boulay).

75. T. (Aeolothynnus) illustris Kirby.

Rhagigaster illustris Kirby, Horn Exped. Pt. i. 1898.

♂. Clypeus broad and not much produced, broadly truncate at apex, very finely punctured. Head, thorax and median segment very closely and finely punctured, clothed with short, thin, grey pubescence; pronotum as wide as head, broadly emarginate anteriorly, anterior margin not elevated; median segment much broader than long. Abdomen elongate, narrower than thorax, segments 2-4 constricted at base, sixth ventral segment with a spine on each side at apical angles. Hypopygium with three spines at apex, the central spine long and stout. Black; sides and apex of clypeus, a small spot at base of each antenna, margins of pronotum obscurely, postscutellum, a narrow, interrupted, transverse band in middle of first abdominal segment, a large spot on each side of segments 2-5 and a minute spot at apical angles of segments 2-4 beneath creamy-white; the two apical abdominal segments ferruginous. Wings hyaline, faintly iridescent, nervures black. Length 10 mm.

Hab.—Central Australia.

The second recurrent nervure is received at the base of the third cubital cell and is almost interstitial with the second transverse cubital nervure. The third cubital cell is very short along the radial nervure.

76. T. (Aeolothynnus) ablatus, n.sp.

♂. Clypeus produced and rather narrowly truncate at apex, the produced apical portion slightly depressed below basal portion, giving the appearance of a transverse carina; apex smooth, the base finely punctured. Head finely and very closely punctured, interantennal carina not developed. Thorax and median segment finely and closely punctured; anterior margin of pronotum straight; median segment rounded. Abdomen elongate, strongly punctured; segments constricted at base, with the apical margin very narrowly depressed. Sixth ventral segment with a spine at apical angles. Hypopygium broad, ending in three long spines, the central spine the longest. Black; mandibles, clypeus in front, margins of pronotum, tegulæ, a spot in middle of scutellum and its lateral margins, postscutellum and a transverse spot on each side of the five basal abdominal segments pale yellow; legs, except coxæ, ferruginous. Wings hyaline, nervures black, stigma ferruginous. Length 7 mm.

♀. Head smooth and shining, about as long as broad, very much narrowed posteriorly, the sides compressed and slightly concave. Thorax and median segment smooth and shining; pronotum much narrowed posteriorly, anterior margin straight with prominent angles, surface flat. Mesonotum very small and narrow; median segment narrow at base, broadened and obliquely truncate posteriorly. Abdominal segments strongly punctured, smooth at base and apex, apical margin broadly depressed; first, third and fourth segments with a raised curved mark, emarginate in middle posteriorly; second segment with three transverse carinæ and the apical margin slightly raised. Pygidium elongate, about three times as long as broad, narrowly rounded at apex, the sides parallel. Head, thorax, median segment and legs rufo-testaceous; abdomen light ferruginous-brown, margins and sides of the segments testaceous. Length 6 mm.

Hab.—S. Australia. Types in Brit. Mus.

77. T. (Aeolothynnus) cerceroides Sm.

Thynnus (*Agriomyia*) *cerceroides* Sm., Cat. Hym. B.M. vii. p.34, n.87, 1859(♂).

Thynnus perelegans Sm., Descr. n.sp. Hym. p.167, n.25, 1879(♂).

♂. Clypeus strongly convex, moderately produced and truncate at apex. Head closely and strongly punctured; thorax and median segment coarsely punctured, anterior margin of pronotum not elevated. Abdomen shining, sparsely punctured, the segments constricted at base; apical angles of ventral segments 3-5 prominent, sixth ventral segment with a spine on each side at apical angles. Hypopygium truncate at apex and narrow, with an acute apical spine. In some specimens the apical angles of the hypopygium are produced into short spines. Length 7-11 mm.

♀. Head narrow, much longer than broad, produced posteriorly; eyes situated at some distance from base of mandibles which are long and pointed; the front is raised into a prominent ridge with a flattened rugulose surface, and there is a strong depression on each side reaching from eye to base of antenna. Thorax and median segment finely punctured; abdomen shining, with a few scattered punctures. Pronotum rectangular, about half as broad again as long, as broad as head; median segment short, broadened from base, and obliquely truncate posteriorly. First abdominal segment with a raised semicircular mark on each side some distance before apical margin, second segment with three transverse carinæ (possibly others may be concealed by the first segment), the apical margin hardly raised; third and fourth segments with a semicircular raised mark on each side before apical margin; pygidium very narrow, of about even width throughout. Black; mandibles, antennæ, pygidium and legs rufo-testaceous; sides and apical margins of the abdominal segments testaceous. Length 5-6 mm.

Hab.—Sydney; Tempe, N. S. W. (Froggatt)—Mackay; Cairns and Cape York, Q. (Turner; ♂♀ in cop.).

Aeol. perelegans Sm., seems to me to be only a variety with the yellow maikings more strongly developed.

78. T. (Aeolothynnus) decipiens Westw.

Thynnus decipiens Westw., Arc.Ent.ii.105,(note)p.124,1844,♂.

♂. Clypeus not very much advanced, convex at base, depressed and rather narrowly truncate at apex. Head and thorax punctured-rugose; pronotum short, as broad as head, more finely sculptured than head or mesonotum, the anterior margin straight and elevated at sides. Median segment finely and closely punctured, rounded, and narrowed from base, not truncate. Abdomen elongate, strongly punctured, segments 2-5 with a strongly depressed transverse line near base and a small triangular depression in middle of apical margin; apical segment rugose with a median, longitudinal carina; sixth ventral segment with a strong spine on each side at apical angles. Hypopygium ending in three spines, the central spine much the longest. Black; the two apical segments ferruginous-red. Wings hyaline. Length 9 mm.

Hab.—Tasmania (Westwood).

79. T. (Aeolothynnus) sanguinolentus, n.sp.

♂. Clypeus much produced and rather narrowly truncate at apex, finely and closely punctured. Head punctured, finely and closely on front, shallowly on vertex. Thorax and median segment deeply but not very closely punctured, the punctures large; pronotum very broadly emarginate anteriorly; median segment depressed and subtruncate posteriorly. Abdomen elongate, shining; segments 2-5 constricted near base, with the apical margin depressed in middle, the same segments beneath with the apical angles acutely produced; sixth ventral segment with a spine on each side at apical angles. Hypopygium ending in three spines, the central spine much the longest. Black; anterior margin of clypeus continued along inner margin of eyes as far as base of antennæ, a short line on each side of anterior margin of pronotum, a small spot at base of tegulæ, a spot on postscutellum, and an oblique line on each side of second and third abdominal segments creamy-white ; the two apical abdominal segments ferruginous-red. Wings hyaline, nervures black. Length 8 mm.

♀. Head smooth and shining, longer than broad, very strongly compressed and convex, narrowed anteriorly. Thorax and median segment rather sparsely punctured; pronotum as broad as head, broader than long, the punctures on the anterior margin setigerous; median segment very short. Abdomen much broader than thorax, sparsely punctured; first segment broadly depressed along apical margin, with a raised curved mark, emarginate in middle, before the depression. Second segment with three transverse carinæ, the one near apex less elevated than the others; the apical margin is not raised. Third segment broadly depressed at apex, with a slightly raised curved mark, emarginate in middle before the depression. Pygidium very narrow, lanceolate, arched at base, with a longitudinal median carina and the margins slightly raised. Black; antennæ, mesonotum, base of first abdominal segment, carinæ on second, the two apical segments and legs ferruginous-brown; apical margins and sides of abdominal segments testaceous. Length 5 mm.

Hab.—Liverpool, N. S.W. (Froggatt; ♂♀ in cop.).

Types in Coll. Froggatt.

A variety of the male has the whole abdomen except the basal segments ferruginous. Allied to *T. decipiens* Westw., but differs in many details both of shape and sculpture.

80. T. (Aeolothynnus) armiger, n.sp.

♂. Clypeus short and broad, narrowly produced and truncate at apex, closely punctured. Head very closely punctured on front, shallowly and more sparsely on vertex. Thorax and median segment finely and closely punctured; anterior margin of the pronotum straight and only slightly raised, rather narrower than head; median segment rounded, with an indistinct longitudinal sulcus from base. Abdomen elongate, shining and shallowly punctured, the segments strongly constricted at base, the apical margin very narrowly depressed, most broadly in middle, leaving the raised portion of the segments narrowly emarginate. Ventral plate of segments 3-5 prominent at apical angles; sixth ventral segment with a spine on each side at apical angles. Epipygium narrowly rounded at apex; hypopygium ending in three acute spines, the central spine the longest. Black; a narrow line on anterior margin of pronotum interrupted in middle, and a transverse line on postscutellum creamy-white; calcaria of tibiæ whitish. Wings hyaline, iridescent, nervures fuscous. Length 9 mm.

♀. Head as broad anteriorly as long, much narrowed posteriorly, shining, with a few scattered punctures, a short sulcus on front between antennæ, clypeus with a strong carina. Pronotum much broader than long, convex, the anterior portion subcarinate, the centre subtuberculate, sparsely punctured. Median segment short, obliquely truncate posteriorly, more closely punctured. Abdomen broader than thorax, strongly pubescent on sides; first segment with a transverse carina before apex, from beneath which spring long hairs; second segment with five transverse carinæ, including the recurved apical margin; the three following segments strongly punctured on apical portion. Pygidium lanceolate. Fuscous-black; antennæ, legs, second abdominal segment and pygidium fusco-ferruginous. Length 5 mm.

Hab.—Mittagong, N. S.W. (Froggatt; ♂♀ in cop.).

Types in Coll. Froggatt.

81. T. (Aeolothynnus) umbripennis Sm.

Thynnus (*Agrioymia*) *umbripennis* Sm., Cat. Hym. B.M. vii. 31, n.78, 1859(♂).

♂. Clypeus narrowly truncate at apex; interantennal carina straight and transverse, front finely rugose, vertex shining and closely punctured. Thorax opaque, very closely punctured; pronotum broad, slightly emarginate anteriorly; scutellum with a faint longitudinal carina; median segment rugulose, nearly twice as broad at base as long. Abdomen elongate, shining and closely punctured; the segments strongly constricted near base, third and fourth ventral segments subtuberculate at apical angles, fifth and sixth with a spine on each side at apical angles, the spine very short and fine on fifth, stout and longer on sixth. Hypopygium ending in three spines, the middle spine the longest; epipygium subtruncate at apex, the apical angles prominent.

Hab.—Wimmera, Vic. (French).

82. T. (Aeolothynnus) gilberti, n.sp.

♂. Clypeus broadly truncate anteriorly, strongly punctured, convex and rather prominent at extreme base, thence almost vertical to apex, pointed at base and reaching the interantennal carina which is transverse. Front finely punctured-rugose, concavely depressed on sides above antennæ, an oblique carina between eyes, pointed anteriorly; vertex sparsely punctured. Thorax and median segment coarsely punctured, most finely on pronotum. Median segment short, almost vertically truncate posteriorly, the surface of the truncation rugose. Abdomen short, fusiform; segments 2-4 with an impressed transverse line near the base. Hypopygium rather short, terminating in an apical spine with a very short spine on each side of its base. Black; with sparse grey pubescence; antennæ, anterior tibiæ and tarsi and abdomen except the two basal segments ferruginous; pronotum anteriorly broadly interrupted in middle and a spot on posterior margin of mesonotum yellow. Wings hyaline, nervures black. The antennæ are very short, of about the same length as the mesonotum. Length 8 mm.

♀. Head smooth and shining, broader than long anteriorly, much narrowed posteriorly, slightly convex. Thorax and median segment almost smooth; pronotum flat, narrower than head, broader than long, narrowed posteriorly, the anterior margin straight; mesonotum not very small, rounded posteriorly; median segment oblique from mesonotum, more sharply depressed towards apex. Abdomen broader than thorax, sparsely punctured; first segment with the apical margin depressed; second with five transverse carinæ, including the raised apical margin. Pygidium small, ovate-lanceolate, with a median longitudinal carina, the margins elevated and slightly diverging towards apex which is rounded. Black; antennæ, legs and carinæ on second abdominal segment fuscous. Length 5 mm.

Hab.—Port Darwin (G. Turner; ♂♀ in cop.).

83. T. (Aeolothynnus) aterrimus Sm.

Thynnus aterrimus Sm., Descr.n.sp. Hym. p.164,n.16,1879(♂).

♂. Clypeus subtriangular, narrowly truncate at apex. Head rugose on front, punctured-rugulose on vertex. Thorax and median segment closely and finely punctured; pronotum short, broadly emarginate anteriorly; a depressed, transverse row of large punctures at base of scutellum. Median segment short and broad, rounded at sides. Abdomen broadly fusiform, sparsely punctured; segments 2-5 strongly depressed at base above and beneath. First ventral segment with a very prominent longitudinal carina, deeply separated from second segment. Hypopygium ending in three small spines, the middle spine the longest, lateral spines divergent.

Hab.—Swan River, W.A.(Smith).

84. T. (Aeolothynnus) saundersi, n.sp.

♂. Clypeus rather narrowly produced and very narrowly truncate at apex. Head rugulose on front, punctured on vertex. Thorax punctured-rugulose; pronotum rather broader than head, anterior margin straight and slightly raised. Mesonotum broad and short; scutellum strongly punctured, with a depressed, transverse row of large punctures at base. Median segment very short, obliquely truncate from a little behind the post-scutellum. Abdomen broadly fusiform, sparsely punctured; segments 2-5 strongly constricted near base, apical margin depressed; first segment oblique, with a median sulcus from base not quite reaching apex, subtuberculate at apex beneath; sixth ventral segment with a spine at apical angles. Hypopygium broad, ending in three spines, the central spine the longest, basal angles prominent. Black; mandibles, apical portion of clypeus, a minute spot above base of each antenna, anterior margin of pronotum, base of tegulæ, a transverse line on postscutellum, a transverse band broadly interrupted in middle on each of the four basal abdominal segments, a spot on each side of fifth segment, a transverse spot on each side of segments 2-5 beneath, a minute spot on each side near middle of the same segments and anterior femora beneath cream-yellow; posterior margin of pronotum and anterior legs dull ferruginous; intermediate and posterior tibiæ and tarsi fuscous. Wings fusco-hyaline, nervures black. Length 14 mm.

Hab.—Adelaide(?). Type in Oxford University Museum.

Most nearly allied to *T. aterrimus* Sm.

Subgenus Agriomyia Guér.

Agriomyia Guér., Voy. Coq. Zool. ii. 2, p.213, 1830(1839); Ashm., Canad. Ent. xxxv. 1903 (♂; nec ♀).

Cephalothynnus Ashm., Canad. Ent. xxxv. 1903.

♂. Labrum long and narrow, strongly bilobed at the apex; clypeus narrowly produced and truncate at the apex, maxillæ smooth, first joint of the maxillary palpi short. In nearly all the species there is an acute tubercle at the apex of the first ventral segment of the abdomen, and the hypopygium has an apical spine only. Antennæ rather short and of even thickness throughout. Second recurrent nervure received near the base of the third cubital cell.

♀. Head strongly flattened in most of the species; second abdominal segment marked with five transverse carinæ, fifth ventral segment punctured. In all the species, except *A. adelaidæ*, the tarsal ungues are bidentate. Pygidium lanceolate-ovate or more rarely lanceolate.

Type, *Agriomyia maculata* Guér.

85. T. (AGRIOMYIA) MACULATUS Guér.

Agriomyia maculata Guér., Voy. Coq. Zool. ii. 2, p.218, 1830 [1839](♂); Guér., Mag. de Zool. xii. p.3, P.100, figs.1-4, 1842(♂); Sauss., Reise de Nov. Zool. ii. 1, Hym. p.116, n.1, 1867(♂).

Var. *Thynnus* (*Agriomyia*) *odyneroides* Westw., Arc. Ent. ii. 2, p.109, P.75, figs.3-4, 1844(♂♀).

Var. *Thynnus variegatus* Klug, Physik. Abh. Akad. Wiss. Berlin, p.20, n.12, P.1, fig.3, 1840[1842](♂).

In spite of the differences in colour and size I cannot find any sufficient ground for division in this common species. The male varies much in the yellow markings on the thorax; *T. odyneroides* Westw., which seems to be the commonest form in Victoria and the western country of New South Wales, is without yellow on the median segment; while the commonest form from Sydney northward is without the yellow mark on the scutellum, but has that on the median segment well developed. The typical form seems to be from S. Australia. *T. variegatus* Klug, seems to be close to the Sydney form.

I have seen very few females, but there does not seem to be much variation. In one specimen from Tasmania, where the prevalent male form is *T. odyneroides*, the pronotum is rather narrower anteriorly than in the specimens I have seen from the mainland. The true limits of variable species such as the present one can only be ascertained when long series of both sexes are available, with full data as to locality and the pairs taken together.

Hab.—Adelaide, S.A., to Cairns, Q.

86. T. (Agriomyia) vividus Sm.

Thynnus vividus Sm., Descr. n.sp. Hym. p.161, n.11, 1879(♂).

This is very near *T. maculatus* var. *odyneroides*, but the clypeus is a little more produced, the scutellum is longer, and the abdomen is strongly punctured, the punctures not confluent.

Hab.—Swan River, W.A.(Smith).

87. T. (Agriomyia) jucundus Sm.

Thynnus (*Agriomyia*) *jucundus* Sm., Cat. Hym. B.M. vii. p.25, n.64, 1859(♂).

This is extremely near *T. maculatus*, but the whole insect is much more feebly sculptured. The yellow marks on the abdomen are larger and extend to the sixth segment. The known specimens are smaller.

Hab.—Australia, N. W. Coast.

88. T. (Agriomyia) medius Sm.

Thynnus medius Sm., Descr. n.sp. Hym. p.170, n.32, 1879(♂).

♂. Clypeus advanced and narrowly truncate at apex, closely punctured. Head and thorax very closely punctured; median segment finely rugulose. Abdomen fusiform, shallowly punctured, the punctures large; segments 2-5 faintly depressed on the apical margin, with a slightly raised curved mark on each side reaching almost to apex; a strongly impressed transverse line near base of segments 2-4. Hypopygium rounded, with an apical spine. Abdomen beneath strongly punctured; first segment with a strong tubercle at apex, deeply separated from second segment.

♀. Head broad anteriorly and rounded at sides, then sharply narrowed to posterior margin; flat, with a slightly convex area in centre; much broader than long; finely shagreened. Pronotum much narrower than head, longer than broad, sides nearly parallel. Mesonotum more than half as long as pronotum, a little longer than broad; the whole thorax sparsely punctured. Median segment rather slender, obliquely truncate posteriorly, more closely punctured than thorax. Abdomen sparsely punctured; first segment with a curved transverse carina, emarginate in middle, before apex, apical margin depressed; second segment with five transverse carinæ, including the recurved apical margin, carina before apex curved and obsolete in middle. Third and fourth segments with a strongly curved raised mark on each side before apical margin. Fifth segment above with a delicate longitudinal carina; beneath coarsely punctured. Pygidium oblong-ovate oblique, with a longitudinal carina and the lateral margins raised. Fusco-ferruginous; head fuscous, legs testaceous. Length 9 mm.

Hab.—S. Australia. In Oxford University Museum.

The male attached to this female differs from typical *T medius* only in the colour of the clypeus, which is black with a yellow line on the anterior margin. Allied to *T. maculatus* Guér.

Var. BREWERI, n.var.

♂. Differs from typical *T. medius* in colour only. Clypeus black with a yellow line on apical margin, a short line on inner margin of eye, anterior margin of the pronotum narrowly interrupted, base of the tegulæ and the postscutellum yellow. The markings on the abdomen beneath as in typical *T. medius*, the band on segments 2-4 broadly interrupted on sides, leaving a small spot on each side near middle and close to apical margin. Length 13 mm.

♀. Similar to that of typical *T. medius* described above, but darker in colour.

Hab.—Albany, W.A. (Brewer). In Oxford University Museum.

89. T. (Agriomyia) rotundiceps Sm.

Thynnus rotundiceps Sm., Cat. Hym. B.M. vii. p.46, n.133, 1859(♀).

?*Thynnus propinquus* Sm., Descr. n.sp. Hym. p.160, n.8, 1879(♂).

♂. Clypeus broad, advanced in middle and very narrowly truncate at apex, convex in centre, with a short longitudinal impressed line in middle; sparsely punctured, rather broadly truncate at base. Head finely and shallowly punctured, shining, interantennal prominence not much elevated and divided by a sulcus. Thorax opaque, finely and closely punctured on pronotum, punctured-rugose on mesonotum and scutellum; anterior margin of pronotum raised. Median segment finely punctured-rugulose, short and obliquely depressed from postscutellum. Abdomen fusiform, with a few small scattered punctures, the two apical segments strongly punctured; segments 2-4 with an impressed transverse line near base. First ventral segment with an acute tubercle at apex. Hypopygium rounded, with a short apical spine. Black; clypeus, inner margin of eyes as high as base of antennæ broadly, a large spot on each side above base of antennæ, anterior margin of pronotum, tegulæ, a narrow transverse band on each side of second, third and fourth abdominal segments and a small spot on each side of fifth near middle, a large spot on each side of second, third and fourth ventral segments and a small spot on each side of the same segments near middle yellow. Wings hyaline, nervures fuscous. Length 15 mm.

♀. Head very large, half as broad again as long, rounded at sides and posterior angles, very flat, a round slightly convex area on front; finely shagreened, a very short and faint longitudinal sulcus between antennæ. Thorax sparsely punctured, pronotum not more than half width of head, longer than broad, depressed at sides anteriorly, with prominent angles, broadly raised and prominent in middle of anterior margin. Mesonotum very narrow, longer than broad. Median segment more closely punctured, slender, very narrow at base, obliquely truncate posteriorly. First abdominal segment truncate anteriorly, finely and closely punctured on upper edge of truncation, apical margin feebly raised with a depressed area before it, giving the appearance of a transverse carina before the depression. Second segment with five strong transverse carinæ, including the raised apical margin. The three following segments sparsely punctured, smooth at base and apex. Pygidium strongly compressed at base, ovate-lanceolate. Ventral segments, including the fifth, strongly punctured. Entirely dark brown. Length 10 mm.

Hab.—Australia (Smith); Cooktown and Mackay, Q.(Turner; ♂♀ in cop.); Adelaide, S.A.(*T. propinquus* Sm.).

The male is described from a Mackay specimen taken with a female exactly corresponding to the type, which is not likely to have come from North Queensland. It is with some hesitation that I sink the name *T. propinquus* Sm , the type of which differs much in colour, but not otherwise.

90. T. (Agriomyia) cingulatus, n.sp.

♂. Clypeus advanced, rather narrowly truncate anteriorly, punctured, with a faint median carina from base not reaching apex. Head large and broad, finely and very closely punctured, with a fine sulcus reaching from between antennæ halfway to anterior ocellus. Thorax very closely and finely punctured, scutellum rather more strongly punctured. Prothorax with a very narrow, shining, depressed transverse line just behind the slightly raised anterior margin, short and very broad. Scutellum large, prominent, raised above mesonotum and postscutellum, with a depressed, smooth transverse line at base, subtruncate at apex. Median segment depressed, obliquely truncate from close to base, closely and finely punctured, with white pubescence on sides. Abdomen short and broad, all the segments rather closely punctured, smooth at extreme apex, segments 2-5 with a depressed transverse line near base, the two apical segments more coarsely punctured. Basal segment beneath truncate vertically at apex and armed with a long acute tubercle. Hypopygium rounded, with the usual apical spine. Black; clypeus yellow, a short transverse mark in middle and a circular one below it brown, the extreme apex black; two small spots at base of antennæ, a small one on each side on posterior margin of head, behind apex of eye, anterior margin of prothorax, tegulæ, a small mark on posterior margin of mesothorax, a spot on mesopleuræ beneath forewing, a short longitudinal line in middle of scutellum, a transverse line on postscutellum, a semicircular spot near base of median segment, and another very minute close to apex, a small spot on either side near apex; a transverse band emarginate posteriorly near apical margin on each side of abdominal segments 1-5 interrupted in centre, apex of tubercle beneath basal segment, a broad line, narrowly interrupted in centre near apical margin of segments 2-4 beneath, a spot on each side of segment 5 beneath and a spot at apex of coxæ pale creamy-yellow. Wings hyaline, nervures black. Length 14 mm.

Hab.—Swan River, W.A. Type in Oxford University Museum.

91. T. (Agriomyia) marginilabris Guér.

Agriomyia marginilabris Guér., Mag. de Zool. xii. p.3, P.100, figs.5-7, 1842(♂).

Agriomyia affinis Guér., *l.c.* p.4, 1842(♂).

Thynnus (*Agriomyia*) *consanguineus* Sm., Cat. Hym. B.M. vii. p.24, n.58, 1859(♂).

Thynnus (*Agriomyia*) *moestus* Sm., *l.c.* p.36, n.93, 1859(♂; nec♀).

♂. Guérin's figure of the head shows the strongly bilobed labrum characteristic of *Agriomyia*. I think the name *affinis* must sink as a synonym. The species may be distinguished from *T. luctuosus* Sm., by the ferruginous legs. There does not appear to be any other distinction, and I should have treated *T. luctuosus* as a mere variety if I had not seen the females of both forms.

♀. Head much broader than long, strongly narrowed posteriorly, the angles not rounded, compressed and slightly concave on sides, smooth and shining. Pronotum broader than long, finely and very sparsely punctured, anterior margin almost straight with prominent angles and a short median sulcus, strongly narrowed posteriorly with a well defined tubercle on each side near angles. Abdomen sparsely punctured; first segment depressed at apex, carina before depression slightly emarginate in middle; second segment with five transverse carinæ, including the raised apical margin; pygidium elongate-ovate with a low median carina and the margins raised. Black; head, legs, second abdominal segment and pygidium bright ferruginous. Length 9 mm.

Hab.—Sydney, N. S.W.(Froggatt; ♂♀ in cop.).

The female differs from that of *T. luctuosus* Sm., in the shape of the head, in the smoother thorax, the tubercles on the pronotum and the broader pygidium. Further collecting is much needed to show the limits of the species in this group.

92. T. (Agriomyia) luctuosus Sm.

Thynnus (*Agriomyia*) *luctuosus* Sm., Cat. Hym. B.M. vii. p.26, n.68, 1859(♂).

Thynnus compressus Sm., *l.c.* p.43, n.118, 1859.

♂. Legs black. Smith's notice of varieties with ferruginous legs seems to apply to *T. marginilabris* Guér.

♀. Head large, much broader than long, strongly rounded at posterior angles, much flattened, shining and very finely shagreened, the front between antennæ deeply emarginate, clypeus with a median carina. Thorax and median segment shining and sparsely punctured, pronotum broader than long, much narrowed posteriorly, anterior margin straight, with prominent angles from which spring a few long hairs. Mesonotum longer than broad; median segment broadened from base, obliquely truncate posteriorly. Abdomen broader than median segment, the segments smooth at base and on the extreme apical margin, elsewhere sparsely but deeply punctured; first segment with a transverse carina near apex strongly emarginate in middle; second segment with four strong transverse carinæ, including the raised apical margin; third segment with a depressed transverse line in middle; third and fourth segments narrowly depressed on apical margin; fifth segment with a longitudinal carina on apical half. Pygidium oblique, ovate-lanceolate, the margins forming low carinæ. Black; head, legs, second abdominal segment and apical margins of the other segments, pygidium and the whole insect beneath fusco-ferruginous. Length 12 mm.

Hab.—Cumberland, N. S.W.

93. T. (Agriomyia) rubellus Sm

Thynnus (*Agriomyia*) *rubellus* Sm., Cat. Hym. B.M. vii.25, n.65, 1859(♂).

Except for the very different colour, I can see little to distinguish this from the common and very variable *A. marginilabris* Guér., but for the present it may be better not to sink the name. I have seen only the type.

Hab.—S. E. Australia.

94. T. (Agriomyia) molestus Sm.

Thynnus molestus Sm., Descr. n.sp. Hym. p.166, n.21, 1879(♂).

♂. Clypeus produced and narrowly truncate at apex, finely punctured at base, more strongly at apex. Head and thorax very closely punctured, the punctures sometimes confluent; interantennal carina only represented by a prominence above base of each antenna. Median segment rugulose, much broader than long. Abdomen closely and rather strongly punctured; first segment short, oblique anteriorly, with a stout blunt tubercle at apex beneath. Hypopygium rounded, with a short apical spine.

Hab.—S. Australia (Smith).

95. T. (Agriomyia) albomaculatus Sm.

Thynnus (*Agriomyia*) *albomaculatus* Sm., Cat. Hym. B.M. vii. p.27, n.69, 1859(♂).

Thynnus conspicuus Sm., Trans. Ent. Soc. London, 1868, p.233, n.4,(♂).

♂. Head rugulose, strongly rounded; clypeus narrowly produced and truncate at apex. Mesonotum and scutellum coarsely punctured; median segment short, rounded at sides, punctured-rugulose. Abdomen fusiform, shining, with a few small and scattered punctures; first ventral segment with an acute tubercle at apex. Hypopygium rounded, with a short apical spine. The size is very variable, but the type is of about the average length.

Hab.—Adelaide, S.A.(Smith).

96. T. (Agriomyia) suspiciosus Sm.

Thynnus suspiciosus Sm., Descr. n.sp. Hym. p.161, n.10, 1879(♂).

♂. Clypeus minutely punctured, very narrowly truncate at apex. Head and thorax very finely and closely punctured; a delicate carina reaching from anterior ocellus to base of clypeus, interantennal prominence bilobed. Scutellum long, subtriangular, narrowly rounded at apex. Median segment obliquely truncate from postscutellum. Abdomen sparsely punctured; first segment with a tubercle at apex beneath. Hypopygium rounded, with a minute apical spine.

Hab.—Swan River, W.A.(Smith).

97. T. (Agriomyia) albopictus Sm.

Thynnus (*Agriomyia*) *albopictus* Sm., Cat. Hym. B.M. vii. p.26, n.67, 1859(♂).

♂. Clypeus convex, produced and narrowly truncate at apex, shining and very finely punctured. Head and thorax opaque and finely rugose; scutellum coarsely punctured, with a feeble longitudinal carina; median segment very short, abruptly but not quite vertically truncate posteriorly, finely punctured. Abdomen fusiform, shallowly punctured; first segment very short, and marked from base almost to apex with a sulcus; sixth segment strongly punctured. First ventral segment with a long tubercle at apex. Hypopygium rounded, with a short apical spine. Colour pale yellow, not white.

Hab.—Swan River, W.A.(Smith).

98. T. (Agriomyia) adelaidæ, n.sp.

♂. Clypeus produced and rather narrowly truncate at apex, closely punctured on sides, more sparsely at apex, the centre nearly smooth, a short carina from base continued by a faintly depressed shining line to centre. Head very closely punctured, a faint longitudinal carina on front between antennæ. Pronotum rugulose, anterior margin raised; mesonotum and scutellum rugose, scutellum with a low carina from base to apex. Median segment rounded, delicately transversely rugulose. Abdomen fusiform, shallowly punctured; apical margin of the segments depressed and smooth; second segment strongly depressed at base; segments 3-5 with an impressed transverse line near base. First ventral segment with an acute tubercle at apex. Hypopygium rounded, with a short apical spine. Black; legs fuscous; anterior margins of face narrowly white. Wings hyaline, tinged with fuscous, nervures fuscous. Length 12 mm.

♀. Head shining, with a few scattered punctures, subquadrate, the sides behind eyes compressed and slightly narrowed, with a concave depression, another depression on front between eye and base of antenna, leaving the eye on a narrow ridge. Pronotum nearly twice as broad anteriorly as long and broadly emarginate, narrowed posteriorly. Abdominal segments delicately striated at base, very sparsely punctured at apex; second segment with four transverse carinæ, including the raised apical margin. Pygidium ovate-lanceolate, with a low longitudinal carina. Light ferruginous; the abdomen ferruginous-brown. Length 7 mm.

Hab.—S. Australia. Type in Brit. Mus.

99. T. (Agriomyia) trochanterinus Westw.

Thynnus trochanterinus Westw., Arc. Ent. ii 2, p.116, P.77, fig.3, 1844(♂).

Thynnus trochantericus D.T., Cat. Hym. viii. 116, 1897(♂).

♂. Clypeus narrowly produced and truncate at apex, hypopygium rounded with a short apical spine as in typical *Agriomyia*. First ventral abdominal segment vertically truncate at apex and produced into a short blunt tubercle.

Hab.—Albany, W.A.; Victoria; New South Wales; Duaringa, Q.

The female of this common species is still unknown.

100. T. (Agriomyia) irregularis Smith.

Thynnus irregularis Sm., Descr.n.sp.Hym.p.162,n.13,1879(♂).

♂. Clypeus produced and very narrowly truncate at apex; head, pronotum and median segment finely and closely punctured; mesonotum more coarsely punctured; median segment short, depressed and rounded. Abdomen smooth, with a few scattered, minute and shallow punctures; fusiform, the basal segment not much narrowed; the two apical segments rugose. Hypopygium elongate-triangular. First ventral segment separated by a groove from second, shallowly truncate and subtuberculate at apex. Wings hyaline, faintly tinged with fuscous, nervures fusco-ferruginous.

Hab.—Swan River (Smith).

101. T. (Agriomyia) laevifrons Sm.

Thynnus lævifrons Sm., Cat.Hym.B.M.vii.p.45,n.130,1859(♀).

♀. Head flattened, shining, with a few small and scattered punctures, much broader anteriorly than long, strongly narrowed posteriorly. Thorax shining, very sparsely punctured; pronotum subrectangular, half as long again as broad, anterior margin with a few setigerous punctures and a deep sulcus extending to middle of segment; sides of prothorax slightly concave. Median segment finely and more closely punctured, obliquely truncate posteriorly, rounded at angles above truncation. First abdominal segment rather strongly punctured, the apical margin very slightly raised, with a broad transverse groove before it; second segment with five transverse carinæ, including the raised apical margin; the following segments rather closely punctured. Fifth ventral segment coarsely punctured. Pygidium ovate with a low longitudinal carina. Black; head piceous; antennæ, mandibles and legs fusco-ferruginous. Length 9 mm.

Hab.—S. E. Australia (Stutchbury).

102. T. (Agriomyia) incensus Sm.

Thynnus (*Agriomyia*) *incensus* Sm., Trans. Ent. Soc. London, p.236, n.10, 1868(♂).

♂. Clypeus produced and very narrowly truncate at apex, strongly punctured, with a carina from base to middle. Head and thorax punctured-rugose; median segment rounded, finely rugulose. Abdomen fusiform, transversely rugulose, the segments not constricted. Hypopygium very small, narrow at apex, and ending in a small spine.

Hab.—Champion Bay, W.A.(Du Boulay).

103. T. (Agriomyia) attenuatus Sm.

Thynnus attenuatus Sm., Cat.Hym. B.M.vii.p.42,n.114,1859(♀).

♀. Head very large, at least thrice as broad as pronotum, nearly twice as broad as long, moderately convex, rounded at sides. Pronotum very narrow; anterior portion depressed, forming a neck, anterior angles prominent, posterior portion much more elevated, a little produced over depressed portion, its anterior angles produced into rather long spines; the whole pronotum twice as long as broad, a little narrowed anteriorly. Median segment flat above, very narrow at base, strongly broadened and obliquely and shallowly truncate posteriorly, as broad at base of truncation as long. First abdominal segment not truncate, depressed and densely pubescent at base, apical margin broadly depressed, leaving a curved carina before apex; second segment with five transverse carinæ, including the raised apical margin; third and fourth segments with a raised curved mark on each side before apical margin, the raised space sparsely punctured. Pygidium lanceolate.

Hab.—Australia (Smith).

There are two specimens in bad condition in the British Museum. It is a very distinct species, and I place it in this genus with considerable doubt.

104. T. (Agriomyia) taeniolatus Froggatt.

Thynnus taeniolatus Frogg., Trans. Roy. Soc. S. Austr. xvi. p.71 1893(♂).

Hab.—Central Australia (Elder Expedition).

I have not seen this species, and cannot assign it to this genus with any certainty.

Subgenus Catocheilus Guér.

Catocheilus Guér., Mag. de Zool. xii. p.8, 1842.

♂. Sixth joint of maxillary palpi rudimentary; labrum narrowed posteriorly; abdomen somewhat flattened, the segments moderately constricted. Second recurrent nervure received near base of third cubital cell.

♀. Fifth ventral segment of abdomen longitudinally striated, pygidium broad and truncate.

Type, *Catocheilus klugii* Guér.

105. T. (Catocheilus) klugii Guér.

Catocheilus klugii Guér., Mag. de Zool. xii. p.8, P.102, figs.1-14, 1842(♂♀).

Thynnus diversus Sm., Cat. Hym. B.M. vii. p.41, n.110, 1859.

Thynnus perplexus Sm., Descr. n.sp. Hym. p.164, n.17, 1879(♂♀).

This species is well figured by Guérin.

Hab.—Swan River.

Subgenus Lophocheilus Guér.

Lophocheilus Guér., Mag. de Zool. xii. p.11, 1842.

Myrmecodes Ashm., Canad. Ent. xxxv. 1903(*nec* Latr.).

Hemithynnus Ashm., *l.c.*

♂. Labrum narrowed posteriorly; abdomen not flattened, or if at all flattened the segments strongly constricted. Second recurrent nervure received at some distance from base of third cubital cell.

♀. Pygidium truncate posteriorly, not contracted on or before the truncation; fifth ventral segment rugose or striated.

Type *L. villosus* Guér.

I include in this subgenus several groups which will probably have to be separated later. The typical species has the first joint of the maxillary palpi shortened and the labium with a tuft of long recurved hairs at the apex. The female has the pygidium very narrow and the mandibles long and acute at the apex.

Most of the males I include in the subgenus have the mouth-parts similar, as far as I have been able to examine them; but *T. apterus* Oliv., has the palpi slender with subequal joints, the maxillæ and the labium smooth, and the labrum longer and less contracted; *T. purpureipennis* Westw., has the labrum shorter than *T. apterus* and truncate at the apex, and the palpi stouter; in *T. lubricus* and *T. vigilans* Sm., the labrum is short, broadly rounded at the apex in *T. lubricus*, smaller and more strongly rounded in *T. vigilans*, the first joint of the maxillary palpi is also shortened.

The usual form of the pygidium in the female is broad with almost parallel sides, vertically truncated and longitudinally striated; the mandibles in the larger species are blunt.

Ashmead places *Lophocheilus* Guér., amongst his Rhagigasterinæ, but states that he has not seen specimens. His guess that it may be the opposite sex of *Eirone* Westw., is wild.

106. T. (Lophocheilus) villosus Guér.

Lophocheilus villosus Guér., Mag. de Zool. xii. 12, P. 103, figs. 7-13, 1842 (♂).

Thynnus niger Sm., Cat. Hym. B.M. vii. p. 30, n. 76, 1859 (♂).

♂. Clypeus short, rather narrowly produced and truncate at apex, closely punctured and without a carina. Head and thorax very closely and finely punctured; scutellum subtriangular, almost pointed at apex. Median segment very closely and minutely punctured, rounded and narrowed to apex. Abdomen fusiform, closely and shallowly punctured, the segments slightly constricted near base. Hypopygium prominent at apical angles, thence rather broadly rounded, subtruncate at apex, with an apical spine. Length 14-17 mm.

♀. Head shining, very sparsely punctured, slightly convex, much broader than long, narrowed and rounded posteriorly; eyes oval and almost touching base of mandibles; a very short longitudinal sulcus between antennæ. Thorax and median segment very finely and closely punctured; pronotum rectangular, about twice as broad as long; median segment oblique from mesonotum. Abdomen much broader than thorax, the segments smooth at base, sparsely punctured at apex; first segment with the apical margin raised and a broad groove before it; second segment with about seven transverse carinæ, including the raised apical margin which is rather broadly separated from the other carinæ, the carinæ in the middle broken and irregular. Fifth ventral segment coarsely rugose. Pygidium lanceolate, sides nearly parallel. Black; legs and pygidium ferruginous; antennæ and mandibles fuscous. Length 10 mm.

Hab.—Tasmania, Huon River (Lea). Type of ♀ in Brit. Mus.

Some specimens of the male have indications of a carina on the clypeus.

Guérin's description is very poor, but I think I am right in identifying his *L. villosus* with *T. niger* Sm., from the type of which my description is taken. It is a common Tasmanian species, but does not seem to occur on the mainland.

107. T. (Lophocheilus) fervens Sm.

Thynnus (*Agriomyia*) *fervens* Sm., Cat. Hym. B.M. vii. p.31, n.79, 1859(♂).

♂. Clypeus short, rather narrowly produced and truncate at apex, with a strong carina from base to apex and closely punctured. Abdomen fusiform; hypopygium very short and broad, slightly prominent at basal angles, thence rounded to apex, with a minute apical spine.

Hab.—Australia (Smith).

108. T. (Lophocheilus) anilitatis Sm.

Thynnus (*Agriomyia*) *anilitatis* Sm., Cat. Hym. B.M. vii. p.37, n.98, 1859(♂♀).

The type is apparently lost. As far as I can judge from Smith's very incomplete description the name should apply to a species very near *T. fervens* Sm., from which it differs in the hypopygium, which is broad at the base, with a rounded prominence on each side near the angles, thence broadly produced and subtruncate at the apex, with an apical spine. The legs are black, not ferruginous as in *T. fervens*, and the calcaria of the tibiæ whitish.

♀. Head much broader than long, narrowed and rounded posteriorly, sparsely punctured. Pronotum about twice as broad as long, very closely and finely punctured; median segment short and minutely punctured. Abdomen punctured-rugulose, segments smooth at base; first segment with a transverse carina before apex, and the apical margin raised; second segment with six transverse carinæ, the basal and two apical carinæ strongly raised, the three others irregular and lower. Pygidium narrow, longitudinally striated at base, sides almost parallel, hypopygium broadened at apex. Fifth ventral segment longitudinally rugose. Black; mandibles except at apex, apex of the two basal abdominal segments and of pygidium, and tibiæ beneath obscure fusco-ferruginous. Length 10 mm.

Hab.—Melbourne (French).

109. T. (Lophocheilus) mamillatus, n.sp.

♂. Clypeus broad, narrowly produced and truncate at apex, with a strong median carina from base reaching nearly to apex, apical margin a little raised. Interantennal prominence strongly bilobed, front rugulose, vertex punctured-rugulose. Head broader than prothorax, clothed with long thin pubescence, white on sides and on clypeus, elsewhere cinereous. Thorax and median segment finely punctured-rugulose, anterior margin of pronotum slightly raised, sculpture strongest on scutellum and on disc of mesonotum. Median segment short, depressed and rounded.

Abdomen fusiform, not very much narrowed at base, first segment with a median carina beneath and a deep groove between first and second segments. Segments 2-4 with a delicate transverse carina near base, followed by a deep transverse line; second segment beneath with a prominent tubercle at base. All the segments finely and closely punctured. Hypopygium broad, with a subtriangular projection on each side near basal angles, thence triangularly produced to apical spine. Black; the two apical abdominal segments ferruginous-red. Wings hyaline, nervures black. Length 15 mm.

Hab.—Fremantle, W.A.

Type in Brit. Mus.(collected by Commander Walker).

110. T. (Lophocheilus) ambiguus, n.sp.

♂. Clypeus strongly convex, broadly truncate anteriorly, deeply punctured, with a carina from base to apex. Head finely and closely punctured, with a faint carina from anterior ocellus to base of clypeus. Antennæ as long as thorax and median segment combined. Thorax finely and closely punctured; median segment very delicately rugulose. Abdomen slender at base, shining, finely and shallowly punctured; segments 2-5 with an impressed transverse line near base and a faint, raised, curved mark on sides near apical margin; the apical segment rugose, with a few rounded striations at apex. Hypopygium elongate-triangular, with a very short curved apical spine. Black; tibiæ beneath light ferruginous. Wings hyaline, tinted with yellow, nervures black. Length 13 mm.

♀. Head convex, about half as broad again as long, rounded at posterior angles. The whole insect sparsely punctured. Pronotum rather narrower than head, rectangular, much broader than long. First abdominal segment truncate anteriorly, apical margin raised, with a groove before it giving the appearance of a transverse carina before apex. Second segment with five transverse carinæ of about even elevation, including the recurved apical margin. All the segments smooth at base. Pygidium narrow, almost vertically truncate posteriorly, longitudinally striated, sides nearly parallel. Fifth segment beneath longitudinally striated. Black; legs testaceous-brown. Length 9 mm.

Hab.—Australia (Macleay). Type in Oxford University Museum.

Very near *T. fervens* Sm., but the hypopygium is quite different.

111. T. (Lophocheilus) tenuatus Sm.

Thynnus (*Agriomyia*) *tenuatus* Sm., Cat. Hym. B.M. vii. p.31, n.80, 1859(♂).

Allied to *T. vigilans* Sm. Hypopygium broad, gradually narrowed, and truncate at apex, without any prominence at basal angles and without an apical spine. Maxillary palpi very slender. In some specimens the legs are fusco-ferruginous.

Hab.—Fremantle, W.A.(J. J. Walker).

112. T. (Lophocheilus) vigilans Sm.

Thynnus (*Agriomyia*) *vigilans* Sm., Cat. Hym. B.M. vii. p.28, n.70, 1859(♂).

♂. Clypeus broadly truncate anteriorly, strongly punctured, pointed at base. Head rather small, rugulose, with thin fulvous pubescence. Thorax delicately punctured, pronotum narrower than head, the anterior margin raised, with a depressed, shining, transverse line behind it. Median segment rounded, rather long and slender, finely rugulose. Abdomen elongate, closely and shallowly punctured, epipygium rugose. Hypopygium rather short, bluntly produced near basal angles, thence triangular to base of the slightly recurved apical spine. Second recurrent nervure received by the third cubital cell on middle of lower margin. Colour as in Smith's description, but varying considerably.

♀. Head a little broader than long, very strongly rounded at posterior angles, smooth and shining, sparsely punctured on front. Pronotum a little broader than long, the sides parallel, finely punctured. First abdominal segment coarsely punctured, the apical margin slightly raised, with a groove before it, giving the appearance of a second transverse carina before apex. Second segment with six transverse carinæ, including the recurved apical margin; the following segments smooth at base, finely punctured at apex. Pygidium narrow, of about even width throughout, obliquely truncate posteriorly, surface of the truncation longitudinally striated. Fifth ventral segment coarsely rugose on apical half with a deep central emargination. Black; second abdominal segment fuscous; head and legs, except coxæ and trochanters, ferruginous. Length 8 mm.

Hab.—Melbourne, Vic. In Oxford University Museum.

Var. INCERTUS, n.var.

♂. Shape and sculpture as in typical *T. vigilans.* Black; mandibles, except at apex, clypeus at apical angles and on sides near base, margin of face, margins of eyes to above base of antennæ, a spot near eye on each side of vertex, a transverse line on postscutellum, a large, transverse mark on each side of the five basal abdominal segments, and a smaller spot on each side of the sixth yellow. Length 18 mm.

Hab.—Australia (Higgins). Type in Oxford University Museum.

Differs from *T. vigilans* in the much larger extent of the yellow markings on the abdomen, and in the larger size. It seems to be fairly constant, as more than one specimen from the same source shows a similar extension of the coloured areas.

113. T. (LOPHOCHEILUS) COGNATUS Sm.

Thynnus cognatus Sm., Cat. Hym. B.M. vii. p.28,n.71,1859(♂).

♂. Clypeus long, convex, and rather broadly truncate at apex. Head small. Median segment very finely and closely punctured. Abdomen elongate, subpetiolate, shining, with a few scattered punctures; first segment very long. Hypopygium with a rounded prominence on each side at basal angles, thence elongate-triangular, with an acute apical spine. Otherwise as in Smith's description.

Hab.—S. E. Australia.

From a collection made between Sydney and Brisbane, and in S. Australia (Stutchbury).

114. T. (Lophocheilus) lubricus, n.sp.

♂. Clypeus strongly convex, coarsely and sparsely punctured, pubescent, the anterior margin slightly depressed, broadly truncate. Front strongly punctured, pubescent, antennæ rather far apart at base, anterior margin of the prominence between them straight, overhanging base of clypeus. Occiput smooth and shining. Pronotum rather narrower than head, nearly smooth, slightly depressed anteriorly, the margin not much raised. Mesonotum finely and closely punctured on sides, more sparsely on disc. Scutellum strongly but shallowly punctured. Median segment rounded, shining, with very minute punctures. Abdomen elongate-fusiform, very shallowly punctured, segments 2-6 with a fine transverse carina near base. Epipygium rounded at apex, with about seven longitudinal carinæ. Hypopygium prominent, broad at base, subtriangular, with a short apical spine. The groove between first and second abdominal segments beneath not very strongly marked. Entirely black, with cinereous pubescence. Wings fusco-hyaline with bronze reflections, nervures black. Length 15-18 mm.

♀. Head nearly twice as broad as long, strongly convex, rounded at posterior angles, sparsely punctured, very shallowly and finely on occiput, more coarsely on front, with a very fine and short longitudinal sulcus on front. Mandibles rather long and pointed. Thorax very finely punctured, pronotum much broader than long; median segment short, sparsely punctured, obliquely truncate posteriorly. First abdominal segment truncate at base, with a transverse carina emarginate in middle just before apex, obliquely striate. Second segment with five well marked transverse carinæ, including the recurved apical margin; another less distinct just before apex. Third and fourth segments punctured near base, smooth and shining at apex, the apical margin slightly depressed, leaving a raised curved mark on each side close to apical margin. Fifth segment smooth at base, coarsely punctured at apex. Pygidium deflexed and subtruncate, more than twice as long as the greatest breadth, gradually widened from base to apex where it is rounded; the surface longitudinally striated. Black; mandibles, antennæ, legs and apical margin of second abdominal segment and of pygidium piceous. Length 8-9 mm.

Hab.—Cairns, Q.(Turner; ♂♀ in cop.).

115. T. (LOPHOCHEILUS) PURPUREIPENNIS Westw.

Thynnus purpureipennis Westw., Arc. Ent. ii. 2, p.143, P.83, fig.10, 1844(♂).

Thynnus maurus Sm., Cat. Hym. B.M. vii. p.37, n.96, 1859(♂).

♂. Clypeus convex in middle, advanced and rather narrowly truncate at apex, rugulose. Head finely punctured, very sparsely on vertex, with a longitudinal frontal sulcus from anterior ocellus. Abdomen elongate, first ventral segment with a broad, triangular truncation at apex; sixth ventral segment with a spine on each side at apical angles. Hypopygium with basal angles prominent; triangular, with a short apical spine. Wings dark fuscous, flushed with purple.

♀. Head nearly twice as broad as long, strongly rounded posteriorly, shining, smooth on vertex, finely punctured on front, position of ocelli marked by deep punctures. Pronotum finely and sparsely punctured, narrower than head, slightly narrowed posteriorly, about half as broad again as long; the anterior margin almost straight, with a few large punctures. Median segment short, obliquely truncate posteriorly, finely rugulose. Abdomen shining, segments smooth at base, sparsely punctured at apex; first segment vertically truncate anteriorly, rugose, the apical margin raised, with a transverse groove before it. Second segment with nine transverse carinæ, including the recurved apical margin, those at base a little lower and often concealed by the first segment. Fifth ventral segment coarsely rugose on apical portion. Pygidium fairly broad, truncate posteriorly and longitudinally striated, sides almost parallel; hypopygium slightly broadened at apex by membranous processes. Black; mandibles and antennæ fuscous-ferruginous. Length 15 mm.

Hab.—Sydney (Froggatt; ♂♀ in cop.).

116. T. (Lophocheilus) excoriatus, n.sp.

♂. Clypeus convex at base, broadly truncate anteriorly and strongly punctured. Head and thorax very closely punctured, with long cinereous pubescence; sides of head with a fringe of long hairs, recalling the genus *Tachynomyia*; scutellum large, broadly truncate at apex. Median segment finely punctured-rugulose. Abdomen elongate-fusiform, sparsely and shallowly punctured; first segment with a sulcus from base nearly reaching apex; segments 2-5 with an impressed transverse line near base; segments 3-4 beneath with a blunt tubercle on each side; epipygium rounded at apex, with a few curved striations. Hypopygium with a longitudinal carina beneath, delicately transversely striated above, broad at base, basal angles slightly prominent, broadly subtriangular, rounded at apex and with a strong spine. Black; mandibles, clypeus, interior margin of eyes as high as base of antennæ, a small spot above base of each antenna, exterior margin of eyes connected by a broad line on vertex, pronotum obscurely, tegulæ, mesopleuræ, abdomen and legs ferruginous; base of first abdominal segment and a broad longitudinal band on apical portion of first and on second segment, narrowly continued on third black. Wings hyaline tinged with yellow, nervures fusco-ferruginous. Length 15 mm.

♀. Clypeus a little advanced, broadly rounded at apex, with a carina from base. Head moderately convex, half as broad again as long, strongly rounded posteriorly and sparsely punctured. Thorax and median segment very finely punctured; pronotum narrower than head, rectangular, half as broad again as long, with a few setigerous punctures along anterior margin; mesonotum not very narrow; median segment short, obliquely truncate posteriorly. Abdomen almost smooth; first segment vertically truncate anteriorly, the apical margin depressed, leaving a transverse carina before apex; second segment with about fifteen low transverse carinæ, including the raised apical margin, the carinæ at apex a little stronger than those at base. Pygidium not contracted, vertically truncate posteriorly and longitudinally striated, much longer than broad and slightly narrowed to apex. Ferruginous; abdomen black; a spot on each side of first segment near middle, a spot on each side of second, an interrupted transverse band on third and fourth and a spot on each side of fifth segment yellow; second segment stained with ferruginous. Length 10 mm.

Hab.—Australia, probably the South-Eastern Colonies. Types in Coll. Froggatt.

Near "*Tachynomyia*" *caelebs* Sauss.

The colour of the clypeus and of the markings on the front of the head in the male would probably be yellow in a fresh specimen.

117. T. (LOPHOCHEILUS) WIESERI D.T.

Tachynomyia caelebs Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.125, n.1, 1867(♂).

Thynnus wieseri D.T., Cat. Hym. viii. 118, 1897(♂).

I have not seen this species, which seems to be very near *T. excoriatus*, but differs in having a tubercle or spine on the fifth ventral segment of the abdomen. Length 10 mm.

Hab.—Australia(Sauss.).

118. T. (LOPHOCHEILUS) PETULANS Sm.

Thynnus petulans Sm., Descr. n.sp. Hym. p.165, n.18, 1879(♂).

♂. Median segment finely rugulose; abdomen shining, sparsely punctured, elongate-fusiform; epipygium deflexed, truncate at apex, longitudinally striated, the striæ curved and rounded to apex. Hypopygium triangular, with a short apical spine, transversely striated above.

Hab.—Swan River, W.A.(Smith).

119. T. (LOPHOCHEILUS) PROTERVUS Sm.

Thynnus protervus Sm., Descr. n.sp. Hym. p.159, n.4, 1879(♂).

♂. Clypeus strongly produced, rather broadly truncate at apex, convex, coarsely punctured. Head finely and closely punctured; interantennal carina transverse, a delicate carina on front from anterior ocellus to between the antennæ. Antennæ about as long as abdomen. Thorax finely and closely punctured, anterior margin of pronotum straight and strongly raised; scutellum with a depressed, transverse row of punctures at base. Median segment rugulose. Abdomen elongate-fusiform, shining, with a faintly impressed transverse line near base of segments 2-6. Epipygium with curved striæ at apex; hypopygium elongate-triangular, with a short apical spine, basal angles prominent. The legs in some specimens are almost entirely black and the wings tinged with yellow.

♀. Head half as broad again as long, convex, rounded at posterior angles, shining and sparsely punctured, with a longitudinal sulcus between antennæ. Thorax and median segment very finely and rather closely punctured, pronotum almost rectangular, much broader than long, the anterior margin straight, with a few large setigerous punctures. Mesonotum small; median segment obliquely truncate from mesonotum. Abdomen shining, very sparsely punctured, third segment broadest; first segment rather long and narrow at base, the apical margin raised and three or four irregular transverse striæ before it; second segment with about twelve transverse carinæ, including the raised apical margin, those near apex the strongest and most regular. Pygidium almost vertically truncate, fairly broad, sides almost parallel, incised near apex leaving a spine on each side continuous with lateral margin; surface of truncation longitudinally striated. Fifth ventral segment coarsely longitudinally rugose. Black; head and second abdominal segment fusco-ferruginous; antennæ, mandibles and legs ferruginous; a transverse band on first abdominal segment near base, a spot on each side of second, a narrowly interrupted transverse band on middle of third and fourth, and two spots on each side of fifth segment yellow. Length 11 mm.

Hab.—Adelaide(Smith). Types (♂♀) in Brit. Mus.

The female has not been previously described. A coupled pair is in the Oxford Museum.

120. T. (Lophocheilus) flavifrons Sm.

Rhagigaster flavifrons Sm., Trans. Ent. Soc. London (3) ii. 5, p.390, 1865(♀).

♀. Head sparsely and deeply punctured on front, more finely and closely on vertex, with a deep longitudinal sulcus on front, half as broad again anteriorly as long, a little narrowed posteriorly, very slightly convex; eyes situated at some distance from base of mandibles; clypeus transverse, with a carina from base to apex. Thorax and median segment sparsely and deeply punctured, minutely and closely punctured between the larger punctures; pronotum nearly as broad as head, much broader than long, subrectangular; median segment broadened and oblique posteriorly, but not strongly truncate. Abdomen very delicately punctured, with a few large and scattered punctures; first segment narrow and truncate at base, widened to apex; second segment wider at apex than at base, transversely rugose at base, with low, irregular, transverse carinæ at apex, the apical margin raised; a small tuft of fulvous hairs close to apical angles of fifth segment. Pygidium rather small, vertically truncate, rarely twice as long as broad, sides almost parallel, produced into a short spine on each side just before rounded apex, longitudinally striated, almost smooth at apex. Black; base of mandibles and front of head yellow; thorax and median segment ferruginous; tarsi ferruginous-brown; pygidium fusco-ferruginous. Length 13 mm.

Hab.—Swan River, W.A.(Du Boulay).

I do not understand why Smith referred this species to *Rhagigaster*.

121. T. (Lophocheilus) obscurus Klug.

Thynnus obscurus Klug, Physik. Abh. Akad. Berlin, p.22, n.4, P.1, fig.4, 1840[1842](♂).

Thynnus (*Thynnoides*) *obscurus* Westw., Arc. Ent. ii. 2, p.138, P.82, fig.2, 1844(♀).

♂. There is a good deal of variation in the development of the carina on the clypeus. I have seen a specimen in Mr. Froggatt's

Collection from Mulwala, N. S.W., in which the clypeus is wholly yellow, and with the carina only visible on the extreme base.

♀. I have examined several females which I believe to be correctly assigned to this species, and find much variation in the number of carinæ on the second abdominal segment. The carinæ are slightly broken and irregular, but vary in number from seven to about twelve. As the specimen with only seven carinæ has also a spine on each side of the pygidium slightly developed, it may prove to be distinct; but in other specimens the number of carinæ is intermediate. In reference to this variation I may refer to my remarks on *T. apterus* Oliv.

Hab.—Victoria; Woodford, Blue Mts.(Waterhouse), Mulwala, N. S.W.(Froggatt).

122. T. (LOPHOCHEILUS) LAEVICEPS Sm.

Thynnus laeviceps Sm., Cat. Hym. B.M.vii.p.44,n.124,1859(♀).

♀. Extremely near *T. obscurus* Klug, but the head is a little smaller and flatter, and the raised apical margin of the second abdominal segment is separated more widely from the transverse carinæ before it.

Hab.—Australia (Smith). Said to come from the North or N.W. Coast.

123. T. (LOPHOCHEILUS) FROGGATTI, n.sp.

♂. Clypeus advanced and rather narrowly truncate anteriorly, punctured and clothed with long cinereous pubescence, with a strong carina from base to apex. Head very finely and closely punctured, interantennal prominence very broad and bilobed; an almost obsolete, interrupted carina from below the anterior ocellus, not reaching base of clypeus. Thorax very finely and closely punctured; median segment delicately rugulose, rounded and depressed. Abdomen fusiform, very finely punctured, segments almost smooth at their base; first segment oblique anteriorly, with a longitudinal sulcus from base not reaching apex; beneath the segment is obliquely truncate at apex, leaving a deep space between first and second segments. Segments 2-5 above with a strongly depressed transverse line near base. Epipygium rugose at apex; abdomen beneath rugulose. Hypopygium with a stout spine on each side near basal angles, thence sharply narrowed and produced with parallel sides, narrowly rounded at the base of the strong apical spine. Anterior coxæ strongly hollowed. Black; the pubescence thin and cinereous. Anterior margin of clypeus, mandibles except at apex, and a minute spot on each side above base of antennæ yellow. Legs, except coxæ, and tegulæ ferruginous. Wings flavo-hyaline, nervures fuscous. Length 22 mm.

♀. Clypeus with a carina from base. Head much broader than pronotum, only slightly convex, strongly rounded posteriorly, shining, almost smooth on vertex, finely punctured on front, with a short longitudinal sulcus between antennæ. Pronotum much broader than long, closely and finely punctured, not much narrowed posteriorly, anterior margin slightly arched, with a few large punctures from which spring long hairs. Mesonotum finely punctured, broadly rounded posteriorly. Median segment short, narrower than pronotum, obliquely truncate posteriorly, coarsely and sparsely punctured, surface of truncation shagreened. Abdominal segments sparsely punctured, smooth at base; first segment with apical margin raised and a groove before it, giving the appearance of a transverse carina before apex; second segment with seven or eight transverse carinæ, including the recurved apical margin, carinæ near base more or less irregular; apical half of fifth ventral segment longitudinally rugose. Pygidium longitudinally striated, oblique, not very narrow, sides parallel, epipygium narrowly rounded at apex, suddenly narrowed just before apex, leaving sharp angles. Black; legs and mandibles, except at apex, ferruginous; antennæ fusco-ferruginous.

Hab.—Leura, N. S.W.(Froggatt; ♂♀ in cop.); Woodford, Blue Mts.(Waterhouse; ♂). Types in Coll. Froggatt.

124. T. (LOPHOCHEILUS) KIRBYI, n.sp.

♂. Clypeus tumid in the centre, produced and rather narrowly truncate at apex; the whole head closely and finely punctured, prominence between antennæ deeply emarginate, pubescence on head long, whitish on front and sides, thinner and cinereous on vertex. Thorax finely and closely punctured, with thin cinereous pubescence; pronotum as broad as head; median segment short, depressed and oblique, with long, thin whitish pubescence. Abdomen fusiform, shining, finely punctured; a deeply impressed transverse line near base of segments 2-5; apical segment rugose, with three semicircular striæ at apex. Abdomen beneath strongly punctured, a fringe of short whitish pubescence on apical margin of the segments. Hypopygium carinate and punctured beneath, transversely striate above; a blunt projection on each side near base, thence produced in an elongate, triangular form, ending in a long, slender, faintly recurved spine. Opaque black; abdomen shining; mandibles, except at apex, and anterior margin of clypeus yellow. Tibiæ and tarsi fuscous. Wings pale fusco-hyaline, nervures black. Length 24 mm.

♀. Head convex, rounded, mandibles very blunt; clypeus transverse, with a median carina. The whole head sparsely punctured, with a short, median, longitudinal sulcus on front. Pronotum a little narrower than head, broader than long, very finely reticulate. Mesothorax and median segment sparsely punctured; median segment short, obliquely truncate posteriorly. First abdominal segment vertically truncate at base, with a longitudinal, median sulcus on surface of truncation, apical margin raised, with three or four fine transverse carinæ just before apex. Second segment with about twelve more or less irregular transverse carinæ, those near apex rather stronger than those at base. Third, fourth and fifth segments smooth at base, sparsely punctured at apex. Pygidium about twice as long as broad, vertical, sides nearly parallel, broadly rounded at apex, with a strong spine on each side near apex forming a continuation of lateral margins. Black; front and posterior margin of head, a broad band on first abdominal segment above the truncation, almost touching apical margin at sides, sides of second segment, apical half of three following segments and extreme base of pygidium yellow; clypeus, mandibles, antennæ, a broad band on vertex interrupted by a broad black V-shaped mark, a curved line on each side of abdominal segments 3-5 near apical margin and legs ferruginous-brown. Length 16 mm.

Hab.—Cumberland County, N. S.W.

125. T. (Lophocheilus) tuberculiventris Westw.

Thynnus tuberculiventris Westw., Arc. Ent. ii. 2, p.118, P.76, fig.2, 1844(♂).

This species may be distinguished from *T. crinitus* by the less strongly fusiform abdomen, which is also closely and shallowly punctured instead of smooth and shining; and by the presence of a small tubercle on each side of the second ventral segment close to the apical margin. Length 20 mm.

I have received a female with this species which can only be distinguished from that of *T. rufiventris* by the shape of the pygidium, the sides of which are not parallel but convergent towards the rounded apex. But it is possible that the pairing is inaccurate in this case.

Hab.—Albany, W.A.; Victoria(French).

126. T. (Lophocheilus) crinitus, n.sp.

♂. Clypeus moderately produced and rather broadly truncate at apex, only slightly convex. Head, thorax and median segment finely rugulose, clothed with fulvous pubescence on head and disc of thorax, with grey pubescence on median segment and on thorax beneath. Pronotum as broad as head, broadly emarginate anteriorly, with prominent angles. Median segment rounded, depressed from postscutellum. Abdomen fusiform, shining, with a slightly impressed transverse line near base of segments 2-5. Epipygium strongly punctured at base, with a few curved striæ at apex. Hypopygium with a rounded prominence on each side at basal angle, thence triangular to base of the acute and slightly recurved apical spine. Black; mandibles except at apex, anterior margin and sides of clypeus, a large spot on each side of all the dorsal segments of abdomen and of all except basal ventral segments orange; legs, except coxæ, ferruginous. Length 29 mm.

♀. Clypeus with a strong carina from base to apex. Head large, broader than long, strongly rounded, sparsely punctured, with a longitudinal sulcus between antennæ, eyes elongate-oval, not touching base of mandibles. Pronotum rather narrower than head, twice as broad as long, anterior margin slightly arched. Thorax and median segment sparsely punctured. Abdomen shining, sparsely and shallowly punctured, first segment vertically truncate anteriorly, surface of truncation slightly concave, apical margin raised, with several transverse striæ before it. Second segment with about twelve more or less irregular transverse carinæ; fifth ventral segment rugose at base, longitudinally striated at apex. Pygidium vertically truncate posteriorly and longitudinally striated, moderately broad, the sides parallel and produced into stout spines near apex of epipygium, hypopygium rounded at apex. Black; mandibles except at apex, antennæ, vertex, disc of pronotum and legs except coxæ ferruginous; front of head, mesonotum, sides of pronotum and of median segment, a broad band on first abdominal segment above truncation, and a very broadly interrupted band on the four following segments above and beneath orange-yellow. Length 21 mm.

Hab.—Melbourne(French; ♂♀ in cop.).

This is the Victorian form of *T. rufiventris* Guérin. In addition to the difference in colour the male may be distinguished by the shorter clypeus; and the female by the more elevated and less numerous carinæ on the second abdominal segment.

A male specimen sent by Mr. French was bred from a cocoon similar to that from which I have bred *Salius australasiæ* Sm., one of the largest of our Pompilidæ.

127. T. (Lophocheilus) rufiventris Guér.

Thynnus rufiventris Guér., Voy.Coq.Zool. ii. 2, p.227, 1830 [1839](♂); Sm., Cat. Hym. B.M. p.13, n.7, 1859(♀).

♂. Abdomen elongate-fusiform, shining, with a slightly impressed transverse line near base of segments 2-6, apical margin of the same segments depressed at sides. Hypopygium with a prominent tubercle on each side at basal angles, thence triangular to base of apical spine The whole abdomen ferruginous-orange, with a large spot of a lighter colour on sides of each abdominal segment.

♀. Clypeus with a carina at base, produced and almost pointed at apex. Mandibles very broad, blunt at apex. Head large, more than half as broad again as long, rounded at posterior angles, moderately convex, with a short longitudinal sulcus between antennæ. Pronotum about two-thirds of width of head, anterior margin arched, with a few large punctures along it, the sides parallel. When the head is depressed the prothorax is seen to be produced anteriorly into a depressed and narrowed neck; this is black and seems to be referred to by Smith as the prothorax, the pronotum and mesonotum being mentioned as the mesothorax and scutellum. Mesonotum transverse and very short, rather more than half as wide as pronotum, median segment short, obliquely truncate posteriorly. Abdomen much broader than thorax, first segment with a few indistinct transverse striæ and a broad groove just before apical margin; second segment transversely striated, with a broad groove before apex. Pygidium broad, vertically truncate, sides parallel, longitudinally striated. Length 21 mm.

Hab.—Sydney (Guèrin); Goulburn, N. S.W.(Froggatt; ♂♀ in cop.).

128. T. (Lophocheilus) wallisii Sm.

Thynnus wallisii Sm., Cat. Hym. B.M. vii. p.14, n.10, 1859(♂♀).

This species is allied to *T. rufiventris* Guèr. Smith's description of the male is fuller than usual, but the apical spine of the hypopygium is acute and slightly recurved, not blunt.

♀. Head sparsely punctured, shining, slightly convex, about half as broad again as long, rounded at posterior angles; mandibles broad, and blunt at apex; clypeus narrowly produced, with a delicate carina from base to apex. Thorax sparsely punctured; pronotum much broader than long, nearly as broad as head, anterior margin slightly arched, with a row of large setigerous punctures. First abdominal segment with several low transverse carinæ before apex; second segment with about twenty low transverse carinæ. Fifth ventral segment longitudinally striated. Pygidium vertically truncate posteriorly and longitudinally striated, sides of epipygium parallel, produced into short blunt spines a little before apex, which is pointed; hypopygium broad, narrowly emarginate at apex.

Hab.—Sydney(Smith); Melbourne(French).

129. T. (Lophocheilus) australis Boisd.

Thynnus australis Boisd., Voy. Astrolabe, Zool. ii. 6, p. 655, P. 12, fig. 2, 1833(♂).

I cannot identify this species from the very poor description, and the figure is utterly useless. I cannot, however, see any cause for supposing it to be identical with *T. annulatus* Kirby, of which it has been regarded as a synonym by many authors, who have followed a vague suggestion of Guérin, who is careful to state that he had not seen either species.

This may prove to be a form of *T. rufiventris* Guér. The length of the figure is 23 mm.

Hab.—Port Western(Boisd.).

130. T. (Lophocheilus) immodestus, n.sp.

♂. Clypeus strongly produced and rather broadly truncate at apex, convex and strongly punctured; a short tubercle at base of each antenna. Head and thorax very closely punctured, with thin pubescence, longest on sides of head; scutellum long, broadly truncate at apex. Median segment finely rugulose. Abdomen elongate, narrowed at base, smooth and shining, with a few scattered punctures. Hypopygium bluntly produced at sides near base, thence triangular to base of short apical spine. Black; clypeus and mandibles yellow; pronotum, tegulæ, a quadrate spot on mesonotum, scutellum, abdomen beneath and legs dull ferruginous; a spot on each side of all the abdominal segments and the whole of the seventh segment ferruginous-orange. Wings flavo-hyaline. Length 20 mm.

♀. Head much broader than long, slightly rounded at posterior angles, sparsely and deeply punctured. Thorax very sparsely punctured; pronotum rectangular, much broader than long, with a row of large setigerous punctures on anterior margin. Median segment short, obliquely truncate posteriorly, minutely and very closely punctured. Abdomen shining, very sparsely punctured; second segment with about nine irregular transverse carinæ. Pygidium truncate posteriorly, longitudinally striated, about half as long again as broad, sides nearly parallel. Fifth ventral segment longitudinally striated. Ferruginous-red; truncation of median segment and abdomen above black; an interrupted band on first, third and fourth segments and a spot on each side of second and fifth segments yellow. Pygidium ferruginous. Length 9 mm.

Hab.—Swan River. Types in Brit. Mus.

131. T. (Lophocheilus) senex Sm.

Thynnus senex Sm., Cat. Hym. B.M. p.19, n. 36, 1859(♂).

♂. Clypeus broad, convex, broadly truncate at apex, a small, oblique, broadly triangular truncation before apex in middle, giving it an appearance of emargination; finely punctured. Head rugulose, interantennal prominence very little developed; a shining, longitudinal line below anterior ocellus. Pronotum long, anterior margin raised with a deep groove behind it. Thorax and median segment finely rugulose. Median segment obliquely depressed, rounded, with a deep depression on each side near basal angles. Abdomen elongate-fusiform, the groove between first and second ventral segments very shallow. Hypopygium triangular, with an apical spine and slight rounded projections at basal angles.

Hab.—West Australia (Smith).

132. T. (Lophocheilus) connectens Sm.

Thynnus connectens Sm., Cat. Hym. B.M. vii. p.45, n. 131, 1859(♀).

♀. Allied to the female of *T. protervus* Sm., from which it differs as follows. Head and thorax almost smooth, mesonotum much broader, median segment coarsely and sparsely punctured, obliquely truncate from some distance behind mesonotum; first abdominal segment short and broad, without transverse striæ; carinæ on second segment rather more irregular and striæ on pygidium rather stronger.

Hab.—Perth, W.A.

133. T. (Lophocheilus) inconstans Sm.

Thynnus inconstans Sm., Cat. Hym. B.M. vii.p.26,n.66,1859(♂).
Thynnus signatus Sm., *l.c.* p.44, n.126, 1859(♀).

♂. Clypeus produced and broadly truncate at apex, rounded at base. Head, thorax, and median segment finely rugulose, disc of mesonotum and scutellum punctured. Abdomen sparsely punctured, slender, first segment oblique and very narrow at base, with a strong sulcus from base not reaching apex; segments 2-5 with a deeply impressed transverse line near base, apical margins depressed, leaving a raised mark before apex curved on sides and deeply emarginate in middle. Hypopygium with a strong rounded projection on each side at basal angles, thence elongate-triangular to apical spine.

♀. Head much broader than long, strongly rounded at posterior angles, deeply and rather sparsely punctured, with a faint, longitudinal, frontal sulcus. Pronotum rectangular, about half as broad again as long, almost smooth, with a few large punctures, each with a hair springing from it, along anterior and lateral margins. Median segment smooth, obliquely truncate posteriorly. Abdomen smooth, with a few large scattered punctures, first segment vertically truncate at base, with a transverse carina just before apex and apical margin raised. Second segment with many transverse carinæ, those near apex strongly raised, those near base irregular and not very distinct. Pygidium deflexed and vertically truncate posteriorly, longitudinally striated, about twice as long as broad, sides parallel. Fifth ventral segment longitudinally striated on apical half.

Hab.—S. E. Australia.

134. T. (Lophocheilus) flavipennis Sm.

Thynnus flavipennis Sm., Cat. Hym. B. M. vii. p. 21, n. 39, 1859 (♂).

♂. Clypeus convex, truncate at apex and sparsely punctured. Head and thorax closely and finely punctured, clothed above with fulvous pubescence, which is rather dense on pro- and mesonotum, the pubescence beneath thin and grey. Median segment shining, very finely rugulose, smooth at base. Abdomen elongate, third and fourth segments a little the broadest, smooth and shining, with a few scattered and minute punctures; segments 2-6 with an impressed transverse line near base. Epipygium rounded at apex, with a few curved striæ; hypopygium with basal angles bluntly prominent, broad and rounded, broadly subtruncate at apex, with a very short apical spine.

♀. Head convex, broader than long, strongly rounded at posterior angles, rather strongly but not very closely punctured, front between antennæ rugose with a short and feeble longitudinal sulcus. Thorax and median segment very finely punctured; pronotum almost as large as head, subrectangular, about half as broad again as long. Median segment obliquely truncate posteriorly. Abdomen very sparsely punctured, second segment with many (about fourteen) more or less irregular transverse carinæ, those near base very delicate, the two at apex rather more elevated. Pygidium not contracted, vertically truncate posteriorly and longitudinally striated, surface of truncation about twice as long as broad, sides parallel and produced into spines near apex, extreme apex narrower and smooth. Ferruginous-brown; truncation of median segment black. In some specimens the abdominal segments are stained with black. Length 11 mm.

Hab.—New South Wales.

The colour of the male is variable, some specimens being without the reversed barb-shaped spot mentioned by Smith. The abdominal segments are black at the base.

135. T. (LOPHOCHEILUS?) OPPOSITUS Sm.

Thynnus oppositus Sm., Descr. n.sp. Hym. p.162, n.12, 1879(♂).

♂. Clypeus broadly truncate anteriorly, very finely and closely punctured, a very delicate carina from base not reaching middle. Head, thorax and median segment very finely and closely punctured; a short, delicate, longitudinal carina below anterior ocellus. Abdomen shining, finely and shallowly punctured, segments not constricted; first segment truncate anteriorly, with a large blunt tubercle above truncation. Hypopygium with basal angles slightly prominent, thence broadly produced, rounded at apex, with an acute apical spine.

Hab.—Swan River, W.A.(Smith).

136. T. (LOPHOCHEILUS) APTERUS Oliv.

Myzine aptera Oliv., Encycl. Méthod. Insect. viii. p.137, n.7, 1811(♀).

Thynnus variabilis Kirby, Trans. Linn. Soc. Lond. xii. p.476, 1818(♂♀); Leach, Journn. de Physique, lxxxviii. p.178; n.2, 1819 (♂).

Myrmecodes flavoguttatus Latr., Nouv. Dict. Hist. Nat. Ed.2[a], xxii. p.143, 1819(♀).

Thynnus olivieri Erichs., Arch. f. Naturg. viii. P.1, p.262, n.235, 1842(♂♀).

Myrmecodes olivieri Lepel., Hist. Nat. Insect. Hym. iii. p.588, n.2, 1845(♀).

Var. *Thynnus audax* Sm., Trans. Ent. Soc. Lond. 1868, p.234, n.6(♂).

This is a common and exceedingly variable species. As far as I can see, the markings on the male are of no value for specific distinction, though it is possible that a long series would show that some of the variations are more or less local. *T. audax* Sm., is a variety in which the usual black groundcolour is replaced by ferruginous, and the yellow markings by a lighter shade of ferruginous. A fine variety from Queensland in Mr. Froggatt's

Collection has the two basal abdominal segments wholly orange-yellow, and the other segments wholly black.

I have seen a large number of females, but hardly any with accurate data as to locality, or taken in copula. They vary much, most markedly in the number and development of the carinæ on the second abdominal segment, so much so that I should have assigned the extreme forms to different species without any doubt had I seen no intermediate gradations. A large series with full data is much needed for a thorough knowledge of this species.

Hab.—Southern Australia from Albany, W.A., to Southern Queensland.

137. T. (Lophocheilus) hyalinatus Westw.

Thynnus hyalinatus Westw., Arc. Ent. ii. 2, p. 106, P. 74, figs. 3, 4, 1844 (♂♀).

Thynnus westwoodi Lep., Hist. Nat. Insect. Hym. iii. p. 566, n. 1, P. 35, fig. 6, 1845 (♂).

Thynnus graffii D.T., Cat. Hym. viii. 107, 1897 (♂).

Hemithynnus hyalinatus Ashm., Canad. Ent. xxxv. 1903 (♂♀).

This species has the thorax of the male black, with the posterior margin of the pronotum ferruginous. The limits of the species in the direction of *T. apterus* Oliv., are extremely ill-defined, and I fail to find any good point of distinction in the female.

The specimens I have seen are much smaller than *T. apterus*, of which it may prove to be a local variety.

Hab.—Tasmania; Lambton, N. S.W. (Schneider).

138. T. (Lophocheilus) maculosus Sm.

Thynnus maculosus Sm., Cat. Hym. B.M. vii. p. 16, n. 18, 1859 (♂).

This species resembles *T. apterus* in appearance, but the antennæ are much shorter, and the scutellum is longer. The nervure dividing the first cubital cell branches on the cubital nervure. The hypopygium is damaged in the type, and the mouth-parts have been removed.

Hab.—Australia(Smith).

139. T. (Lophocheilus) annulatus Kirby.

Thynnus annulatus Kirby, Trans. Linn. Soc. xii. 2, p. 476, 1818 (♂).

Thynnus brownii Leach, Journ. de Physique lxxxviii. p. 178, 1819 (♂).

Myrmecodes australis Gray, Griffith's Anim. Kingd. xv. p. 516, 1832 (♀).

Thynnus brownii Westw., Arc. Ent. ii. 2, p. 113, P. 76, fig. 1, 1844 (♂).

♂. Clypeus bell-shaped, but somewhat rounded anteriorly and strongly bent inwards at the apical angles. Hypopygium very broadly truncate, not reaching beyond the epipygium, except a short, narrow process to the base of the apical spine.

♀. The second abdominal segment has about thirteen transverse carinæ, those near apex most elevated, those near base irregular. Fifth ventral segment longitudinally striated on apical half. Pygidium truncate posteriorly, longitudinally striated, with a spine on each side parallel to the lateral margin.

Hab.—S.W. Australia.

140. T. (Lophocheilus) affinis Guér.

Thynnus affinis Guér., Voy. Coq. Zool. ii. 2, p. 226, 1830 [1839] (♂).

♂. There is a specimen in the British Museum which I assign to this species with some doubt. It is allied to *T. annulatus* Kirby, from which it differs in the shape of the hypopygium which is subtriangular, with an acute apical spine; and in the epipygium which is less strongly striated and not deflexed. There is a yellow spot on each side of all the abdominal segments, not of the first five only as in Guérin's type. The clypeus is shaped as in *T. annulatus*.

Hab.—Albany, W.A.

Subgenus Macrothynnus, n.subgen.

♂. Labrum broad and full as in *Thynnus*, from which it may be distinguished by the antennæ which are slender at the apex.

♀. Pygidium truncate posteriorly and broadly oval, not contracted before or on the truncation.

This group consists of a few very large species, two of which, *T. friederici* D.T., and *T. poultoni*, may have to be separated when closer examination is possible.

Type, *Thynnus simillimus* Sm.

141. T. (Macrothynnus) simillimus Sm.

Thynnus simillimus Sm., Cat.Hym.B.M.vii.p.15,n.12,1859(♂).
Thynnus molitor Sm., *l.c.* p.43, n.120, 1859(♀).

♂. Clypeus broad, truncate at apex, rugose. Head, thorax and median segment rugulose; median segment short, truncate from a little behind postscutellum, rounded at sides and covered with grey pubescence. Abdomen very closely covered with minute punctures, first segment as broad as second. Hypopygium with slight prominences at basal angles, very broad and rounded to apex, with a very short apical spine. Wings fusco-hyaline, with a purple sheen.

♀. Head coarsely and rather sparsely punctured, not quite as broad as pronotum. Thorax and abdomen sparsely and finely punctured, the four apical abdominal segments smooth at base. First abdominal segment with the apical margin raised and several transverse striæ before it. Second segment crossed near middle by eight transverse carinæ between two rather more elevated transverse carinæ, the apical margin raised, with four very small transverse carinæ just before it, and seven or eight very fine transverse carinæ near base, the whole forming a continuous series. Fifth ventral segment coarsely longitudinally striated, smooth at base. Pygidium smooth at base, not much contracted, vertically truncate posteriorly, with many arched carinæ on the surface of the truncation, which is large and oval; epipygium reflexed at apex.

Hab.—Sydney to Brisbane.

I sink *T. molitor* as the female of *T. simillimus* with very little hesitation, though I do not know that they have been taken coupled. Both sexes of the West Australian species *T. insignis* Sm., are very nearly related to this species. *T. molitor* cannot be the female of *T. klugii* Westw., as suggested by Smith, the localities being widely different; also the real female of *T. klugii* is now in the British Museum Collection.

142. T. (MACROTHYNNUS) INSIGNIS Sm.

Thynnus insignis Sm., Cat. Hym. B.M. vii. p.15, n.11,1859(♂).

♂. Clypeus broadly truncate at apex, sparsely punctured, with obscure, arched, transverse rugæ. Head, thorax and median segment with dense pubescence, that on the front, pronotum and disc of mesonotum fulvous, elsewhere grey. Head finely and very closely punctured, mesonotum rugose. Median segment almost vertically truncate from postscutellum. Abdomen smooth and shining, broadest at base. Hypopygium slightly prominent at the basal angles, thence very broadly subtriangular to base of the small apical spine.

♀. Head half as broad again as long, strongly rounded at posterior angles, shining, sparsely and deeply punctured, most closely between antennæ; clypeus with a short carina at its base, anterior margin straight. Pronotum smooth, anterior margin straight, with a row of deep punctures, about twice as broad as long, a little narrowed posteriorly and broadly emarginate. Mesonotum and median segment sparsely punctured, median segment widened from base, almost vertically truncate posteriorly. Abdomen large, very sparsely punctured; first segment vertically truncate anteriorly, apical margin raised, with a broad groove before it, giving the appearance of a transverse carina before apex; second segment with the apical margin raised, with a broad groove before it, the rest of the segment occupied by about ten broken and irregular, low, transverse carinæ between two more elevated carinæ. Pygidium vertically truncate posteriorly, smooth and shining at base, with strong, curved striæ above base of truncation, surface of truncation elongate-ovate, with strong longitndinal striæ on basal half. Fifth ventral segment longitudinally striated. Ferruginous-brown, mesonotum, median segment, second dorsal abdominal segment, base of third and pygidium black. Length 21 mm.

Hab.—Swan River, W.A.(Smith). Allied to *T. simillimus* Sm.

143. T. (Macrothynnus) friederici D.T.

Thynnus klugii Westw., Arc. Ent. ii. 2, p. 140, P. 82, fig. 1, 1844(♂).
Thynnus friederici D.T., Cat. Hym. viii. 107, 1897(♂).

♂. Clypeus strongly convex, depressed and very broadly truncate at apex, rugulose; interantennal carina broadly rounded at apex, a delicate carina from anterior ocellus nearly reaching base of clypeus. Head and thorax finely rugulose, the pubescence close and short, fulvous above and grey beneath; scutellum excavated on disc, with a subtubercular elevation on each side of the concave space. Median segment oblique, punctured-rugulose, with long grey pubescence. Abdomen almost smooth; first segment not quite as broad at apex as the second. Epipygium long, deflexed, broadly truncate at apex, coarsely striated, striæ curved at apex. Hypopygium broad at base, sharply narrowed and produced into a blunt, strongly recurved process. Length 38 mm.

The mandibles are very strongly bidentate, with a very long beard on the outer margin, the sides of the head with a fringe of long hairs; the antennæ slender at the apex; the anterior coxæ concave at their base; the spur on the anterior tibiæ strongly developed; hind femora swollen in the middle and subtuberculate.

♀. Mandibles long, bearded on outer margin, strong but not blunt at apex. Clypeus broadly but slightly emarginate at apex, with a carina from base to centre. Head sparsely punctured on vertex, more finely and closely on front, with a deep longitudinal frontal sulcus, which is very broad between the antennæ, where the front on each side of it is produced into an acute tubercle. Eyes oval, situated very near base of mandibles. Pronotum punctured-rugose, subrectangular, slightly narrowed posteriorly, anterior angles acute, broader than long. Median segment obliquely truncate posteriorly. The horny spur at apex of anterior tibiæ is as long as the two basal joints of the tarsus combined; and the basal joint of the anterior tarsi is strongly emarginate near the base. Abdomen strongly and rather sparsely punctured; first segment rugose, apical margin very slightly raised, with a narrow and shallow groove before it; second segment with the apical margin strongly raised and a delicate transverse carina near base, the intervening space transversely rugose-carinate. Pygidium not contracted, vertically truncate posteriorly, the face of the truncation oval and longitudinally striated. Fifth ventral segment transversely striated. Entirely fuscous. Length 27 mm.

Hab.—Swan River, W.A. Type of ♀ in British Museum.

Westwood suggests that his *T. gravidus* may be the female of this species, and Smith suggests *T. molitor.* The female described above was placed with the males in the British Museum Collection, and I feel no doubt as to the correctness of the sexing.

144. T. (Macrothynnus) poultoni, n.sp.

♂. Very nearly allied to *T. friederici* D.T., from which it differs in the following points: clypeus less convex and broadly emarginate at apex, and entirely black; pronotum slightly narrower and also entirely black, mesonotum more deeply sculptured; disc of scutellum coarsely rugose and much less concave than in *T. friederici*; median segment obliquely truncate from postscutellum; first abdominal segment broader and shorter; sculpture of epipygium coarser and the striæ much less regular, and it is much more narrowly truncate at the apex, and the hypopygium is much longer, though otherwise similar in shape. Structure of the posterior femora similar in the two species. Length 35 mm.

Hab.—Western Australia (Du Boulay); probably from the Champion Bay district. Type in British Museum.

145. T. (Macrothynnus) dilatatus Sm.

Thynnus dilatatus Sm., Cat. Hym. B.M. vii. p. 43, n. 121, 1859 (♀).

♀. Head rather small, subopaque, much broader than long. Pronotum slightly emarginate anteriorly, broader than head, subrectangular, a little broader than long. Thorax and median segment sparsely punctured; median segment almost vertically truncate posteriorly. First and second abdominal segments with the apical margin raised, and covered with many low and more or less irregular transverse carinæ; the three following segments with scattered punctures. Fifth ventral segment longitudinally striated. Pygidium vertically truncate posteriorly, with a few curved carinæ above and on the base of the truncation, surface of the truncation broadly oval, subtruncate at apex. Intermediate tibiæ very much dilated. Entirely black; legs and antennæ fuscous.

Hab.—Australia(Smith); N.W. Coast(British Museum).

Nearest to *T. novaræ* Sauss., but the pygidium in the present species is not sharply contracted before the truncation, on which account I place it in this group, but consider that it may very likely belong to one of the species of *Thynnus* proper.

Subgenus Thynnus.

Thynnus Fab., Syst. Ent. p.360, n.113, 1775.
Myrmecodes Latr., Gen. Crust. et Insect. iv. p.118, n.521, 1809.
Thynnoides Guér., Voy. Coq. Zool. ii. 2, p.214, 1830(1839).
Zaspilothynnus Ashm., Canad. Ent. xxxv. 1903.
Thynnides Ashm., *l.c.*
Thynnidea Ashm., *l.c.*
Tachynomyia Ashm., *l.c.*(nec Guér.).
Guérinius Ashm., *l.c.*
Homalothynnus Enderlein, Zool. Anzeiger, xxvii. p.466, 1904.

♂. Labrum broad and full, rounded at sides and very slightly narrowed at base. Joints of maxillary palpi subequal; antennæ of nearly even thickness throughout, not slender at apex. Second recurrent nervure received at a considerable distance from base of third cubital cell.

♀. Pygidium more or less sharply contracted at base of posterior truncation or on the truncation. Maxillary palpi usually two-jointed, but in *Thynnoides fulvipes* Guér., they are three-jointed.

I do not consider the distinctions given by Guérin for *Thynnoides* are sufficiently marked when a large number of species are examined.

Type, *Thynnus dentatus* Fab.

Ashmead's subgenera are very misleading; his species taken for the types are often wrongly identified, and the pairing is usually inaccurate. *T. pedestris* Fab., being the type of *Myrmecodes* Latr., that name must sink, as *pedestris* is undoubtedly a true Thynnus.

146. Thynnus dentatus Fab.

Thynnus dentatus Fab., Syst. Ent. p.360, n.1, 1775(♂); Smith, Cat. Hym. B.M. vii. 11, 1859(♂); Latr., Gen. Crust. et Insect. i. T.13, f.2-4, 1806(♂).

Smith gives a fair description of the male. Median segment vertically truncate and overlapped by scutellum and postscutellum. Abdomen conical, first segment truncate at base and not divided by a groove from the second beneath. Dorsal plate of apical segment longitudinally striated, narrowly emarginate at apex.

♀. Head smooth and shining, strongly rounded at posterior angles, front deeply excavated above base of antennæ, the concave area, extending two-thirds of the distance to the posterior margin, divided by a broad longitudinal carina, the surface of which is hollowed, longitudinally striated and thinly clothed with long hairs; on each side near base of carina, about half-way to eye, is a cluster of deep punctures from which spring a few long hairs. Eyes oval, not reaching base of mandibles. Pronotum as wide as head, anterior margin straight, narrowed posteriorly and broadly emarginate on posterior margin; covered with large shallow punctures, a row of deeper punctures along anterior margin from each of which springs a hair. Mesonotum small and smooth; median segment short, almost smooth, obliquely truncate posteriorly. First abdominal segment vertically truncate anteriorly, the surface of the truncation concave, a transverse carina just before the apex of the segment and a cluster of deep punctures with long hairs springing from them in the middle of the apical margin. Second segment above with nine transverse carinæ, including the recurved apical margin; the three following segments smooth, with a few large punctures near apex, the fifth deeply emarginate at apex above and beneath, strongly obliquely striated beneath. Pygidium contracted near base, very narrow, transversely striated between marginal carinæ on the contracted portion, thence obliquely truncated and slightly widened to apex, where it is narrowly emarginate. Black; a spot above base of antennæ, a spot on side of prothorax near anterior angle, mesothorax, a broad band above the truncation of first abdominal segment, a spot on each side of second segment, a band broadly interrupted on middle of third segment, curved on sides and nearly reaching apical margin, a spot on each side near apical angles of fourth and fifth segments and a line at base of anterior tibiæ yellow. Length 13 mm.

Hab.—Cooktown(Turner); Cairns, Q.(Nugent)♂; Lizard Island, Q., ♂♀(Brit. Mus.).

147. T. PULCHRALIS Sm.

Thynnus pulchralis Sm., Cat. Hym. B.M. vii. 68, 1859(♂); Sm., Brenchley's Cruise of the Curaçoa, P.43, fig.4, 1873.

This very variable species is close to *T. dentatus* Fab., of which it may possibly prove to be a variety. The colour in both species is very variable, nor is the darker colour of the wings in *T. pulchralis* a constant character. Both forms occur at Cooktown, but I have not seen *T. dentatus* from any locality south of Cairns. I have taken a specimen at Mackay almost intermediate in colour, which may prove to be another species, as the hypopygium is subconical at the apex instead of truncate or toothed.

The female can only be distinguished from that of *T. dentatus* by the rather more strongly raised and regular carinæ on the second abdominal segment, but a long series may show this to be a variable character.

Hab.—Adelaide, S.A., to Cooktown, Q.

148. T. VENTRALIS Sm.

Thynnus ventralis Sm., Trans. Ent. Soc. London (3) ii. 5, p.389, 1865.

Thynnus smithii Frogg., Proc. Linn. Soc. N.S. Wales (2) vi. p.16, 1891(♂).

Thynnus conspicuus Sm., Brenchley's Cruise of the Curaçoa p.457, P.43, fig.3, 1873(♂)[nec *T. conspicuus* Sm., Trans. Ent. Soc. 1868].

Thynnus wackernellii D.T., Cat. Hym. viii. 118, 1897(♂).

Homalothynnus eburneus Enderlein, Zool. Anzeiger, xxvii. p.468, 1904.

♂. Clypeus punctured, anterior margin almost straight between the toothed apical angles, base narrowly truncate, joined by a continuation of the interantennal prominence. A short longitudinal sulcus from anterior ocellus. Pronotum broadly emarginate anteriorly. The scutellum and postscutellum overlap the median segment, projecting beyond the vertical truncation. Abdomen conical. The whole insect shining, smooth, with minute punctures, abdomen more strongly punctured beneath. Dorsal plate of apical segment longitudinally striated above, emarginate at apex. Hypopygium obliquely striated above, punctured beneath, with a lateral tooth on each side near base, apical margin narrowly truncate with a strong apical spine. Apical margin of hypopygium varying a little in form as in *T. dentatus*.

♀. Head almost smooth, with a large shining depression on each side above base of antennæ, the broad ridge between the depressions with a longitudinal carina and raised marginal carinæ; a small space above each depression coarsely punctured, with a few long hairs. Pronotum sparsely punctured, narrowed posteriorly, anterior margin straight, posterior margin broadly emarginate. Mesothorax almost smooth, a small cluster of punctures with a few long hairs near base. Median segment short, almost vertically truncate posteriorly, sparsely punctured. Abdominal segments almost smooth above, the first vertically truncate anteriorly with a median sulcus on the truncation, a cluster of punctures with long hairs in middle of apical margin; second segment with nine prominent transverse carinæ, including the recurved apical margin; pygidium narrow, contracted near base, the contracted portion transversely striated, truncate posteriorly, surface of the truncation elongate-oval, and emarginate at apex. Abdomen beneath strongly but irregularly punctured and pubescent, fifth segment coarsely striated. Black; clypeus, depressions at base of antennæ, sides of prothorax near anterior angles, mesothorax, except a transverse line near base, a broad transverse band on first abdominal segment, a spot on each side of second, a band near apex of third, emarginate in middle, a transverse band almost interrupted on each side of fourth, a spot on each side of fifth on apical margin, head and thorax beneath, apical half of the two basal segments of abdomen beneath, a spot on each side of the three following segments and legs yellow; coxæ and femora above and tibiæ beneath black. Antennæ and fifth abdominal segment beneath fuscous. Length 17 mm.

Hab.—King's Sound, N.W.A.(Froggatt), Roebourne, N.W.A. ♂♀(French).

A very plentiful species, but I have seen only one female.

Smith calls *T. ventralis* a female, but describes a male. The type is not available, but I think the name must apply to this species.

149. T. EMARGINATUS Fab.

Thynnus emarginatus Fab., Syst. Ent. 360, 2, 1775(♂ as ♀).

♂. Clypeus truncate anteriorly, the angles not produced. Pronotum short, narrowed anteriorly, anterior margin raised and as broad as head. Thorax and scutellum shining; mesonotum much broader than long; scutellum very large, broadly rounded posteriorly, postscutellum produced much beyond the vertically truncate median segment, narrowly and deeply emarginate at apex. Abdomen broad at base, gradually tapering to apex; first segment vertically truncate anteriorly; sixth ventral segment with a short spine on each side at apical angles. Hypopygium broad at base, with a spine on each side, thence sharply narrowed to apex, the apical angles produced into short spines, with the usual central spine. Ferruginous-brown; mandibles, clypeus and posterior margin of pronotum yellow; scutellum fuscous at base and apex; abdominal segments with a pale ferruginous transverse band on each side. Wings hyaline, nervures fuscous. Length about 18 mm.

Hab.—Australia (Banks).

The type, probably taken at Cooktown, seems to be still unique. The hypopygium resembles that of *T. dentatus.*

150. T. PEDESTRIS Fab.

Tiphia pedestris Fab., Syst. Ent. p. 354, 8, 1775 (♀).

Myrmecodes pedestris Latr., Gen. Crust. et Insect. iv. p. 118, n. 521, 1809 (♀) [nec Ashm., Canad. Ent. xxxv.].

♀. Head shining on vertex with a few shallow punctures; front with a large and very shallow depression on each side divided by a faint longitudinal carina, the carina clothed with long hairs, a few long hairs on the depressions. Thorax shining, with sparse and scattered punctures; pronotum short, rather narrower than head, straight on anterior margin, strongly and broadly emarginate posteriorly. Median segment very short, almost vertically truncate from just behind mesonotum, angles at base of truncation prominent. Head black; front and outer margin of eyes yellow. Thorax yellow above, margins of pronotum black. Tibiæ and tarsi yellow. [Abdomen missing].

Hab.—Australia (Banks).

This is the female of a Thynnus of the typical group, but the depressions on the front are not deeply excavated as in *T. dentatus,* and the pronotum is shorter and more deeply emarginate posteriorly. It is nearer to *T. vernalis* described by me in this paper, and may prove to be the opposite sex of *T. emarginatus* Fab. Ashmead's remarks on *Myrmecodes pedestris* seem to refer to *T. apterus* Oliv.

151. T. BRENCHLEYI Sm.

Thynnus brenchleyi Sm., Brenchley's Cruise of the Curaçoa, p.456, P.43, fig.2, 1873(♂).

♂. Clypeus broadly truncate at apex, apical angles produced into short spines, pointed at base and almost extending to apex of the interantennal prominence. Head and thorax shining, finely punctured, very sparsely on the mesonotum and scutellum, the scutellum produced at apex into a fine tubercle, overhanging postscutellum and median segment. Abdomen elongate-conical, shining, finely punctured, sixth segment with a spine on each side at apical angles beneath, dorsal plate of apical segment longitudinally striate, broadly truncate at apex. Hypopygium with a spine on each side at base, thence subtriangular with an apical spine, transversely striated above. First segment beneath prominent at base.

Smith gives a good figure, but his description, as usual, is almost confined to colour.

♀. Mandibles broad and flattened at base, pointed at apex, with a minute tooth near middle of inner margin, external margin fringed with long hairs. Clypeus and head strongly punctured, head smooth on vertex and with a smooth, shallow depression on each side above base of antennæ, the space between the depressions broad, with a longitudinal carina which extends to base of clypeus. Front very strongly punctured, with long cinereous pubescence, posterior margin of head broadly emarginate. Pronotum as broad as head, broadly emarginate anteriorly, shallowly punctured, with a row of deeper punctures on anterior margin, from each of which springs a long hair. Mesonotum very narrow, rounded posteriorly, punctured, and clothed, except on anterior margin, with long, dense, cinereous pubescence. Median segment very short, almost vertically truncate posteriorly, smooth. First abdominal segment vertically truncate anteriorly, surface of truncation smooth, slightly concave, with a median sulcus, dorsal surface densely clothed at base with long fulvous pubescence, transversely striate, with a transverse carina before apex and apical margin recurved. Second segment with about nine transverse carinæ, including the recurved apical margin, those near base irregular and less prominent. The remaining segments smooth above. Abdomen beneath strongly punctured, with long thin pubescence; fifth segment coarsely longitudinally striated, emarginate. Pygidium compressed, truncate posteriorly, strongly narrowed just before truncation and transversely rugulose, smooth at base, surface of truncation elongate-oval, smooth. Black; depressions above antennæ, sides of prothorax anteriorly, a line at base of mesonotum interrupted in middle, a spot on each side of second and fifth abdominal segments, a broad band near apex of third and fourth; anterior portion of head beneath, prosternum and mesosternum, first abdominal segment in middle, a deeply emarginate band on second, a large spot on each side of third and fourth, coxæ beneath, a spot at base of trochanters and an obscure line at base of tibiæ yellow. Mandibles, except apex, tibiæ and tarsi fusco-ferruginous. Length 20 mm.

Hab.—Champion Bay, W.A.(Smith); Narrabri, N.S.W.(Froggatt); Mackay, Q.(Turner; ♂♀ in cop.).

152. T. OCHROCEPHALUS Sm.

Thynnus ochrocephalus Sm., Trans. Ent. Soc. London, 1868, 231(♂).

This is very near *T. brenchleyi.* It differs in the colour on the head and pronotum being ochraceous instead of yellow, also in the want of colour beneath. The clypeus is much more strongly longitudinally striated and less produced at the apical angles; there is a carina in the middle of the interantennal prominence. The scutellum is broadly subtruncate at the apex, not produced over the postscutellum, which reaches but does not project beyond the truncation of the median segment. The first abdominal segment beneath is obliquely, triangularly truncated at the apex, with a groove separating it from the second segment. The hypopygium is broader and shorter than in *T. brenchleyi*, and the whole insect is finely and much more closely punctured and opaque.

Hab.—Champion Bay, W.A.(Smith).

153. T. DARWINIENSIS, n.sp.

♂. Clypeus produced at apical angles into short spines, broadly emarginate between the spines, the emargination broken in the centre by a slight projection; sparsely punctured, prominent and pointed at base. Head finely and closely punctured, a short, V-shaped carina between antennæ, apex touching base of clypeus; a very fine longitudinal sulcus from apex of carina nearly reaching anterior ocellus. Pronotum finely punctured, most closely at sides. Disc of mesonotum and scutellum sparsely punctured, mesonotum with the usual two lateral sulci, the space between the sulci very finely and closely punctured. Median segment vertically truncate, finely punctured on sides, scutellum and postscutellum broadly rounded posteriorly, postscutellum reaching to the truncation of median segment, but not projecting beyond it. Mesopleuræ very finely punctured, clothed with short white pubescence. Abdomen shining, rather sparsely punctured, segments smooth on apical margin. First segment vertically truncate anteriorly, with a shallow median sulcus on truncation, as broad as second segment. Sixth segment beneath with a lateral spine at apical angles. Dorsal plate of epipygium coarsely longitudinally striated, emarginate at apex. Hypopygium with a prominent spine on each side near base, thence strongly narrowed, apical angles produced into short blunt spines at base of the strong apical spine. Abdomen beneath more coarsely punctured, with fine grey pubescence. Black; clypeus, labrum and mandibles pale yellow, mandibles ferruginous at apex; carina between antennæ, a small spot below anterior ocellus, two minute spots on vertex and margins of eyes narrowly interrupted at apex ochraceous-brown, margins of prothorax luteous-yellow; two oblique lines on each side of mesothorax, posterior margin of scutellum, the whole of postscutellum narrowly interrupted near the anterior angles and the truncation of median segment ochraceous-brown. Thorax beneath light ochraceous-brown, mesopleuræ black with an ochraceous line below base of primaries. Coxæ, femora and trochanters beneath, anterior tibiæ and tarsi ochraceous, posterior tibiæ fuscous. The truncation of first abdominal segment, a narrowly interrupted median transverse band on segments 2-6 pale yellow, median interruption broader on apical segments; the five basal segments beneath with an obscure black apical spot and a band on apical margin of sixth pale yellow. Wings hyaline, nervures testaceous-brown, tegulæ luteous-yellow. Length 16 mm.

Hab.—Port Darwin (G. Turner).

Most nearly allied to *T. nigropectus* Sm., but is much less strongly punctured. The colour is also different and less extensive.

154. T. ZONATUS Guér.

Thynnus zonatus Guér., Voy. Coq. ii. 2, p.222, 1830 [1839] (♂).

Thynnus nigropectus Sm., Descr. n.sp. Hym. B.M. p.165, n.19, 1879 (♂).

This is near *T. darwiniensis*, but is much larger; the whole insect is closely punctured, the coloured areas are more extensive, especially on the abdomen, and of a much brighter yellow. The abdomen is of a much more elongate shape. The hypopygium has two spines on each side; Smith says it is trifid. The colour of the mesothorax and abdomen differs slightly from Guérin's description, but I think my determination is correct. Guérin gives the length as 27 mm. I have a specimen measuring 23 mm., but Smith's type is smaller.

Hab.—Swan River (Smith), Roebourne, N.W.A. (French). Guérin gives no locality.

155. T. ELGNERI n.sp.

♂. Clypeus large, very broadly truncate at apex, finely longitudinally striated, pointed at base and touching interantennal prominence, which is very widely V-shaped. Head strongly punctured, anterior ocellus situated in a small depression. Thorax less strongly punctured than head; scutellum broadly rounded at apex; median segment obliquely truncate from postscutellum. Abdomen rather closely punctured; first segment obliquely truncate anteriorly; second segment a little broader than first or third. Sixth ventral segment with a spine on each side at apical angles. Hypopygium with a broad spine on each side near base, thence sharply narrowed and produced, emarginate at apex, with a short spine at each of the angles and a strong central spine. Black; mandibles, clypeus, interantennal prominence, except a black median line not reaching apex, margins of eyes very narrowly interrupted at summit, an interrupted transverse line on vertex, margins of pronotum, tegulæ, a large quadrate spot on posterior margin of mesonotum, mesopleuræ, except a large black spot beneath posterior wing, apical half of scutellum, postscutellum, median segment except a broad black line on each side, a transverse band on the six basal abdominal segments above, interrupted in middle except on first segment, apex of first ventral segment, the whole of the three following segments and apex of fifth yellow; legs ferruginous; anterior coxæ yellow. Wings hyaline, nervures black, stigma ferruginous. Length 11 mm.

Hab.—Cape York, Q. (Elgner). Type in Coll. Froggatt.

This species resembles *Agriomyia maculata* Guér., in colour, but not in any structural details.

156. T. SABULOSUS, n.sp.

♀. Head strongly rounded at sides, broadly emarginate posteriorly, vertex slightly convex and smooth, front strongly punctured, with long hairs and a strong, short, median carina; a rather shallow, smooth depression between base of antenna and eye, the eyes oval, reaching nearly to base of mandibles, the position of the posterior ocelli indicated by a large puncture on each side on vertex. Pronotum finely and very shallowly punctured, a row of deep punctures each with a hair springing from it along anterior margin, which is almost straight, hind margin broadly emarginate. Mesonotum punctured; median segment smooth, short and obliquely truncate posteriorly.

EUCALYPTUS CALEYI, Maiden (DROOPING IRONBARK.)

EUCALYPTUS CREBRA (on the right); E. CALEYI (on the left).

Abdomen very sparsely punctured; first segment obliquely concavo-truncate anteriorly, with a faint, interrupted, transverse carina before apex, apical margin raised. Second segment with eight transverse carinæ, including the recurved apical margin, the apical carinæ the strongest. Pygidium smooth at base, vertically truncate posteriorly, contracted and transversely striated before the truncation, surface of truncation oval, slightly emarginate at apex, almost smooth. Fifth segment beneath longitudinally striated. Anterior tibiæ strongly notched at apex and produced into three spines. Pale yellow; mandibles, antennæ, tarsi, pygidium and fifth abdominal segment beneath fusco-ferruginous; front, sides and posterior margin of head united with a triangular mark on vertex, a transverse band close to anterior margin of pronotum and posterior margin narrowly, anterior margin of mesonotum, truncation of median segment, truncation and apical margin of first abdominal segment, second segment except a spot on each side, a curved mark on each side of third and fourth segments on apical margin and sides and base of the segments, fifth segment except a spot on each side near apical angles, base of first segment below, trochanters and femora above and tibiæ below black; apical margins of abdominal segments 2-4 beneath and a broadly triangular mark at apex testaceous. Length 17 mm.

Hab.—Adelaide River, Northern Territory. Type in Brit. Mus.

157. T. VESTITUS Sm.

Thynnus vestitus Sm., Cat. Hym. B.M. vii. p 15, 1859 (♂).

♂. Clypeus truncate anteriorly, shallowly punctured, connected by a fine carina with interantennal prominence, which is divided by a delicate longitudinal carina. The whole head finely punctured-rugulose, opaque, with a small shining mark below anterior ocellus. Pronotum with anterior margin raised and broadly emarginate, very shallowly and finely punctured-rugulose. Mesonotum and scutellum punctured, scutellum with a median longitudinal carina. Median segment closely punctured, with a strong median sulcus from base to truncation, not covered at base by the postscutellum, obliquely truncate posteriorly, with long white pubescence, thickest on sides. First abdominal segment narrowed to base, obliquely concavo-truncate anteriorly, with a deep median sulcus on truncation, carinate beneath and truncate at apex, the carina produced into a small tubercle over truncation. The whole abdomen shallowly punctured, most closely and finely beneath. Sixth segment with a spine on each side at apical angles beneath. Dorsal plate of seventh segment above longitudinally striated, broadly subtruncate at apex; hypopygium with a strong spine on each side near base: [apex damaged in the type]. Otherwise as in Smith's description.

Hab.—Swan River, W.A. (Smith).

158. T. LEACHIELLUS Westw.

Thynnus leachiellus Westw., Arc. Ent. ii. 2, p.135, P.77, fig.1, ♂, P.83, fig.4, ♀, 1844.

Thynnus interruptus Westw., *l.c.* p.115 (nec Klug) [♂].

Zaspilothynnus leachiellus Ashm., Canad. Ent.xxxv. 1903 (♂♀).

♂. First abdominal segment beneath prominent in middle with an oblique triangular truncation at apex. There is a spine on each side of the sixth segment beneath at the apical angles, not of the fifth as Ashmead states.

♀. The depression on each side of head above antennæ very large, reaching to posterior margin. Ashmead seems to rely on this character in founding his genus *Zaspilothynnus*, but it is found in females of typical *Thynnus* allied to *T. dentatus*. Ashmead, with his usual inaccuracy, describes quite a different female in his generic description of *Thynnus*.

Hab.—Sydney, N.S.W.; Moreton Bay (Brit. Mus.).

A very common species.

159. T. VERNALIS, n.sp.

♂. Clypeus truncate anteriorly, apical angles very slightly prominent, punctured and with a little fine pubescence, which in some lights gives the clypeus the appearance of being longitudinally striated; connected at base with the interantennal prominence by a short narrow carina. Head very finely rugulose in front, delicately punctured on occiput; the whole thorax finely punctured, scutellum higher than mesonotum with a depressed transverse line at base; median segment very finely rugulose, with grey pubescence, obliquely truncate from postscutellum. Abdominal sparsely punctured above, more coarsely beneath. First segment narrow at base, as broad at apex as second, beneath prominent in middle with a small oblique subtriangular truncation at apex. Sixth segment beneath with a spine at apical angle on each side. Dorsal plate of seventh segment coarsely longitudinally striated, rounded at apex. Hypopygium finely transversely striated above, with a spine on each side near base, thence rather narrowly produced, gradually narrowed into a sharp, slightly recurved, apical spine. Black; clypeus, mandibles except at apex, the prominence between antennæ, margins of eyes narrowly interrupted at apex, margins of prothorax, anterior margin narrowly interrupted in middle, tegulæ, a spot on mesopleuræ at base of forewing, another very small one behind it, a transverse band near apex of scutellum, a spot on each side at anterior angles, postscutellum, an irregular longitudinal band on middle and a longitudinal band on each side of median segment, a transverse band on the six basal abdominal segments, interrupted in middle and wider beneath than above, coxæ beneath and a line beneath posterior and intermediate femora yellow; tibiæ, tarsi, apex of sixth abdominal segment and seventh segment dull ferruginous. Wings very pale, flavo-hyaline, nervures fuscous. Length 22 mm.

♀. Head convex, sparsely punctured in front, almost smooth on occiput, without any depressed space; eyes oval, oblique, situated at some distance from base of mandibles. Pronotum shining, with a few small, scattered punctures, a row of punctures, each with a long hair on anterior margin, as broad as head, slightly narrowed posteriorly, anterior margin almost straight, posterior margin broadly emarginate. Median segment very short, obliquely truncate posteriorly, punctured on sides. First abdominal segment vertically truncate anteriorly, with a tuft of long hairs in middle before apex, two transverse carinæ near apex and apical margin recurved forming a third; beneath with a slight truncation at apex. Second segment with about eleven transverse carinæ, excluding the recurved apical margin, carinæ in middle irregular, those at apex the strongest. The remaining segments smooth above, with a few punctures at apex, coarsely punctured beneath, smooth at base; fifth segment beneath longitudinally striated. Pygidium compressed, truncate posteriorly, narrowest just before truncation, transversely striated above, truncation of an oval shape. Black; mandibles at their base, flagellum, fifth abdominal segment beneath, tibiæ and tarsi dark ferruginous; a large subquadrate spot above base of antennæ on each side, a large spot on each side of pronotum joining on middle of anterior margin, leaving posterior margin and sides broadly black, mesothorax except a transverse line at base, a broad transverse band above truncation of first abdominal segment, a spot on each side of second, a narrowly interrupted transverse band in middle of third, a transverse spot on each side of fourth, a triangular spot near apex of first segment beneath and a large spot on each side of the three following segments yellow. Length 19 mm.

Hab.—Mackay, Q. (Turner; ♂♀ in cop.).

160. T. ANCHORITES, n.sp.

♂. Clypeus truncate anteriorly, apical angles slightly produced, pointed at base and connected by a narrow carina with apex of interantennal prominence; head densely and finely punctured, most finely so on front, a short longitudinal sulcus between antennæ. Pronotum about as broad as head, punctured, anterior margin raised. Mesothorax and scutellum densely punctured, scutellum with an ill-defined longitudinal carina, broadly rounded at apex. Median segment oblique, concave at apex, very finely and densely punctured. Abdomen densely and shallowly punctured, first segment rounded and obliquely truncate anteriorly, with a deep median sulcus on truncation, as wide at apex as second segment. Dorsal plate of apical segment shining in centre, longitudinally striated at sides. Hypopygium triangular, with the basal angles produced into tubercles, transversely rugulose above, with a faint median carina, punctured beneath, apical spine slightly curved. Black; clypeus, mandibles, except at apex, margins of eyes narrowly interrupted at apex, two spots between antennæ, pronotum, except a black spot on posterior margin in middle and sides at posterior angles, a spot on mesopleuræ beneath wing, a large square spot on scutellum, postscutellum, a large spot on median segment with a spot on each side near apical angles, a broad band on each of abdominal segments except seventh, narrowly interrupted in centre except on basal segment, base of first segment beneath, and a large spot on each side of segments 2-5 bright yellow. Wings light flavo-hyaline, nervures black. Length 23 mm.

Hab.—Killalpanima, S.A., 100 miles east of Lake Eyre(H. J. Hillier). Type in Brit. Mus.

161. T. CAMPANULARIS Sm.

Thynnus campanularis Sm., Trans. Ent. Soc. Lond. 1868, p.232, n.2(♂).

♂. Clypeus broadly truncate at apex, irregularly longitudinally striated, pointed at base and connected with interantennal prominence by a short narrow carina. Head and thorax closely and finely punctured, median segment obliquely truncate from postscutellum, surface of truncation slightly concave and delicately rugulose. Abdomen elongate, first segment obliquely truncate anteriorly, concave at base; beneath with an oblique triangular truncation at apex, separated by a shallow groove from second segment. A faintly impressed transverse line near base of second and third segments. Sixth segment with a spine on each side at apical angles beneath; dorsal plate of apical segment narrowly rounded at apex, rugulose at base, longitudinally striated on sides and at apex. Hypopygium with a prominent spine at base on each side, thence narrowly produced to the apical spine, which is slightly recurved.

Hab.—Sydney(Smith).

162. T. confusus Sm.

Thynnus confusus Sm., Cat. Hym. B.M. vii. p.13, n.5, 1859(♂).

♂. The whole insect closely punctured; median segment almost vertically truncate from postscutellum. First abdominal segment almost vertically truncate anteriorly; beneath with a small oblique, triangular truncation at apex and a groove between first and second segments. There is no spine at the apical angles of the sixth ventral segment. Dorsal plate of apical segment punctured, broadly rounded at apex. Hypopygium only slightly prominent near basal angles, thence sharply narrowed and very narrowly produced to apical spine.

Hab.—Australia(Smith).

A specimen in the British Museum Collection, which appears to be an immature or discoloured example of this species, is from the Swan River.

I do not regard this species as in any way allied to *T. variabilis* Kirby, as suggested by Smith.

163. T. sulcifrons Sm.

Thynnus sulcifrons Sm., Cat. Hym. B.M. vii. p.43, n.119, 1859(♀).

♀. A broad central elevated ridge on head reaching from vertex to clypeus, with a deep excavation on each side reaching nearly to posterior margin, head widened and rounded behind eyes, shining, with a few minute punctures. Pronotum nearly twice as broad as long, sparsely punctured, a row of large punctures along anterior margin, each with a long hair springing from it. Median segment almost smooth. Abdomen smooth with a few scattered punctures; first segment vertically truncate anteriorly, with a transverse carina before apex and apical margin recurved; second segment with about ten transverse carinæ, including the recurved apical margin. Pygidium compressed, truncated posteriorly, very narrow just before truncation, with sides concave and obliquely striated; surface of truncation broader than long, rugose at base, apex smooth, rounded and expanding at sides.

Hab.—Swan River.

This may prove to be the female of *T. confusus* Sm.

164. T. SEDUCTOR Sm.

Thynnus seductor Sm., Trans.Ent.Soc.Lond.1868,p.234,n.7(♂).

♂. Clypeus broadly subtruncate anteriorly, apical angles not prominent, punctured-striate. Interantennal prominence deeply emarginate. Pronotum broadly emarginate anteriorly, the angles slightly produced. Median segment obliquely concavo-truncate from postscutellum, with a small tubercle on sides near base, covered with long grey pubescence. First abdominal segment obliquely truncate anteriorly, as broad at apex as second, divided beneath from second by a shallow groove. Sixth segment without a spine at apical angles beneath; dorsal plate of seventh segment very slightly produced, narrowly rounded at apex, rather faintly longitudinally striated. Hypopygium triangularly prominent at basal angles, thence broadly produced and rounded at apex, with a short, curved, apical spine, above obliquely striated, with a longitudinal carina.

♀. Head shining, sparsely punctured, rounded at posterior angles, eyes small and narrow. Thorax and abdomen almost smooth, very sparsely punctured; pronotum nearly as long as broad; median segment almost vertically truncate posteriorly; first abdominal segment vertically truncate anteriorly, transversely striated, apical margin raised. Second abdominal segment with many transverse carinæ, apical carinæ much more prominent than basal. Pygidium obliquely truncate posteriorly, narrow at base and transversely striated between the marginal carinæ which diverge to base of truncation; surface of truncation smooth, broadly oval, with three arched carinæ near base, epipygium reflexed at apex. Fifth segment beneath transversely striated, rugose at base. Head and thorax light ferruginous, abdomen yellow, all the segments at base and sides and apical margin of second segment black. Legs fuscous. Length 15 mm.

Hab.—Champion Bay, W.A. (Smith; ♂♀ in Brit. Mus.).

The pronotum in the female is broadly emarginate anteriorly, and there is a very slight subtuberculate prominence in the middle of the first abdominal segment above the basal truncation.

165. T. PICTICOLLIS, n.sp.

♀. Head nearly twice as broad as long, very sparsely punctured, a short longitudinal sulcus on front. Pronotum as broad as head, half as broad again as long, very slightly narrowed posteriorly, almost straight on the anterior, broadly emarginate on posterior margin, very finely and closely punctured, a few deep punctures along anterior margin. Mesonotum and median segment sparsely punctured, median segment very short, depressed, vertically truncate posteriorly. Abdomen smooth with a few scattered punctures, first segment truncate anteriorly, with about four irregular transverse carinæ near apex, including the raised apical margin. Second segment broader than first; with about fifteen transverse carinæ, decreasing in elevation from the recurved apical margin to the basal carinæ. Pygidium contracted, smooth at base, vertically truncate posteriorly, strongly contracted and transversely striate just before truncation, surface of truncation oval and finely longitudinally striated, smooth at apex. Beneath the first segment is prominent at the base, with a groove between first and second segments, all the segments shining with sparse punctures, except fifth which is rugose at base in middle, elsewhere coarsely obliquely striated. First joint of anterior tarsi produced on the outside at apex, strongly emarginate at base on inner side with a small tubercle near middle. Black; pronotum except posterior margin ferruginous-red. Length 21 mm.

Hab.—Swan River, W.A. Type in Brit. Mus.

166. T. EXCAVATUS, n.sp.

♂. Clypeus truncate anteriorly, apical angles pointed, punctured, with fine thin pubescence, connected at base by a broad carina with interantennal prominence, on which there is a very fine longitudinal carina. Head finely rugulose on front, finely punctured on occiput. Thorax finely rugulose, densely punctured on disc of mesonotum, scutellum elevated with a depressed transverse line at base. Median segment obliquely truncate from postscutellum, surface of truncation concave. Abdomen punctured above and beneath, elongate-conical, first segment obliquely truncate anteriorly, concave at base and narrowed, as broad at apex as second, beneath prominent in middle, subtuberculate, with a triangular truncation at apex. Sixth segment with a spine at apical angles beneath. Dorsal plate of apical segment longitudinally striated, rounded at apex; hypopygium transversely striated above, with a spine on each side near base, thence gradually narrowed, terminating in a slightly recurved apical spine. Black; mandibles except at apex, clypeus, two oblique lines between antennæ, margins of eyes interrupted at apex yellow; base of fourth and the whole upper surface of the following abdominal segments flavo-ferruginous. A little thin grey pubescence on head and on sides of median segment. Wings fusco-hyaline at base, hyaline at apex. Length 19-28 mm.

♀. Head smooth on vertex, front and clypeus punctured, clypeus with a very short carina at base; a densely punctured space between the antennæ clothed with fulvous pubescence. Pronotum as broad as head, nearly twice as broad as long, slightly narrowed and broadly emarginate on posterior margin, smooth and shining, with a few scattered punctures, a row of punctures along anterior margin with long fulvous hairs; a large but not deep depression on each side of pronotum, touching anterior margin. Mesonotum and median segment sparsely punctured, median segment short and vertically truncate posteriorly. First abdominal segment vertically truncate anteriorly, pubescent at base, with two transverse carinæ before apex and apical margin recurved. Second segment with about eleven transverse carinæ, including the recurved apical margin, basal carinæ curved to centre, leaving a few interrupted ones at sides near base; the remaining segments sparsely punctured above, more closely beneath. Fifth segment beneath longitudinally striated. Pygidium truncate posteriorly, slightly narrowed before truncation and transversely striated, surface of truncation smooth, faintly emarginate at apex. Black; depressed marks on pronotum, base of first abdominal segment above truncation, a band interrupted in middle near base of second, a transverse mark on each side on third and a minute spot on each side of fourth yellow. Length 16-25 mm.

Another specimen has the yellow bands on the second and third segments continuous, and almost the whole of the pronotum and mesonotum yellow. A male from Cooktown has the wings darker and flushed with purple.

Hab.—Cairns, Q.(Turner; ♂♀ in cop.); Cooktown(Brown; ♂).

167. T. FENESTRATUS Sm.

Thynnus fenestratus Sm.,Cat.Hym.B.M.vii.p.18, n.27, 1859 (♂).
Thynnus crassipes Sm., *l.c.* p.44, n.123, 1859 (♀).

♂. Clypeus truncate anteriorly, sparsely and coarsely punctured, labrum emarginate at apex, head and thorax finely punctured rugulose; median segment covered with long pubescence, truncate posteriorly, postscutellum not quite reaching base of truncation. First abdominal segment obliquely truncate anteriorly, beneath with a prominent carina from base to apex, a triangular truncation at apex and a groove between first and second segments. Dorsal plate of apical segment longitudinally rugose; a short blunt spine on each side of sixth segment beneath at apical angles. Hypopygium with a projection on each side near basal angle, thence gradually narrowed towards apex, then narrowly produced to base of apical spine.

♀. Head very strongly punctured on front, smooth on vertex, posterior angles only slightly rounded; pronotum of the same breadth as head, nearly as long as broad, broadly emarginate anteriorly, not narrowed posteriorly, smooth with a row of large punctures along anterior margin, each with a hair springing from it. Median punctured, with long hairs, obliquely truncate posteriorly. First abdominal segment vertically truncate anteriorly, with four strong transverse carinæ before apex and apical margin recurved; second segment with seven transverse carinæ, including the recurved apical margin; the remaining segments smooth at base, with large sparse punctures near apex. Fifth segment beneath transversely rugose. Pygidium contracted at base, then obliquely truncate, transversely striate between diverging marginal carinæ to apex of epipygium, hypopygium expanded at apex with membranaceous sides. Black; mandibles, antennæ and legs fuscous. Length 12 mm.

Hab.—Swan River (Smith); Champion Bay, W.A.(Du Boulay).

168. T. MOROSUS Sm.

Thynnus morosus Sm., Descr. n.sp. Hym. p.168, n.28, 1879 (♂).

♂. Clypeus broadly truncate anteriorly, shining, very sparsely punctured. Scutellum raised above mesonotum, with a depressed transverse line at base, broadly subtruncate at apex. First abdominal segment beneath with an oblique triangular truncation at apex, first and second segments separated by a shallow groove, second segment feebly prominent in middle of basal margin beneath. A short spine on each side at apical angle of sixth segment beneath. Hypopygium with a strong spine on each side near base, thence gradually narrowed, thence narrowly produced and slightly widened to base of apical spine, where it is truncate.

Hab.—Champion Bay, W.A.

In fresh specimens the thorax is clothed with long fulvous pubescence; on the median segment and beneath the pubescence is grey.

169. T. FLAVILABRIS Guér.

Thynnus flavilabris Guér., Mag. de Zool. xii. p.8, 1842 (♂); nec *Guérinius flavilabris* Ashm., Canad. Ent. xxxv. 1903(♂).

♂. The first abdominal segment beneath has a small, oblique, triangular truncation at apex. There is no spine at the apical angles of the sixth ventral segment; the apical segment is rugose, broadly rounded at apex. Hypopygium transversely striated at base above, longitudinally striated near apex, with a blunt spine on each side near base, thence gradually narrowed to base of apical spine where it is narrowly rounded. The palpi are rather longer and much stouter than in typical species of *Thynnus*. Black; clypeus yellow, median segment densely clothed with white pubescence.

Hab.—Sydney, N.S.W. (G. A. Waterhouse).

The female of this large and common Sydney species appears to be still unknown. Ashmead's identification is undoubtedly erroneous. The labrum of *T. flavilabris* is not bilobed, nor are the sides of the hypopygium almost straight.

170. T. picipes Westw.

Thynnus picipes Westw., Arc. Ent. ii. 2, p. 114, P. 77, fig. 2, 1844(♂).

Thynnus pubescens Lepel., Hist. Nat. Hym. iii. p. 569, n. 2, 1845(♂).

Thynnus oblongus Sm., Trans. Ent. Soc. London, 1868, p.232, n.3(♂).

Thynnus blasii D.T., Cat. Hym. viii. 103, 1897(♂).

♂. Closely allied to *T. flavilabris* Guér., but the clypeus is much less coarsely punctured, the abdomen finely and closely punctured and clothed with short, thin, white pubescence, and the hypopygium is narrower. The tibiæ and tarsi are dull ferruginous.

Hab.—Albany, W.A. (Westwood); Melbourne(French).

171. T. obscuripennis Guér.

Thynnus obscuripennis Guér., Voy. Coq. Zool. ii. 2, p.227, 1830 [1839](♂).

I have not seen this species, which seems to be allied to the shuckardi-group, but is apparently distinct from *T. flaviventris*.

172. T. SHUCKARDI Guér.

Thynnus shuckardi Guér., Mag. de Zool. xii. p.7, P.100, fig.13, 1842 (♂); Westw., Arc. Ent. ii. 2, p.136, ♂♀, P.83, fig.5, ♀, 1844 (♂♀).

The male of this species is very well figured by Guérin. It is a very common species in the neighbourhood of Sydney, and may be distinguished from the allied Victorian *T. guérinii* Westw., by the pubescence on the median segment, which is golden in *T. shuckardi* and white in *T. guérinii.* The breadth of the hypopygium is variable in both species, and I should certainly be inclined to sink Westwood's name were it not that the females received from Mr. French as those of *T. guerinii* show a marked difference in the sculpture of the second abdominal segments, showing about thirteen transverse carinæ instead of about eight, as in *T. shuckardi.* The fifth abdominal segment beneath is transversely rugose in *T. shuckardi,* strongly obliquely rugose-striate in *T. guérinii.* The pygidium seems to be rather narrower in *T. shuckardi. T. flaviventris* Guér., is also very near, but always has the two apical abdominal segments black; and the female will probably prove to be distinct.

Hab.—Sydney.

173. T. GUERINII Westw.

Thynnus guérinii Westw., Arc. Ent. ii. 2, p.137, 1844(♂).

The male, as I have stated, seems only to differ from *T. shuckardi* in the colour of the pile on the median segment.

♀. Head shining, front strongly, vertex delicately and sparsely punctured; much broader than long, convex, rounded at posterior angles. Pronotum nearly smooth, half as broad again as long, sides parallel, anterior margin straight, with a row of deep punctures from each of which springs a long hair. Mesonotum and median segment punctured, median segment widened from base to the truncation, vertically truncate posteriorly. First joint of anterior tarsi very broad and strongly emarginate at base on inner margin. First abdominal segment vertically truncate anteriorly, punctured-rugose, apical margin raised, with a deep transverse groove before apex, which gives the appearance of a second transverse carina when the segment is viewed from behind. Second segment with about thirteen transverse carinæ, those at base much less elevated and more irregular than those at apex. The three following segments smooth at base, with large scattered punctures at apex. Pygidium narrow, contracted before base of posterior truncation, transversely striated between diverging marginal carinæ to near apex of epipygium which is dilated into a curved process on each side; hypopygium rounded and narrowly emarginate in middle at apex, projecting very little beyond epipygium. Fifth segment beneath obliquely rugose-striate. Entirely chestnut-brown. Length 14 mm.

Hab.—Melbourne (French); Albany, W.A.(Westwood).

I see no reason to doubt the correctness of the pairing in this case.

174. T. FLAVIVENTRIS Guér.

Thynnus flaviventris Guér., Voy. Coq. Zool. ii. 2, p.229, 1830 [1839](♂); Guér., Mag. de Zool.xii. p.7,P.101, figs.21-23,1842(♂).

The two apical abdominal segments seem always to be black, and the wings fusco-hyaline. The species varies much in size, Guérin's figure representing an unusually small specimen; most specimens are quite as large as *T. shuckardi*. In Guérin's figure of the hypopygium the basal prominence is not shown, but I have little doubt that this a mistake.

The probable female differs from that of *T. shuckardi*, but as I do not feel much confidence in the correctness of the pairing, I think it best to leave it undescribed.

Hab.—Swan River.

175. T. VARIPES Sm.

Thynnus varipes Sm., Cat. Hym. B.M. vii. 67, 1859(♂).

Thynnus vespoides Sm , Descr. n.sp. Hym. 165, 1879(♂).

Thynnus indistinctus Sm., Descr. n.sp. Hym. 169, 1879(♂).

Thynnus substitutus Schulz, Spolia Hymenopterologica, p.160, 1906 (♂).

Clypeus sparsely punctured; head and thorax rugulose, clothed with dense cinereous pubescence; median segment abruptly truncate from just behind postscutellum, covered with long white pubescence. Abdomen subconical, closely and shallowly punctured; first segment almost vertically truncate anteriorly, with a longitudinal carina beneath from base to apex, where there is a very small vertical triangular truncation. Apical segment coarsely punctured, broadly truncate at apex. Hypopygium with a prominent spine on each side at base, thence more or less gradually narrowed, and produced to base of apical spine; transversely striated above.

Hab.—Adelaide, S.A.; Western Australia (Smith).

The differences between *T. varipes* and *T. vespoides* are confined to the colour on the fifth abdominal segment. In *T. indistinctus* the colour is more obscure, but there does not appear to be any other distinction. Smith merely examined the specimens superficially, and attached far too much importance to colour.

176. T. FLAVOPICTUS Sm.

Thynnus flavopictus Sm., Cat. Hym. B.M. vii. 21, 1859(♂)

♂. Clypeus irregularly longitudinally striated, broadly truncate at apex, the apical angles not produced, pointed at base and connected by a narrow carina with the interantennal prominence, which is emarginate at apex. Head very finely rugulose, with thin fulvous pubescence; thorax finely and closely punctured, scutellum broadly subtruncate at apex. Median segment obliquely truncate from postscutellum, with a short, longitudinal sulcus on each side near apex, minutely punctured. Abdomen elongate, closely punctured above and beneath, first segment oblique at base and narrowed, with a median sulcus not reaching apex, third and fourth segments very slightly broader than the others, apical segment longitudinally striated at apex and rounded, dorsal plate normal, not produced from the base or flattened; first segment beneath with a broad, oblique, triangular truncation at apex and a groove between first and second segments. Sixth segment without a spine at apical angles. Hypopygium with a spine on each side near base, thence produced in an elongate-triangular form to the apical spine, which is faintly recurved. Smith's description as to colour is sufficient.

♀. Head almost smooth, front between antennæ punctured, with a short median sulcus, strongly rounded to posterior margin. Clypeus broadly emarginate at apex. Thorax punctured, pubescent, pronotum with the anterior margin straight, nearly twice as broad as long, not very strongly narrowed posteriorly. Median segment short, very finely punctured, obliquely truncate posteriorly. Abdomen sparsely punctured, the segments smooth at base, first segment vertically truncate anteriorly, with a low transverse carina before apex; second segment smooth at base, then crossed by four transverse carinæ, the basal one the least prominent, space between apical carina and the slightly recurved apical margin of segment delicately transversely striated. Pygidium smooth at base, then strongly contracted, the middle of the contracted portion elevated, with marginal carinæ, sides concavely depressed and obliquely striated; truncate posteriorly, elongate-oval, the margins raised, epipygium considerably shorter than hypopygium, truncate at apex with a spine projecting at right angles close to base of truncation. Fifth segment beneath smooth at base, coarsely rugose at apex. Black; mandibles, antennæ, legs and apex of epipygium ferruginous; basal half of first four abdominal segments nearly reaching apical margin on sides, a broad band on each side of fifth segment, a spot on each side of second, third and fourth segments beneath and the whole of fifth beneath yellow. Length 14 mm.

Hab.—S.W. Australia (Worsfold; ♂); ♀ in Coll. Brit. Mus.

177. T. FLAVOFASCIATUS Sm.

Thynnus flavofasciatus Sm., Cat. Hym. B.M. vii. 45, 1859 (♀).

♀. Head rather small, convex, almost smooth, with a short longitudinal sulcus between antennæ. Thorax and median segment almost smooth, pronotum with a few large punctures along anterior margin; median segment short, obliquely truncate posteriorly. Abdomen almost smooth, with a few scattered punctures on apical margin of fourth and fifth segments. First segment vertically truncate anteriorly, the apical margin raised, and a less prominent carina just before apex. Second segment with four transverse carinæ at some distance from apex, apical area with two or three indistinct transverse striæ, apical margin very slightly raised. Fifth segment beneath coarsely longitudinally striate-rugose. Pygidium truncate posteriorly, surface of truncation smooth, narrow, elongate-oval; contracted before truncation and marked with a series of carinæ diverging towards apex, narrowly Λ-shaped.

Hab.—Swan River, W.A.(Smith). Allied to *T. flavopictus* Sm.

178. T. agilis Sm.

Thynnus agilis Sm., Cat. Hym. B.M. vii. p.20, n.38, 1859(♂).

♂. Clypeus broadly subtruncate anteriorly, sparsely punctured; head and thorax finely rugulose; scutellum punctured. Median segment oblique, rounded at the sides, with thin grey pubescence. Abdomen elongate, shallowly punctured, first segment oblique anteriorly, with a groove between first and second segments beneath; apical segment rugose. Hypopygium prominent near basal angles, subtriangular, with a short apical spine.

Hab.—Swan River, W.A.(Smith); Sydney, N.S.W.(Froggatt).

179. T. assimilis Sm.

Thynnus assimilis Sm., Cat. Hym. B.M. vii. p.20, n.37,1859(♂).

♂. Clypeus strongly punctured, broadly truncate anteriorly and connected by a narrow carina with interantennal prominence. Head very finely punctured, with a short arched carina above anterior ocellus. Thorax finely punctured, scutellum shining, narrowly truncate at apex. Median segment depressed, oblique, rounded at sides. Abdomen closely and shallowly punctured, first segment oblique at base, with a shallow groove between first and second segments beneath; seventh longitudinally striated above, rather narrowly truncate at apex. The segments without an impressed transverse line near base. Hypopygium short, with blunt projections near basal angles, thence gradually narrowed, shortly produced, subacute at apex, but without an apical spine.

Hab.—Swan River(Smith).

Smith compares this species with *T. melleus* Westw., giving the chief points of difference, except the absence of an impressed line on the abdominal segments. He says that the hypopygium is truncate at the apex; this is the case in the type, but only through injury.

180. T. FRENCHI, n.sp.

♂. Clypeus produced and broadly truncate anteriorly, convex, shallowly punctured and connected with interantennal prominence by a narrow carina. Head rugulose on front, finely and closely punctured on vertex. Antennæ stout, rather shorter than head and thorax combined. Thorax finely and closely punctured; disc of mesonotum and scutellum more coarsely and sparsely punctured; scutellum subtriangular, rather long, narrowly truncate at apex, prominent, with a depressed transverse line at base. Median segment depressed, rounded at sides, very finely and closely punctured, with thin, short, grey pubescence. Abdomen elongate, rather closely punctured above, finely and very closely punctured beneath; basal segment oblique anteriorly; segments 2-5 with a slightly impressed transverse line near base; epipygium rugose. Hypopygium projecting very little beyond epipygium, showing from above only a short lanceolate spine. Black; mandibles except at apex, clypeus, margins of eyes interrupted on vertex, posterior margin of pronotum, tegulæ, apex of femora, tibiæ above, tarsi, a band narrowly interrupted in middle near apical margin of the six basal abdominal segments, the breadth of the bands occupying about one-third of the length of the segments, and a spot on each side of the same segments beneath yellow. Markings of the abdomen of a very pale colour. Wings flavo-hyaline, nervures fulvous. Length 20 mm.

Hab.—Melbourne(French). Allied to *T. melleus* Westw.

181. T. MELLEUS Westw.

Thynnus (Agriomyia) melleus Westw., Arc. Ent. ii. 2, p.118, P.76, f.g.4, 1844(♂).

Thynnus melleus Sm., Cat. Hym. B.M. vii. p.67, 1859(♀).

♂. Median segment broad and short, rounded at sides. Hypopygium small, often hardly showing beyond epipygium, basal angles prominent, with a blunt tooth, thence sharply narrowed to base of apical spine.

♀. Head broader than long, rounded at posterior angles, shining, minutely and sparsely punctured. Thorax sparsely punctured; pronotum with the anterior margin straight, with a few large setigerous punctures, much broader than long, slightly narrowed posteriorly. Median segment short, obliquely truncate posteriorly. Abdomen very sparsely punctured; first segment with the apical margin depressed, leaving a transverse carina emarginate posteriorly before apex; second segment with three strong transverse carinæ, the space between them and the raised apical margin with a few delicate transverse striæ. The three following segments with a raised curved mark on each side before apex. Pygidium strongly contracted, lanceolate, truncate posteriorly, the surface of the truncation long and very narrow, slightly widened to apex. The colour varies from black to ochraceous.

Hab.—Southern Australia from Champion Bay, W.A.(Du Boulay) to Duaringa, Q.(Barnard), ♂♀ in cop.

182. T. INSIDIATOR Sm.

Thynnus insidiator Sm., Descr.n.sp.Hym.p.163,n.15,1879(♂♀).

♂. Clypeus truncate anteriorly, finely and sparsely punctured, narrowly truncate at base and connected rather broadly with the interantennal prominence, on which there is a very delicate longitudinal carina. Head and thorax finely punctured-rugulose; scutellum punctured, broadly subtruncate at apex. Median segment depressed, oblique, the sides strongly inflated, very finely punctured-rugulose, with a median sulcus from base, not reaching apex. Abdomen elongate, rather sparsely punctured, an impressed transverse line near base of segments 2-5, apical margin of the same segments slightly depressed; apical segment rugose. Hypopygium triangularly prominent near basal angles, thence gradually narrowed to base of the small apical spine. A groove between first and second segments beneath.

♀. Head smooth with a few scattered punctures, slightly broadened anteriorly; mandibles rather blunt, eyes situated near their base, on sides of head. Thorax and median segment sparsely punctured, pronotum half as broad again as long; median segment obliquely truncate posteriorly. Abdomen sparsely punctured, first segment concavo-truncate anteriorly, with a median sulcus on the truncation, the apical margin broadly depressed, a raised curved mark before apex deeply emarginate in middle. Second segment with three transverse carinæ near base, the apical portion showing traces of fine transverse striæ. The remaining segments deeply and rather sparsely punctured, depressed on apical margin. Pygidium lanceolate, oblique and very slightly widened at apex. Fifth segment beneath longitudinally striate.

Hab.—Swan River, W.A.(Smith; ♂♀ in cop.).

183. T IRRITANS Sm.

Thynnus irritans Sm., Trans. Ent. Soc. London, 1868,p.235(♂).

♂. Clypeus strongly punctured, broadly truncate at apex, very narrowly at base, and connected with interantennal prominence by a broad carina. Head punctured-rugulose, rather small, hardly as broad as pronotum; a sulcus from just below anterior ocellus to between the antennæ. Thorax closely punctured, anterior margin of pronotum straight; scutellum broadly truncate at apex. Median segment short, oblique from postscutellum, then vertically concavo-truncate to apex, delicately punctured-rugulose. Abdomen elongate, closely punctured, first segment oblique, not truncate at apex beneath; a slightly impressed curved line near base of segments 2-4. Hypopygium triangular, short, slightly prominent at basal angles and with a short apical spine.

♀. Head much narrowed posteriorly, narrower than pronotum, flattened on front, antennæ near together at the base, with a shallow depression on each side between base of antenna and eye. Eyes almost round, situated some distance from base of mandibles. The whole head shining, with minute punctures. Pronotum finely punctured, nearly twice as broad as long; median segment short, obliquely truncate posteriorly, delicately punctured. Abdomen shining, segments smooth at base, punctured at apex; first segment vertically truncate anteriorly, depressed on apical margin, with a curved mark before apex strongly emarginate in middle. Second segment with three transverse carinæ, and the apical margin raised, one or two obscure striæ between third carina and apex. Pygidium oblique, truncate to apex, lanceolate, very narrow, slightly widened to apex, with delicate diverging marginal carinæ before the apical truncation. Fifth segment beneath coarsely longitudinally striated. Entirely castaneous. Length 9 mm.

Hab.—Champion Bay(Du Boulay; ♂); N.W. Coast(♂♀; Brit. Mus.).

184. T. SUBINTERRUPTUS Sm.

Thynnus subinterruptus Sm., Trans. Ent. Soc. Lond. 1868(♂).
Thynnus frater D.T., Cat. Hym. viii. 106, 1897(♂).

♂. Clypeus broadly truncate anteriorly, finely punctured, narrowly truncate at base and connected by a broad carina with the interantennal prominence. Head and thorax finely punctured rugulose, scutellum punctured. Anterior margin of pronotum raised and broadly emarginate. Scutellum rather long, subtriangular. Median segment oblique from just behind postscutellum, rounded at sides, closely punctured, with long grey pubescence. Abdomen smooth, with a few punctures along the apical margins of the segments, and a depressed transverse line, slightly curved in centre near base of segments 2-6. Apical segment rounded, rugose. Hypopygium with a small spine at basal angles, thence broadly produced, subtruncate at apex with a curved apical spine. Otherwise as in Smith's description.

Hab.—Champion Bay, W.A.(Du Boulay).

185. T. BASALIS Sm.

Thynnus basalis Sm., Cat. Hym. B.M. vii. p.23, 1859(♂).
Thynnus vastator Sm., Descr. n.sp. Hym. 158, 1879(♂♀).

♂. Clypeus truncate anteriorly, finely punctured, most sparsely in centre; head and thorax finely punctured-rugulose, a delicate carina from below anterior ocellus ending on the interantennal prominence. Scutellum punctured, median segment finely rugulose, oblique, rounded at sides. Abdomen elongate, the sides nearly straight, a shallow groove between first and second segments beneath, a transverse impressed line near base of segments 2-5 above. Basal angles of hypopygium only slightly prominent.

♀. Head shining, sparsely punctured, convex, subquadrate, rounded at posterior angles. Thorax rather sparsely punctured, with a little thin pubescence; pronotum nearly twice as broad as long, median segment short, obliquely truncate posteriorly. Abdomen sparsely punctured, smooth at base and apex of the segments, first segment broadly depressed along apical margin, leaving a raised, curved mark emarginate in the middle before apex; beneath prominent at base, with an oblique, triangular truncation to apex. Second segment with three transverse carinæ near base, succeeded by five very small transverse carinæ, the apical margin slightly raised. Third and fourth segments with a raised curved mark on each side, interrupted in the middle of the segments. Fifth segment beneath longitudinally striated. Pygidium lanceolate, very narrow, slightly widened towards apex, with a longitudinal carina and the lateral margins raised, forming carinæ.

Hab.—Sydney (Froggatt); Wimmera, Vic. (French); Adelaide (Smith); Swan River (Smith).

Except that typical *T. basalis* is a rather smaller and more slender insect, I fail to find any distinction. I have not seen a female from Western Australia. My descriptions are drawn from the types of *T. vastator*, taken at Adelaide.

186. T. tuberculifrons Sm.

Thynnus tuberculifrons Sm., Descr. n. sp. Hym. p. 161, n. 9, 1879 (♂).

♂. Clypeus truncate anteriorly, apical angles slightly produced, sparsely punctured. The blunt tubercle mentioned by Smith is merely the apex of the usual interantennal carina. Scutellum rather narrowly subtruncate at apex, median segment oblique from a little behind postscutellum, with a short median sulcus from base, and rounded at sides. Hypopygium triangular with a short apical spine and a slight rounded projection on each side at basal angles.

♀. Head subrectangular, slightly rounded at posterior angles, much broader than long, slightly convex, and finely punctured. Thorax sparsely punctured, pronotum about twice as broad as long, raised in middle and longitudinally subcarinate, the anterior margin straight, very little broader than posterior margin, which is broadly and very slightly emarginate. Median segment punctured, short, obliquely truncate posteriorly. First abdominal segment very broadly depressed at apex, with a curved, raised mark on each side above basal truncation. Second segment with three prominent carinæ near base, apical area obscurely transversely striate, apical margin a little raised; third and fourth segments depressed at apex, smooth, with a raised, curved, punctured mark on each side. Pygidium lanceolate, very narrow, slightly widened at apex. Length 11 mm.

Hab.—Swan River, W.A. (Smith; ♂♀ in cop.).

The female from which my description is taken is damaged by gum about the head and on the apex of the abdomen. The male has a superficial resemblance to *T. carbonarius* Sm., but is quite different in the shape of the clypeus and hypopygium. There is no spine on the sixth ventral segment in *T. tuberculifrons*, and no produced dorsal plate on the apical segment.

187. T. andreanus, n.sp.

♂. Clypeus longitudinally punctured-striate, not much produced, broadly truncate anteriorly, the margin very narrowly depressed. Antennæ as long as thorax and median segment combined. Head broad, very closely and minutely punctured, interantennal prominence rounded at apex, connected with clypeus by a very short, narrow carina. Thorax very finely rugulose, scutellum broadly rounded at apex, median segment obliquely truncate from postscutellum. Abdomen longer than head and thorax, finely and shallowly punctured, broadest at base, first segment almost vertically truncate anteriorly, beneath with a strong median carina, broadly and vertically triangularly truncate at apex, the sixth ventral segment with the apical angles bluntly prominent. Dorsal plate of apical segment produced and longitudinally striated, rounded at apex. Hypopygium with a strong spine on each side near base, thence elongate and gradually narrowed, ending in a long, slight recurved spine. Black; pubescence grey; mandibles, except at apex, clypeus, except a small spot on each side near apical angles, margins of eyes, interrupted on vertex, two small spots between antennæ, margins of pronotum, narrowly interrupted in middle of anterior margin, a small spot on mesopleuræ at base of forewings, apex of scutellum, postscutellum, median segment, a broad band on apical part of abdominal segments, narrowly interrupted in middle above and broadly beneath, epipygium, prosternum, and posterior coxæ beneath orange-yellow. A triangular mark at apex of each abdominal segment dull ferruginous. A narrow, black, transverse line on each side on apical margin of the first five segments. Wings flavo-hyaline, nervures dark fuscous. Length 29 mm.

♀. Head subquadrate, rounded at posterior angles, slightly convex, broader than long, shining, finely and sparsely punctured, almost smooth on vertex, with a delicate longitudinal carina on front. Thorax and median segment smooth and shining, pronotum about half as broad again as long, slightly narrowed to posterior margin, which is broadly emarginate, anterior margin straight. Mesonotum small, broadly rounded posteriorly. Median segment short, strongly widened from base, obliquely truncate posteriorly, much narrower than pronotum. Abdomen smooth and shining, with a few scattered punctures on apical segments; first segment truncate anteriorly, closely obliquely striate, the striæ diverging from middle to apical margin. Second segment with many transverse carinæ, the two apical carinæ prominent and straight, the other carinæ decreasing in elevation to base, very faint on sides near base, arched to middle and irregular. Abdomen beneath sparsely punctured, third and fourth segments with a smooth, arched, depressed area at apex; fifth segment coarsely longitudinally striated. Pygidium truncate posteriorly, compressed before the truncation and obliquely striate, surface of the truncation ovate, obliquely striate at base, smooth at apex, epipygium recurved at apex. Head ferruginous, with a large yellow mark on front narrowly interrupted in middle. Pronotum yellow, with a triangular mark on middle of anterior margin ferruginous; mesonotum ferruginous, posterior margin broadly yellow; median segment black. Abdomen fuscous; truncation of basal segment black; a broad band on first segment above truncation extending nearly to apical margin, a large spot on each side of second segment, a transverse band on third and fourth segments before apical margin, narrowly interrupted in middle on third and broadly on fourth yellow. Abdomen beneath ferruginous; first segment at apex and a large spot on each side of segments 2-4 yellow. Legs ferruginous. Length 22 mm.

Hab.—New South Wales (Staudinger).

188. T. CARBONARIUS Sm.

Thynnus carbonarius Sm., Cat. Hym. B.M. vii. p.23, n.51, 1859(♂).

Thynnus cœlebs Sauss., Reise d. Nov. Zool. ii. 1, Hym. p. 122, n.10, 1867(♀).

Thynnus clypearis Sauss., Stett. Ent. Zeit. xxx. p.59, n.9, 1869, (♂♀).

Rhagigaster clypeatus Sm., Descr. n.sp. Hym. p.77, n.5, 1879(♂).

Thynnus hirnii D.T., Cat. Hym. viii. 108, 1897(♂).

Saussure's descriptions are sufficient. He describes the female as belonging to the male *T. clypearis* with some doubt, but he is quite correct. I have compared Smith's types. He places this species and *T. basalis* in *Thynnoides*, but I do not consider them very near either to each other or to typical *Thynnoides*.

Hab.—Sydney(Froggatt; ♂♀ in cop.); Adelaide(Smith).

189. T. MOECHUS, n.sp.

♂. Clypeus punctured, broadly advanced and subemarginate at apex, the apical angles rather prominent, with an obscure carina from base to apex, the centre convex. Head and thorax very closely and finely punctured, median segment finely rugulose. Pubescence on front of head, vertex and thorax above fulvous, elsewhere grey. Abdomen elongate, basal segment narrow, not as broad at apex as second segment; segments 2-5 shallowly punctured with an impressed transverse line near base; epipygium rugose, truncate at apex. Hypopygium subtriangular narrowly produced at apex, with a short apical spine. Black; tibiæ and tarsi fusco-ferruginous. Wings hyaline tinged with yellow, nervures black. Length 15 mm.

♀. Head small, with a concave depression on each side in front, the depressions smooth and shining, the rest of head finely punctured. Pronotum opaque, sparsely punctured, broadly emarginate anteriorly, half as broad again as long, as broad as head. Median segment shining, very short and narrow, shining, obliquely truncate from just behind mesonotum. Abdomen much broader than thorax, the segments smooth at base, very finely punctured at apex; first segment obliquely striated; second segment with transverse carinæ, the three or four apical carinæ straight, those nearer the base less elevated, arched in middle, oblique and numerous at sides. Pygidium arched at base, oblique posteriorly, long and narrow, a little compressed before the oblique truncation, widening gradually towards apex, longitudinally striated before base of truncation. Entirely fuscous. Length 11 mm.

Hab.—Sydney, N.S.W.(Froggatt; ♂♀ in cop.). Types in Coll. Froggatt.

Allied to *T. novarœ* Sauss. The female closely resembles that of *T. carbonarius* Sm., but the sculpture of the second abdominal segment is different, and the head and thorax are smaller. The male has no spine on the sixth ventral segment as in *T. novaræ*, and the shape of the clypeus is different.

190. T. NOVARÆ Sauss.

Thynnus novaræ Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.119, n.5, 1867(♂♀).

Thynnus remissus Schulz, Spolia Hymenopterologica, p.161, 1906.

Saussure's description is good. In the two male specimens I have seen, the anterior portion of the clypeus is longitudinally striated, as is also the epipygium. They may possibly be distinct.

Hab.—Sydney, N.S.W.(Saussure).

Saussure compares this species with *Thynnoides fulvipes* Guér., but I think that his identification of *T. fulvipes* is incorrect.

191. T. PSEUSTES, n.sp.

♂. Clypeus delicately longitudinally striate-punctured, prominent at base, then deflexed to apex and broadly truncate. Head, thorax and median segment very finely and closely punctured, head and thorax above with thin fulvous pubescence. Scutellum rather long, with a delicate, longitudinal, median carina. Median segment longer than broad, with a short longitudinal sulcus on each side at apex. Abdomen elongate, finely and closely punctured; segments 2-4 with an impressed transverse line near base. Dorsal plate of apical segment produced, narrow at apex and longitudinally striated. Hypopygium transversely striated above, with a spine on each side near basal angles, thence produced and elongate-triangular, with a minute apical spine. Sixth ventral segment with a spine on each side at apical angles. Black; mandibles and clypeus yellow; legs, except coxæ and trochanters, ferruginous. Wings hyaline tinged with yellow, nervures fusco-ferruginous. Length 14 mm.

♀. Head coarsely and sparsely punctured, subrectangular, rounded at posterior angles, a little broader than long, and slightly convex. Thorax sparsely punctured; pronotum emarginate posteriorly, broader than long, sides nearly parallel. Median segment short, obliquely truncate posteriorly, closely and minutely punctured. First abdominal segment concave-truncate anteriorly, closely and deeply punctured above the truncation, apical margin strongly raised with a deep transverse groove before it. Second segment with about nine rather irregular transverse carinæ, including the recurved apical margin; the three following segments delicately aciculate at base, very sparsely punctured at apex, apical margin very slightly depressed, with a faintly raised curved mark on each side. Fifth ventral segment coarsely longitudinally striated. Pygidium compressed at base, obliquely truncate and widened posteriorly, longitudinally striated before and at base of the truncation, smooth at apex; epipygium with a rounded lobe on each side near base of the truncation. Entirely light ferruginous. In more mature specimens black, with the mandibles, antennæ and legs fusco-ferruginous. Length 11 mm.

Hab.—Australia(Dämel); Sydney(Froggatt; ♂♀ in cop.).

Types in Oxford University Museum.

192. T. WALKERI, n.sp.

♂. Clypeus large, prominent at base, broadly truncate at apex, longitudinally punctured-striate. Antennæ as long as head and thorax. Head a little broader than pronotum, finely rugulose; thorax very finely punctured-rugulose, punctured on disc of mesonotum and on scutellum; scutellum with an almost obsolete longitudinal carina. Median segment transversely rugulose, obliquely depressed from just behind postscutellum. Abdomen closely and shallowly punctured, short, second segment a little the broadest; first segment oblique, narrowed to base, with a carina from base to apex beneath and a deep groove between first and second segments, second ventral segment subtuberculate at base. Segments 2-4 above with a depressed transverse line near base. Sixth ventral segment with a spine on each side at apical angles. Dorsal plate of epipygium a little produced, punctured at base, longitudinally striated at extreme apex. Hypopygium with an acute spine on each side near base, thence sharply narrowed and produced with parallel sides to base of the long apical spine, transversely striated above. Opaque black; mandibles, except at apex, clypeus, margin of interantennal prominence, margins of eyes interrupted on vertex, tegulæ and anterior coxæ yellow. Legs fuscous, anterior legs ferruginous. Pubescence on head and disc of thorax short and fulvous, elsewhere grey; a band of grey pubescence on apical margin of abdominal segments. Wings fusco-hyaline, nervures black, stigma fuscous. Length 17 mm.

Hab.—Fremantle, W.A.(Walker). Type in Brit. Mus.

193. T. ATROX, n.sp.

♂. Clypeus very prominent at base, then vertical to apex, where it is very broadly truncated, coarsely longitudinally striated. Antennæ rather longer than thorax and median segment combined. Head and thorax very finely and closely punctured, with thin cinereous pubescence. Median segment short, obliquely truncate from a little behind postscutellum, clothed with long grey pubescence. Abdomen short, very closely and shallowly punctured, first segment not as broad as second, truncate at base, with a median sulcus on the truncation; a deep groove between first and second ventral segments, second segment with a tubercle at base. All the segments above with a band of grey pubescence on apical margin. A spine at apical angles of sixth ventral segment. Dorsal plate of epipygium produced, longitudinally striated, narrowly truncate at apex. Hypopygium prominent at basal angles, thence broad and gradually narrowed to apex where it is broadly rounded, without an apical spine. Entirely black; legs fusco-ferruginous. Wings hyaline faintly tinged with fuscous, nervures black. Length 21 mm.

Hab.—Fremantle, W.A. Type in Oxford University Museum.

Allied to *T. walkeri*, but the clypeus and hypopygium are very different.

194. T. NIGRIPES Guérin.

Thynnoides nigripes Guér., Mag. de Zool. xii. p.10, 1842.

The original description is poor, and I have not seen the type. There is a damaged specimen in the British Museum which may belong to this species, but the hypopygium does not answer to the description, being without an apical spine, which may possibly have been broken. In any case I do not think the species will come at all near typical *Thynnoides*.

Hab.—Swan River(Guérin).

195. T. SIMPLEX Sm.

Thynnus simplex Sm., Descr. n.sp. Hym. p.167, n.26, 1879(♂).

♂. Clypeus very prominent at base. Scutellum long, narrowly truncate at apex; abdomen shining, sparsely and shallowly punctured, first ventral segment with a carina from base, produced at apex into a curved tubercle overhanging the deep groove between first and second segments. Sixth ventral segment with a spine on each side at apical angles. Hypopygium with a blunt prominence near basal angles, thence broadly produced and gradually narrowed, rounded at apex, with a short apical spine; transversely striated above.

Hab.—Champion Bay, W.A.(Du Boulay).

196. T. CRUDELIS, n.sp.

♂. Clypeus rugulose, produced and rather narrowly truncate at apex, prominent at base. Head finely rugose, interantennal prominence broadly truncate at apex, a delicate longitudinal carina from a little below anterior ocellus almost reaching base of clypeus. Thorax finely and very closely punctured; pronotum a little narrower than head, anterior margin straight and slightly raised. Median segment rounded, finely rugulose, with a strong median sulcus from base to apex. Abdomen elongate, very finely and shallowly punctured; segments 2-5 with an impressed transverse line near base and a strongly raised transverse mark on each side just before apical margin above and beneath. Sixth segment coarsely punctured, with a spine on each side at apical angles beneath; apical segment with the dorsal plate slightly produced, marked with strongly curved striæ. Hypopygium prominent, subtriangular, narrowly truncate at apex, with a short, recurved, apical spine; obliquely striated above, punctured beneath. Black; apical abdominal segment ferruginous-red. Wings hyaline, nervures black, stigma fuscous. Third cubital cell long, receiving the second recurrent nervure near the middle of its lower margin. Length 13 mm.

Hab.—Swan River, W.A. Type in Oxford University Museum.

197. T. NUBILIPENNIS Sm.

Thynnus nubilipennis Sm., Descr. n. sp. Hym. p. 167, n. 24. 1879(♂♀).

♂. Clypeus short and broad, truncate at apex. The whole insect finely punctured, more strongly on abdomen than elsewhere, median segment almost smooth. Abdomen elongate, first segment narrower than second, segments 2-4 depressed at base. Epipygium longitudinally rugose. First ventral segment with an oblique triangular truncation at apex, segments 2-5 subtuberculate near apical angles. Hypopygium with a spine on each side near base, thence gradually narrowed and rounded at base of apical spine.

♀. Head deeply but rather sparsely punctured, with a shallow, smooth depression on each side between base of antennæ and eyes. Pronotum rectangular, much broader than long, finely and closely punctured, with a few large punctures from which spring long hairs along the anterior margin. Median segment and abdomen rather strongly punctured, median segment very short, oblique from just behind mesonotum. First abdominal segment with a transverse carina just before apex, and apical margin slightly raised; second segment with six transverse carinæ, including the raised apical margin. Fifth ventral segment longitudinally rugose-striate; sides of abdomen thinly clothed with long hairs. Pygidium elongate, truncate posteriorly, contracted before apex and narrow, with a longitudinal carina between raised margins reaching on to surface of truncation, which is elongate, subtriangular, broadened to apex and truncate.

Hab.—Mackay to Cairns (Turner; ♂♀ in cop.).

This will probably prove to be a geographical form of *T. frauenfeldianus* Sauss., from Sydney.

198. T. FRAUENFELDIANUS Sauss.

Thynnus frauenfeldianus Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.120, n.7, 1867.

This is very near *T. nubilipennis* Sm., from which it may be distinguished in the male sex by the finely rugulose head, the lesser development of the yellow markings on the pronotum and abdomen, and the shape of the hypopygium which is hardly at all prominent at the basal angles, elongate-triangular to the apical spine.

Saussure describes the male only. The female is very similar to that of *T. nubilipennis*, but may be distinguished by the broader and much smoother head. The specimen before me does not otherwise differ from *T. nubilipennis*, but is immature as to colour.

Hab.—Sydney.

199. T. MODESTUS Sm.

Thynnus modestus Sm., Cat. Hym. B.M. vii. p.19, n.34, 1859 (♂).

♂. Clypeus broad, strongly convex, not much advanced, broadly truncate at apex, subtruncate at base and connected with the interantennal prominence by a narrow carina. The whole insect closely and finely punctured, punctures on abdomen shallow and larger. Scutellum broad and rather short; median segment depressed, rounded, with a longitudinal sulcus from base to centre, and one on each side from centre to apex. Abdomen elongate-fusiform, first segment beneath with an oblique triangular truncation at apex, and divided by a groove from second segment, segments 2-4 above depressed at base. Hypopygium with a strong prominence on each side at basal angles, thence narrowed and produced to apical spine.

Hab.—Swan River (Smith).

♀. Head shining, very finely and sparsely punctured, broader than long and broader than thorax, moderately convex, eyes situated at some distance from base of mandibles, a deep depression on each side reaching from eye to base of antenna, front with a deep, longitudinal, median sulcus. Thorax, median segment and abdomen very sparsely punctured; pronotum almost rectangular, half as broad again as long; median segment short and broad, rather abruptly truncate posteriorly. First abdominal segment vertically truncate anteriorly, apical margin slightly raised, with a narrow groove before it; second segment with eight or nine rather irregular transverse carinæ; fifth ventral segment longitudinally striated. Pygidium oblique, vertically truncate posteriorly, a little contracted and longitudinally striated before the truncation, surface of truncation smooth and broadly oval. Head, thorax, median segment and legs ferruginous; abdomen black; a transverse band on first segment above truncation, a spot on each side of second, and an interrupted transverse band on third, fourth and fifth segments yellow. Length 14 mm.

Type ♀, in Oxford University Museum, ex Coll. Saunders.

200. T. CONSTRICTUS Sm.

Thynnus constrictus Sm., Cat. Hym. B.M. vii. p. 19, n. 35, 1859 (♂).

♂. Clypeus produced and rather broadly truncate at apex, sparsely and deeply punctured, connected by a narrow carina with the interantennal prominence, which is broadly rounded at apex; front of head punctured-rugose, vertex sparsely punctured. Pronotum short and broad, almost smooth, anterior angles produced; mesonotum and scutellum closely punctured. Median segment broad, rounded at sides, finely rugulose, almost smooth at base. Abdomen fusiform, shallowly and sparsely punctured, the segments constricted at base. Second ventral segment subtuberculate at base. Hypopygium with a tooth on each side near basal angles, thence produced in an elongate-triangular form to base of the strong apical spine.

Hab.—Swan River (Smith). Nearest to *T. modestus* Sm.

201. T. UNIFASCIATUS Sm.

Thynnus unifasciatus Sm., Brenchley's Cruise of the Curaçoa, 458, P.xliii. f.1, 1873.

♂. Clypeus strongly convex, more narrowly truncate at apex than in most of the species of *Thynnus*, coarsely punctured. Lateral anterior angles of prothorax slightly prominent; anterior margin of pronotum, which is as broad as the head, rather strongly raised at sides. Mesonotum and scutellum shallowly but not very sparsely punctured, scutellum strongly hollowed in middle and towards apex. Median segment oblique, short and transversely striate. The hypopygium has a strong tooth on each side near base, thence narrowed abruptly and produced with parallel sides, subconical at extreme apex, with a faintly recurved apical spine. First abdominal segment longitudinally carinate beneath, the carina produced at apex into a long tubercle over-arching the rather deep groove which separates the first and second segments. Wings hyaline, anterior wings fuscous on basal half and along costa. Length 18-23 mm.

Hab.—Mackay, Q.(Turner).

The original description is very poor, but is accompanied by a good figure. The species is very distinct, but is most nearly allied to *T. impetuosus* Sm.

202. T. IMPETUOSUS Sm.

Thynnus impetuosus Sm., Trans. Ent. Soc. Lond.1868,p.233(♂).

♂. Clypeus produced and truncate at apex, apical margin depressed and membranous, the raised portion above the depression strongly emarginate, coarsely punctured-rugose. Head broad, sparsely punctured, anterior ocellus situated in a depression, from which a delicate carina reaches to base of clypeus. Anterior margin of pronotum raised, the lateral angles slightly prominent, a deep transverse groove behind margin; pronotum almost smooth, mesonotum sparsely punctured. Scutellum rather strongly punctured, with a transverse depressed line at its base, subtriangular rather narrowly truncate at apex, depressed at apex and slightly concave, overlapping postscutellum and reaching base of the median segment, which is abruptly truncate, transversely striated and clothed with white pubescence. Abdomen fusiform, shallowly and finely punctured, first segment beneath with a strong median carina produced at apex into a long tubercle, overhanging the groove between first and second segments. Apical segment above coarsely punctured. Hypopygium with a prominent, acute spine on each side near base, thence narrow and elongate to base of the strong, slightly recurved apical spine. Black; anterior margin of clypeus and margin of interantennal prominence yellow; centre of clypeus and apex of mandibles ferruginous. Abdominal segments with a band of short white pubescence on the apical margins. Wings fusco-hyaline. Length 26 mm.

Hab.—South Australia (Smith, Blackburn).

Smith's description is even more feeble than usual.

203. T. MELANOTUS, n.sp.

♂. Clypeus rather narrowly produced and subtruncate at apex, coarsely punctured, with a carina from base not quite reaching apex. Head shining, sparsely and very finely punctured; interantennal prominence strongly developed, rounded and deeply emarginate anteriorly, with a delicate longitudinal carina. Antennæ as long as abdomen. Thorax shining, sparsely and rather finely punctured; anterior margin of pronotum raised, the angles not prominent; scutellum broadly truncate at apex. Median segment rounded, very finely and closely punctured, with thin grey pubescence. Abdomen shallowly and rather finely punctured; segments 2-4 of about even breadth, with an impressed transverse line near base. Epipygium rugose, truncate at apex. Hypopygium prominent near basal angles, thence narrowed and produced in an elongate-triangular form to base of apical spine. First ventral segment with a strong longitudinal carina, subtuberculate at apex; second segment with a blunt tubercle at base. Anterior coxæ moderately concave. Entirely black. Wings hyaline, nervures fuscous. Length 18 mm.

Hab.—Swan River. Type in Oxford University Museum.

204. T. BINGHAMI, n.sp.

♂. Clypeus short, a little produced and broadly truncate at apex, finely punctured. Antennæ about as long as thorax and median segment combined. A very delicate carina from below anterior ocellus to apex of interantennal prominence. Head and thorax finely rugulose, scutellum and disc of mesonotum punctured. Median segment transversely rugulose, obliquely truncate from postscutellum. Abdomen closely and very minutely punctured, fusiform; first segment obliquely truncate anteriorly, with a longitudinal sulcus on the truncation; beneath with a carina from base to apex, subtuberculate and with a broadly triangular, vertical truncation at apex. Segments 2-4 above depressed at base, with a slightly raised mark on each side close to apical margin. Epipygium with one or two oblique striæ at apex. Hypopygium with a strong spine on each side near base, thence sharply narrowed and produced to base of the short apical spine. Black; mandibles, except at apex and clypeus yellow; legs ferruginous. Pubescence grey, thickest on sides of head and on median segment. A faint steely lustre on thorax. Wings hyaline, tinged with yellow, nervures fuscous. Length 20 mm.

Hab.—Australia.

205. T. WATERHOUSEI, n.sp.

♂. Clypeus convex, broadly emarginate at apex, closely punctured. Head very finely punctured, a delicate curved carina below anterior ocellus joined by a longitudinal carina which reaches apex of the rounded prominence between antennæ. Thorax finely and closely punctured, more strongly on disc of mesonotum and scutellum; pronotum broadly emarginate anteriorly, anterior margin raised and produced at lateral angles. Median segment rounded, with a fine longitudinal sulcus from base, finely punctured at base, very finely rugulose before apex, extreme apex smooth. First abdominal segment obliquely concave, truncate anteriorly, segments 2-5 with a strongly impressed transverse line near base, all the segments closely and shallowly punctured above, more finely and sparsely beneath. First segment beneath deeply parted from second at apex, with a strong median carina, produced at apex into a blunt tubercle; second segment with an indistinct median carina. Hypopygium with a prominent tubercle on each side near base, thence narrowly produced, sides almost parallel, conical at apex with a short spine. Black; anterior margin of face and clypeus, narrowly interrupted in centre, and a small spot at base of mandibles on the outer side yellowish-white. Wings fusco-hyaline, nervures black. Length 14-17 mm.

♀. Clypeus transverse, with a very short median carina from base, not reaching apex. Head wider than thorax, broader than long, strongly rounded at posterior angles, convex, shining and very sparsely punctured, a short longitudinal sulcus between antennæ; front round base of antennæ concavely depressed. Pronotum about twice as broad as long, anterior margin straight, finely and sparsely punctured. Mesothorax and median segment sparsely punctured, median segment short and obliquely truncate posteriorly. First abdominal segment strongly punctured, with a transverse carina before apex, apical margin slightly recurved. Second segment with five transverse carinæ, including the recurved apical margin, the carinæ irregular and broken on sides. The remaining segments and all segments beneath smooth at base, punctured at apex; fifth segment beneath coarsely rugose. Pygidium narrow, elongate, about four times as long as wide, rounded at apex, lateral margins subparallel; strongly depressed and almost vertically truncate; a median carina from base of truncation reaching to apex, lateral margins also raised, forming marginal carinæ. At base of truncation are one or two delicate oblique striæ. Black; spines of tarsi and apex of pygidium fusco-ferruginous. Length 10-12 mm.

Hab.—Woodford, Blue Mts., N.S.W. (G. A. Waterhouse; ♂♀ in cop.).

206. T. ULTIMUS, n.sp.

♂. Clypeus truncate anteriorly, depressed and membranaceous on apical margin, raised portion before apex emarginate in middle, closely punctured. Head very finely rugulose, pubescent, prominence between antennæ rounded at apex, with a faint longitudinal carina from below anterior ocellus. Thorax finely punctured, pronotum short, depressed anteriorly; scutellum prominent, subtriangular, sides almost vertical. Median segment depressed, very finely rugulose and covered with short whitish pubescence. Abdomen fusiform, rather narrow, segments very closely and shallowly punctured, segments 2-5 with an impressed transverse line near base, faint on fourth and fifth segments, and a raised lateral mark near apical margins of second and third segments. First segment beneath carinate from base with a small tubercle at apex and a small triangular truncation below tubercle. Segments beneath slightly depressed at apex, and with a rounded, faintly raised mark on each side near apical margin. Hypopygium elongate, with a small spine on each side near base, thence gradually narrowed to apical spine. Black; clypeus and mandibles except at apex yellow; apex of interantennal prominence, scape and first joint of antennæ beneath and legs dull ferruginous; coxæ black except at apex; posterior margin of pronotum, abdominal segments at apex above and beneath, and at sides, and the whole of the apical segment obscure ferruginous. Wings hyaline, fuscous in the radial cell, nervures fusco-ferruginous at base, black at apex. Length 14 mm.

♀. Head smooth and shining, slightly narrowed anteriorly, front much elevated in centre, obliquely depressed towards posterior and lateral margins, sides slightly concave above base of antennæ. A fine longitudinal sulcus between antennæ. Thorax punctured finely, short, pronotum nearly twice as broad as long, mesonotum not very narrow; median segment short, coarsely punctured, obliquely truncate posteriorly. First abdominal segment vertically truncate anteriorly, punctured at base, with a broadly emarginate carina before apex; second segment with four transverse carinæ including the recurved apical margin; apical segments punctured, sparsely and finely above, more closely beneath; fifth segment rugose beneath, and emarginate above and beneath. Pygidium narrow, lanceolate, slightly widened and rounded at apex, with a longitudinal median carina and a marginal carina on each side. Dark fuscous; mandibles, except at apex, clypeus, antennæ, legs, second abdominal segment and pygidium fusco-ferruginous. Length 9 mm.

Hab.—Mackay, Q. (Turner; ♂♀ in cop.).

207. T. FULVIPES Guér.

Thynnoides fulvipes Guér., Voy. Coq. Zool. ii. 2, p.233, 1830 [1839](♂); Mag. de Zool. xii. p.10, P.102, figs.15-17, 1842(♂).

?*Thynnoides rubripes* Guér., Voy. Coq. Zool. ii. 2, p.233, P.8, fig.9, 1830[1839](♂).

Thynnus labiatus Klug, Physik. Abh. Akad. Wiss. Berlin, p.23, n.17, 1840[1842](♂).

Thynnus (*Agriomyia*) *moestus* Sm., Cat. Hym. B.M. vii. p.36, n.93, 1859(♀ nec ♂).

♂. This differs in the sculpture from the closely allied *T. fumipennis* Westw. Head very closely and finely punctured, thorax rather shallowly punctured, abdomen very shallowly and rather sparsely punctured. The hypopygium is narrower, being lanceolate from the basal prominences, not subtriangular as in *T. fumipennis.* The colour of the wings shows considerable variation, but the tegulæ in this species are black. The usual size seems to be from 16-19 mm. Guérin gives 21 mm. for *T. fulvipes,* and 14 mm. for *T. rubripes*; but I have not seen specimens reaching either extreme.

♀. Head shining, sparsely but rather deeply punctured, broader than long, very strongly rounded at posterior angles. Thorax and median segment rather strongly punctured; pronotum short, nearly twice as broad as long, with a row of long hairs along anterior margin. Median segment rather abruptly truncate posteriorly, surface of truncation almost smooth. First abdominal segment truncate anteriorly, coarsely but sparsely punctured, the apical margin very slightly raised, with a broad, strongly depressed space before it, leaving a transverse carina before the depression with a row of hairs springing from beneath it. Second segment with five transverse carinæ, including the raised apical margin; the remaining segments very sparsely punctured. Pygidium lanceolate, slightly widened at apex, epipygium forming a median carina. Fifth ventral segment coarsely longitudinally rugose. Black; head and legs bright ferruginous; pygidium fusco-ferruginous; mandibles black at apex. Length 11 mm.

Hab.—New South Wales and Victoria. Very common on the Blue Mountains.

The female differs in the colour of the head from *T. fumipennis* which is black, with the exception of the legs and pygidium. The present species is also much more strongly punctured on the head and thorax.

208. T. FUMIPENNIS Westw.

Thynnus (*Thynnoides*) *fumipennis* Westw., Arc. Ent. ii. 2, p. 108, P. 75, figs. 1-2, 1844(♂♀).

♂. Thorax coarsely rugose, abdomen closely and shallowly punctured. Clypeus rather more deeply emarginate at apex than in *T. fulvipes* Guér. Tegulæ ferruginous.

Hab.—Melbourne to Sydney.

209. T. SENILIS Erichs.

Thynnus senilis Erichs., Arch. f. Naturg. viii. 1, p. 263, n. 236, 1842(♂).

♂. This resembles *T. fumipennis* in the sculpture of the abdomen, but the thorax is punctured as in *T. fulvipes.* The legs are black, and the wings hyaline sometimes slightly tinted with yellow.

Hab.—Tasmania (Erichson); Victoria (French).

210. T. PUGIONATUS Guér.

Thynnoides pugionatus Guér., Voy. Coq. ii. 2, p.234, 1830 [1839](♂).

♂. Mesopleuræ red. Otherwise the male is so close to *T. gracilis* Westw., that I am inclined to think they may prove to be identical when long series are studied. Anterior angles of pronotum strongly produced.

♀. The head is a little longer and narrower than in the specimens of *T. gracilis* that I have seen.

Head longer than broad, slightly rounded at posterior angles, sparsely punctured. Pronotum about twice as broad as long, almost smooth, with a row of setigerous punctures along anterior margin; mesonotum not much narrowed. Median segment strongly punctured, obliquely truncate posteriorly. First abdominal segment very coarsely punctured, depressed and almost smooth at apex, leaving a raised transverse carina before apical margin. Second segment with five transverse carinæ, not including the slightly raised apical margin; the remaining segments rather sparsely punctured. Fifth ventral segment rugose. Pygidium lanceolate, raised into a narrow carina at base, the carina branching narrowly towards apex. Dull fusco-ferruginous, the abdomen black. Length 10 mm.

Hab.—Sydney (Froggatt; ♂♀ in cop.).

211. T. GRACILIS Westw.

Thynnus (*Thynnoides*) *gracilis* Westw., Arc. Ent. ii. 2, p 139, P.83, figs.2-3, 1844(♂♀).

Thynnus (*Thynnoides*) *bidens* Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.118, n.3, P.4, fig.68, 1867(♂).

Thynnus viduus Sauss., Reise d. Nov. Zool. ii. 1, Hym. p.123, n.12, P.4, fig.70, 1867(♀).

Thynnus dallatorrei Schulz, Spolia Hymenopterologica, p.160, 1906(♂).

♂. Clypeus long, broadly emarginate at apex. Angles of pronotum very prominent.

Hab.—Adelaide (Westwood); Melbourne (French); Mittagong, N.S.W. (Froggatt).

South Australian specimens seem to be usually much larger than others, but they do not differ otherwise.

212. T. SERVILLEI Lep.

Elaphroptera servillei Lep. St. Farg., Hist. Nat. Ins. Hym. iii. p.571, n.2, P.36, fig.1, 1845(♂).

"Antennes noires. Tête noir, ses poils noirs, mandibules à base rousse, à bout brun. Chaperon roux. Corselet et abdomen d'un gris noir, un peu velus. Pattes d'un testace roussâtre. Ailes un peu enfumées, quoique transparentes, nervures brunes; côte et point marginal roux. Mâle. Long. 5 lignes.

Nouvelle Hollande, Musée de M. Serville."

I am quite unable to identify this species from the description, nor does the figure give much assistance.

213. T. HUMILIS Erichs.

Thynnus humilis Erichs., Arch. f. Naturg. viii. 1, p.264, n.238, 1842(♀).

I have not been able to identify this species, nor does the description enable me to assign it to any of the subgenera.

The following species allied to the typical dentatus-group of *Thynnus* have been described from the Austro-Malayan region.

THYNNUS ATRATUS Sm.

Thynnus atratus Sm., Journ. Proc. Linn. Soc. vi. p.51, 1861 (♂); Sm., *l.c.* viii. p.77, 1864(♀).

Hab.—Halmaheira.

THYNNUS LUGUBRIS Sm.

Thynnus lugubris Sm., Journ. Linn. Soc. Zool. vii. p.25, 1863(♂).

Hab.—Ceram. This differs very slightly from *T. atratus*.

Thynnus erraticus Sm.

Thynnus erraticus Sm., Journ. Proc. Linn. Soc. Zool. iv. Suppl. p.114, 1860(♂).

Hab.—Batchian.

Thynnus pullatus Sm.

Thynnus pullatus Sm., Journ. Linn. Soc. Zool. vii.p.26, 1863(♂).

Hab.—Bouru.

Thynnus placidus Sm.

Thynnus placidus Sm., Journ. Linn. Soc. Zool. vii.p.26, 1863(♂).

Hab.—Waigiou. The species has the median segment exposed.

Thynnus serriger Sharp.

Thynnus serriger Sharp, Willey, Zool. Results iv. p.388, P.xxxv. fig.13, 1900(♀).

Hab.—New Britain.

Thynnus olivaceus, n.sp.

♂. Clypeus large, pointed and tumid at base, broadly truncate at apex, punctured, thinly clothed with short pubescence. Head broad, finely punctured, pubescent; front between the antennæ prominent, rounded anteriorly, joined to base of clypeus by a short carina; a faint longitudinal carina on vertex reaching from between posterior ocelli to posterior margin of the head. Thorax finely and shallowly punctured, pronotum nearly as broad as head, anterior margin slightly raised, with a deep transverse groove behind it. Scutellum broadly triangular, produced at apex into a small tubercle. Postscutellum covering base of median segment, which is obliquely truncate, the surface of the truncation almost smooth, with a little short pubescence, longer on sides of segment. Abdomen shining, sparsely punctured, first segment vertically truncate anteriorly, as broad as second, which is broader than the following segments; sixth segment with a spine on each side beneath at apical angles. Hypopygium carinate beneath, broad at base with a strong spine on each side, thence produced shape to apex, a spine on each side before apex; apical spine acute, curving slightly downwards. Claspers rather narrow, bluntly rounded at apex, and clothed with long fulvous pubescence. Black; clypeus, mandibles, except at apex, two spots narrowly separated between antennæ, margins of eyes, margins of pronotum narrowly, a spot on each side of prothorax above anterior coxæ, tegulæ, a small spot on meso-pleuræ beneath base of anterior wing, another larger one above base of intermediate coxæ, apical half of scutellum, postscutellum, truncation of median segment, a spot on each side of first abdominal segment on surface of truncation, apex of segment beneath, a small spot on each side of second, third and fourth segments above, a large spot on each side of the same segments beneath, a small spot on each side of fifth segment beneath and a line on coxæ beneath ochraceous-yellow. Legs, mouth-parts and pubescence ferruginous. Abdomen in some lights of a dark green colour. Wings fusco-hyaline, nervures black. Length 24 mm.

Hab.—German New Guinea. Allied to *T. dentatus.*

The following Austro-Malayan species belong to the subgenus *Aeolothynnus* :—

THYNNUS (AEOLOTHYNNUS) VAGANS Sm.

Thynnus vagans Sm., Journ. Proc. Linn. Soc. Zool. vi. p. 51, n.2, 1862(♂); Sm., Proc. Zool. Soc. London, 1877, p.83, n.4(♀).

Hab.—Celebes.

T. (AEOLOTHYNNUS) LAEVISSIMUS Sm.

Thynnus laevissimus Sm., Journ. Proc. Linn. Soc. Zool. viii. p.77, 1864(♀).

Hab.—New Guinea.

T. (AEOLOTHYNNUS) ABDUCTOR Sm.

Thynnus abductor Sm., Journ. Proc. Linn. Soc. Zool. viii. p.78(♂).
Thynnus candidus Sm., Descr. n.sp. Hym. p. 171, 1879(♂).

Hab—Salwatty, New Guinea, Morty.

Genus ISWAROIDES Ashm., Canad. Ent. xxxv. 1903.

"♂. Hypopygium 5-dentate or with five spines. Clypeus anteriorly not much produced, rounded, without a tooth at the basal lateral angles. Metathorax with a median tooth at apex; abdomen longer than head and thorax united, cylindrical, the sides parallel, the segments constricted at apex, immaculate; maxillary and labial palpi both 4-jointed.

"♀. Pygidium not very narrow, oblong, rounded at apex; basal segment of abdomen without a strongly curved furrow on each side or a strong transverse furrow before the apex. Head seen from above triangular. Eyes small, oval, extending to base of mandibles; clypeus very short, truncate; mandibles falcate, pointed at apex, maxillary palpi 4-jointed, labial palpi 3-jointed; second segment of abdomen with two transverse folds or carinæ towards apex. Type *I. koebelei* Ashm."

I have not seen any species corresponding to these characters. Ashmead does not seem to have published any description of the species.

I have omitted from the list of Australian species two which I am convinced have been described as Australian by mistake, and are almost certainly South American. They both belong to the genus *Scotaena* Klug, of which *Ornepetes* Guér., is in my opinion a synonym.

SCOTAENA FASTUOSA Sm.

Thynnus fastuosus Sm., Descr. n.sp. Hymenoptera, p.170, n.34, 1879(♂).

Very near *Thynnus decorus* Sm., from Brazil, which is probably a synonym of *Scotäena trifasciata* Klug, from Bahia.

Hab.—Australia (Smith).

SCOTAENA FLAVOVARIEGATA Sm.

Thynnus flavovariegatus Sm., Descr. n. sp. Hym. p. 170, n. 33, 1879(♂).

Hab.—Australia (Smith).

Both species were purchased by the British Museum from a dealer many years ago, so that the localities are not on good authority.

I have also omitted *Thynnus gravidus* Westw. (Arc. Ent. ii. 2, p.141, P.82, fig.3, 1844) which, as I mentioned in the first part of this paper, I believe to be the female of *Oncorhinus xanthospilus* Shuck., though without sufficient proof absolutely to sink the name as a synonym.

The following new species have come to hand since the publication of the first part of this paper :—

TACHYNOMYIA IMBELLIS, n.sp.

♂. Clypeus narrowly truncate at apex and deeply punctured. Head coarsely rugose, broadly emarginate posteriorly, cheeks with long grey pubescence. Pronotum short and broad, finely punctured; mesonotum and scutellum rugose, scutellum narrowly truncate at apex. Median segment rounded, strongly and closely punctured. Abdomen subpetiolate, strongly but sparsely punctured; first ventral segment with a longitudinal carina and deeply separated from second segment. Hypopygium truncate at apex, with a strong apical spine. Black; second, third and fourth abdominal segments dark ferruginous. Wings hyaline, with a faint fuscous cloud at apex; nervures black. Length 10 mm.

Hab.—Perth, W.A. Type in British Museum.

RHYTIDOGASTER DISCREPANS, n.sp.

♂. Clypeus subtruncate at apex, finely rugose; with a short median carina from base, abruptly branched before centre and continued as two parallel carinæ to apical margin. Head finely rugose, interantennal carina broadly V-shaped, a short transverse carina below anterior ocellus. Thorax rugose; anterior angles of pronotum prominent; scutellum triangular. Median segment rounded, finely punctured-rugose. Abdomen shining, shallowly punctured, most finely and closely on sides; segments 2-4 with a strongly depressed transverse line near middle, base of the segments more sparsely and finely punctured. Epipygium narrowly produced and rounded at apex, produced into acute angles at sides before apex; recurved spine of hypopygium only extending a little beyond epipygium. Entirely black. Wings hyaline, nervures fuscous. Length 17 mm.

♀. Head subquadrate, very slightly rounded at posterior angles. The whole insect very deeply and rather sparsely punctured. Pronotum broader than long, slightly narrowed anteriorly. Median segment flattened, widened from base and almost vertically truncate posteriorly. First abdominal segment vertically truncate at base; epipygium with prominent, acute angles at sides before apex, slightly produced in middle and rounded at apex. Hypopygium produced beyond epipygium, rounded at apex and membranous. Black; antennæ, mandibles, a spot on each side between eye and base of antenna, and legs ferruginous. Length 13 mm.

Hab.—Fremantle, W.A.(Walker). Type in British Museum.

The male is nearest to *Rhagigaster obtusus* Sm., which should probably be placed in this genus. The female is without the grooves on the head which are characteristic of *Rhagigaster*; and the maxillary palpi are apparently four-jointed, certainly not six-jointed.

RHYTIDOGASTER PYXIDATUS, n.sp.

♂. Clypeus broadly subtriangular, almost pointed at apex, strongly punctured and without a carina. Antennæ very stout, interantennal carina transverse and almost straight. Head and thorax rugose; median segment more finely rugose, not truncate. Abdomen very closely and shallowly punctured; epipygium rather narrowly produced and truncate at apex, reaching beyond and overarching the curved spine of hypopygium. First ventral segment of abdomen subtuberculate at apex. Black; epipygium ferruginous-red, black at extreme apex. Wings fuscous, nervures black. The division of the first cubital cell is not marked even by a scar. Length 14 mm.

Hab.—Fremantle, W.A.(Walker). Type in British Museum.

This is a very distinct species, and may prove to be generically distinct when the female is discovered.

This Part includes the whole of the remainder of the Australian Thynnidæ at present known. With one or two exceptions, I have refrained from describing females of which the males are unknown, considering that such descriptions would not be in the interests of science. The females are so frequently taken with the males, that the names given to them would soon have to be sunk, whilst the difficulty of certain identification in the Colonies would be much increased.

Where nothing to the contrary is mentioned, the types of the new species are in my own possession, and will be presented to the British Museum.

I exclude from the family the genus *Anthobosca*, which I consider to be more nearly related to *Myzine*.

The South American species of *Thynnidæ*, with the exception of *Aelurus*, seem to belong to different genera from any Australian forms. Two species described as *Tachypterus* by Weijenberg seem to me to be more nearly related to *Scotaena*, and do not belong to the *Diamminæ*.

Cameron* has recently described a new genus, *Adontothynnus*, from S. Africa, but the characters he gives are those of *Anthobosca*. He has been misled by Ashmead, who states that the maxillary palpi are five-jointed in *Anthobosca*, and has not consulted Guérin's description.

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* Rec. Albany Museum (S. Africa) i. 1906.

REVISION OF THE AUSTRALIAN SPECIES OF *ADELIUM.*

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

(Plate iii.)

Since 1862 when Blessig wrote his admirably succinct paper* on Australian Heteromera, nothing has been done towards a systematic review of the large genus *Adelium.* Blessig had then fifteen species to consider. Excluding New Zealand and Island species, those described have increased to eighty, of which many are identified in Australian museums. Having collected a large number of these insects myself, and with the material and information kindly supplied by other Australian entomologists, amongst whom I would especially mention Messrs. Lea, Blackburn, Sloane and French, I have ventured to hope that this imperfect monograph will be of some assistance towards a better knowledge of the relation and classification of this genus. The opportunity of a visit to the Museums of Brussels, Paris, and especially to the Natural History Museum of London, has enabled me to further verify my identification of species by a comparison of my collection with types. I take this opportunity of expressing my obligations to Mr. C. O. Waterhouse and Mr. C. J. Gahan for their courtesy and kindly assistance at the last-mentioned Institution.

The Heteromerous insects known under the generic term *Adelium* are widely distributed over Australia. It is probable some of them will be found wherever there is sufficient moisture and soil to produce timber on that Continent. It is doubtful if a true *Adelium* has yet been found outside Australia (including

* Hor. Soc. Ent. Ross.

Tasmania), the so-called *Adelium* from New Zealand and New Caledonia having markedly different characters. So far back as 1866 this was pointed out by Pascoe* when he formed the genus *Pheloneis* for the reception of *A. harpaloides* White; at the same time also he separated *Seirotrana* and *Coripera* from the true *Adelium*. All three of these genera are differentiated from *Adelium* by the character "Elytra prothoraci arcte applicata," while *Pheloneis* has the further distinction in "antennæ articulis apicalibus, ultimo excepto, transversis," and "tarsi antici et intermedii articulis, ultimo excepto, plus minusve latioribus, et triangulariter transversis." Considering therefore that *Seirotrana* and *Coripera* are generally held by entomologists (I consider rightly) as good genera (although the Munich Catalogue made the mistake of confounding *Coripera* with *Pseudhelops*; and the Supplementary Catalogue of Mr. G. C. Champion again merges *Seirotrana* with *Adelium*) it is difficult to understand why Bates should rename *Pheloneis harpaloides* as an *Adelium*† without giving sufficient, or any, reason except that "Adelium is evidently a polymorphous genus."

Even if the genus *Pheloneis* be not accepted, as in my opinion it should be, the New Zealand insects are much nearer *Seirotrana* or *Coripera* than *Adelium*; while one species, *A. aucklandensis* Broun, seems to be very near *Licinoma*. While in New Zealand I captured some ten species of so-called Adelia, and identified them from Captain Broun's excellent Catalogue.

Blessig's memoir has supplied another character which is an additional aid in the separation of Pascoe's genera from *Adelium*, namely in the posterior intercoxal process being "abruptly truncate." In some of the New Zealand insects there is some modification of this, *e.g.*, *A. nigritulum* Broun, and *A. indagator* Broun, have this process moderately truncate (*i.e.*, truncate with slightly rounded angles), but in the narrow epipleuræ, in the position and structure of the coxæ, and in the elytral sculpture

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* Journn. of Ent. ii. p.483.

† Ann. Mag. Nat. Hist. 1874, Vol.xii. p.32.

these species show some affinity to *Coripera*. The shortness of the antennæ, especially of the third joint, together with their subtriangular form mark a strong departure from the Australian Adelia. It is for New Zealand or British entomologists to decide as to whether the genus *Pheloneis* be finally accepted, but enough has been said to show a strong combination of characters which would prevent the so-called Adelia of New Zealand from inclusion with the true Adelia of Australia. From an examination of the Bates Collection in the British Museum, I would exclude also the New Caledonian Adelia, all of which are expressly described as having "the base [of prothorax] closely applied to the base of the elytra," besides having the prosternal process, mesosternum, and trisinuate base of prothorax quite different from any Australian *Adelium*. For the New Caledonian insects I would therefore suggest the name *Neoadelium* as applicable to *A. nigroæneum* Bates, *A. fairmairei* Bates, *A. marginatum* Bates, and *A. externocostatum* Bates, *A. caledonicum* (Auct.?), *A. pustulosum* Fauv.,(the last two unrecorded in the Munich Cat.; and the last nom. præocc.).

Stridulation.—A character hitherto unrecorded in *Adelium* is their power of stridulation. Mr. Sharp in the Cambridge Natural History (Part ii. p.264) records that in *Praogena* the under surface of the head has the gular region striate for this purpose, and adds "This is the only case in all the Tenebrionidæ in which any sound-producing organ has been discovered." In the common Sydney species *A. calosomoides* (or *geniale*?) a stridulation is very marked. Mr. C. J. Gahan, an authority on this subject as his excellent paper* shows, dissected several specimens of Adelia in my presence, and showed the stridulating organs to be oblique files or raised ridges near the apex of the upper surface of the abdomen. These were present in the following species:—*A. geniale* (or *calosomoides*), *A. auratum*, *A. plicigerum* and *A. licinoides*, but were absent from *A. porcatum* and *A. striatum*. I have noticed a similar, or even louder, stridulation when taking

* Trans. Ent. Soc. Lond. 1900, p.433.

Apasis howitti Pasc., on Mount Macedon, and *A. puncticeps* Lea, on Mount Kosciusko, forms closely allied to *Adelium*.

Variation.—I have below referred to varieties in the species *A. calosomoides* Kirby. The same remarks apply to other species which have a wide range, as *A. brevicorne*, *A. porcatum*, *A. plicigerum*, *A. auratum*. In such cases a distinct species is to be considered as one which shows a more or less constant combination of characters, each of which may be subject to some variation. On the other hand, where two species described as different show only one or even two variations, I have considered them as local varieties. Thus I consider *A. virescens* Boisd. = *A. brevicorne* Blessig = *A. neophyta* Pasc., to be extraordinarily variable in colour and size; and I have specimens from the north of New South Wales, Victoria and South Australia which vary in colour from bronze to nearly black (Blessig especially mentions a black variety known as *A. sphaeroides*), and in size from 8·5 x 3·5 to 11 x 5 mm. *A. plicigerum* Pasc., only differs from *A. rugosicolle* Macl., in having its pronotum less coarsely rugose, and very slightly in colour. Another difficult and unsatisfactory character for differentiation of species is the foliation of the prothorax. In Adelia generally where such foliation exists it is rarely separated from the disc by a distinct division as in Cardiothorax, and frequently the sculpture of the discal lobes is continued without break to the sides. In common species like *A. calosomoides* a dozen specimens captured together will present every variation of this character, from widely explanate border to a specimen which shows very slight foliation.

The most reliable characters appear to be —(1) The form and length of antennæ, especially that of the third joint; (2) form and sculpture of prothorax and elytra; (3) what Blessig describes as the "intercoxal process," a disc forming the anterior portion of the first abdominal segment between the posterior coxæ. Other determining factors are size, colour, clothing, form of tibiæ, tarsi, epipleuræ, eyes and oral organs.

Sexual variations.—The following, though by no means constant, are the normal variations in the sexes:—(1) Male narrower and generally smaller than female. (2) Male with tarsi, especially anterior tarsi, more dilate. (3) Antennæ of male proportionally longer than in female.

History.—Kirby, in 1817, founded the genus *Adelium* for the reception of three insects, *A. calosomoides*, *A. licinoides* and *A. caraboides*, of which the last had already been described as *Calosoma porcatum* by Fabricius in 1774. As to *A. calosomoides*, I shall refer to this species later. *A. licinoides* = *A. cisteloides* Erichs., according to Champion.* This species has a wide range in Victoria and Tasmania.

In 1835, Boisduval (Voyage de l'Astrolabe) added six species, *A. abbreviatum*, *A. harpaloides*, *A. helopioides*, *A. punctipenne*, *A. rugicolle* and *A. virescens*.

A. abbreviatum Boisd. = *A. impressum* Blanch., is a common Tasmanian insect, whose identity has been preserved by Blessig.

A. harpaloides Boisd.—Two specimens marked "Coll. Dejean" are in the Bates Coll. in the British Museum, and exactly correspond to *A. calosomoides* Kirby, except in being smaller. This species must not be confounded with *A. harpaloides* White, from New Zealand = *Pheloneis harpaloides* Pasc. = *A. amaroides* Bates.†

A. helopioides Boisd. = *A. licinoides* Kirby, in the opinion of Pascoe.

A. virescens Boisd.—In the British Museum a number of specimens labelled *A. virescens* are placed as synonymous with *A. brevicorne* Blessig, and *A. neophyta* Pasc. I saw the same species marked *A. virescens* Boisd., in the Brussels Museum.

A. punctipenne and *A. rugicolle* Boisd., are quite unknown to me, and as with all Boisduval's descriptions, they are entirely inadequate for identification, especially in the absence of measurements and localities of capture.

Castelnau added one species, *A. angulicolle*, which has a wide range in New South Wales and Victoria. I have specimens from Wagga, N.S.W., and near Melbourne, Vic. Though I

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* Trans. Ent. Soc. Lond. 1894.

† Ann. Mag. Nat. Hist. Ser.4, Vol.xii. p.32.

have not seen the type, it is the most easily recognised of all the genus, and is well known in all collections, besides being figured by Blessig.

In 1842, Erichson described *A. elongatum*, *A. tenebrioides* and *A. cisteloides.*

A. elongatum Erichs.—If my identification be correct—and my specimens (taken at Launceston, Tas.) agree with those named as above in the Macleay Museum—this should be referred to *Seirotrana* as the description of Erichson certainly warrants.

A. tenebrioides Erichs.—No authoritatively named specimens are to be found in the Sydney museums. The specimens labelled *A. tenebrioides* in the Macleay Museum are certainly wrongly identified.* In the British Museum I found one specimen labelled "Compared with type by Dr. Haag," which exactly corresponds with specimens I have seen from the Dandenong Ranges, Vic., and from King Island, Tas. It differs from *A. similatum* Germ., in its narrow prothorax, and more elongate depressed form.

A. cisteloides Erichs. = *A. licinoides* Kirby, *fide* Champion.†

In 1845 Blanchard described *A. carinatum* and *A. impressum*, of which the latter is identical with *A. abbreviatum* Boisd.,‡ while the former is a mystery of the past, whose identity I have been able to trace only by the following note :—" M. Blanchard (Hist. Nat. d. Ins. ii. p.35) a fondé en peu de mots un genre Tropidopterus, qu'il place à la suite des Adelium, et auquel il donne pour type une espèce de l'Australie, soi-disant décrite par M. Boisduval, sous le nom de carinatus. Mais il n'existe dans la 'Faune de l'Océanie' de cet auteur, qu'un seul insecte qui porte ce nom, et c'est un Curculionide du genre Amycterus " (Lacordaire, Gen. Col. v).

In 1848 Germar described *A. similatum*; and, in 1861, Blessig described *A. brevicorne* in his able monograph on the genus.

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* Since rectified [June 9th].

† Trans. Ent. Soc. Lond. 1894.

‡ Blessig, Hor. Soc. Ent. Ross. 1862.

While *A. simulatum* was originally described from Adelaide, it is also a common Victorian species. I have specimens from Adelaide, Gisborne, and Mallee District, Vic., (see also Blackburn, Proc. Linn. Soc. N. S. Wales, 1891, p.535).

A. brevicorne Blessig = *A. neophyta* Pasc. = *A. virescens* Boisd.? (*fide* Champion, Trans. Ent. Soc. Lond. 1894, p.404).

Mr. Champion has pointed out the synonymy of *A. neophyta* with *A. brevicorne* Blessig. I have given above the evidence for considering *A. virescens* Boisd., as identical with these. If this synonymy should stand, it would give *A. virescens* precedence. I consider that for the present the name *A. brevicorne* should remain, since of *A. virescens* it may be said that the name is misleading, the description futile, and the identity uncertain.

In 1866 Pascoe described eight species, viz., *A. augurale*, *A. auratum*, *A. congestum*, *A. latum*, *A. obesum*, *A. striatum*, *A. succisum* and *A. vicarium*, which he continued in 1869 with the fourteen species *A. aerarium*, *A. ancilla*, *A. commodum*, *A. geniale*, *A. neophyta*, *A. orphana*, *A. pilosum*, *A. plicigerum*, *A. reductum*, *A. repandum*, *A. ruptum*, *A. scutellare*, *A. scytalicum* and *A. steropoides*; and, in 1870, *A. geminatum*. Of these I have examined the types and note the following facts.

A. augurale Pasc., though closely allied to *A. porcatum*, Fabr., differs from that species in its brighter metallic green colour, and in having *all* its raised intervals on the elytra interrupted; in *A. porcatum* there is generally one or more interval nearest the suture uninterrupted. I have taken this species in quantity near Glen Innes, N. S. W.

A. auratum Pasc.—In the British Museum and in many Australian Collections (Macleay and Australian Museums; Mr. Simson's Coll.) are specimens labelled *A. fossulatum* Dupont, which are evidently identical with *A. auratum* Pasc. The name seems to have come from Macleay himself, possibly as an MS. name, but I can nowhere find any description under the name *A. fossulatum*; nor is it included in the Munich Catalogue. This fine species is found in the North Coast region of New South

Wales, and extends at least to Rockhampton, from both of which districts I have specimens.

A. congestum Pasc. = *Seirotrana parallela* Germ., and will be more fully referred to in my notes on *Seirotrana.*

A. latum Pasc.—This appears to me to be only a variety of *A. abbreviatum,* though possessing certain distinctive characters of doubtful specific value (see Champion's note, Trans Ent. Soc. Lond. 1894, p.402). I have two specimens labelled Melbourne. Mr. Champion's specimens were taken by Mr. J. J. Walker at Launceston, Tas. Pascoe's locality was Victoria.

A. obesum Pasc.—Though closely allied to *A. similatum* Germ., the differences are well marked. It is in general larger, more robust, more convex, with the prothorax much more widely rounded at the sides, with a corresponding constriction at the base, than Germar's species. The foliation at the sides is also much more explanate, the sculpture of the pronotum is less rugose, and the elytral intervals more convex, while the punctures in the striæ are more regular. I have several specimens from the Preston Reservoir, Melbourne.

A. striatum Pasc. = *A. viridipenne* Macl.—The largest Australian species and well known in all collections. The tropical form has a greenish tint, hence Macleay's species, but there is no other perceptible difference between them. I have black specimens from Mackay, Q.; also a cotype of Macleay's *viridipenne,* with a specimen that is intermediate in colour between them. These vary in size from 19 to 25 mm. long. There is a large striate form close to *A. striatum* in the Bates Coll., marked with an MS. name of Bates' from the mountains of Tasmania, but this is possibly a mistake of locality.

A. vicarium Pasc., is the common form to be found near Perth, W.A.

A. aerarium Pasc.—The only specimen I have seen of this is the type (unique). It is very close to *A. angurale* Pasc., but is of a brighter green colour, is smoother, and has more parallel sides to the prothorax.

A. ancilla Pasc., is a near ally of *A. nitidum* Carter, from which it differs in its more distinct hind angles to the prothorax *inter alia.* This and the preceding species are labelled Darling Downs, Q., but I have never seen them in nature.

A. commodum Pasc.—A common Tasmanian insect, very Licinoma-like from its narrow and nearly smooth prothorax, scarcely emarginate at the apex. It is in most collections.

A. succisum Pasc., is a synonym of *A. angulicolle* Castel., *fide* Pascoe (Ann. Mag. Nat. Hist. 1869, p.132).

A. geniale Pasc.—I have long been in doubt as to its distinction from *A. calosomoides.* This doubt has been intensified by an examination of the respective types. In Pascoe's notes following the brief description he says *A. geniale* is distinguished from *A. calosomoides* by having elytra *striated* with the same broad outline. I had some trouble in finding Kirby's type in the British Museum, but Mr. Gahan kindly unearthed it from the "Century of Insects Coll." in a separate place, and I was astonished to find that it is *distinctly striated*, and that no specimen marked *geniale* or *calosomoides* in the British Museum or in my own long series had more marked striations. The figure given by Kirby, and presumably copied by Blessig, is thus misleading, as presenting smooth, unstriate elytra. It would appear that Pascoe had not examined Kirby's type when he wrote the above. The pronotum of Kirby's type is also more rugose than any specimens marked *geniale* or *calosomoides* that I could find. In such polymorphous insects as Tenebrionidæ it is unwise to dogmatise, but the evidence is strongly in favour of considering the above two species as merely variations of a very polymorphic species of wide range. The variations consist of (1) great diversity of size, especially in width, and in relation to sex; (2) colour-variation from shining bronze to a discolorous form in which the prothorax is green or green-bronze; (3) variation in the rugosity of pronotum; (4) elytral sculpture from being nearly smooth, *i.e.*, with intervals not raised, to marked striation in which the intervals are subconvex. (In the latter case somewhat raised lines appear towards the apex). It is possible that the greater rugosity of pronotum, and marked striation of the elytra in this type-specimen of *A. calosomoides* is due to a long immersion in spirits. Mr. Sloane has informed me that Carabidæ that have been long immersed in spirits have had their sculpture so much intensified as to cause frequent mistakes of identification.

A. neophyta is a synonym of *A. brevicorne* Blessig, according to Champion,* an opinion with which I concur. It has the widest range of any *Adelium* that I know. I have taken it in the North-East of New South Wales, Sydney, Victoria, while I have specimens from Adelaide, the locality of Blessig's type. As with all common insects of wide range, it varies greatly in size and colour, the general colour a dark shining bronze varying to black. Blessig specially mentions a black variety known to collectors as *A. sphaeroides.*

A. orphana Pasc.—The type of this is a unique specimen I have never seen elsewhere. It is even narrower and more parallel than *A. commodum.* Yankee Jim Creek, Vic.

A. pilosum Pasc.—I have one specimen from Victoria that corresponds with the type. It is a near ally of *A. scutellare* Pasc., but has its sides of prothorax roundly angulate, which in combination with its pilose clothing and split intercoxal process should separate it from its congeners.

A. plicigerum Pasc. = *A. rugosicolle* Macl. (var.).—My specimens of *A. plicigerum* from Mackay, Q., correspond very well with the type from Queensland. My specimens of *A. rugosicolle* are cotypes kindly given me by Mr. Masters. They only differ slightly in size, and in the greater rugosity of the pronotum of *A. rugosicolle.* The latter is worth noting as a geographical variety. Both differ from *A. auratum* Pasc., in having the prothorax rugose; in *A. auratum* it is smooth; while from *A. lindense* Blackb., it is distinguished by its thinner edge to pronotum *inter alia.*

A. reductum Pasc., a small coppery insect allied to *A. calosomoides* Kirby. I have specimens from Gosford, Wyong, N.S.W.; and Brisbane which correspond to the type.

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* Trans. Ent. Soc. Lond. 1894.

A. repandum Pasc. = *Seirotrana repanda*, and will be dealt with under *Seirotrana* later.

A. ruptum Pasc.—I have one specimen from Queensland (I believe from Mackay) which exactly corresponds with Pascoe's type from Victoria. Here again it is possible that some mistake of locality has occurred. This and *A. steropoides* differ from all other Adelia known to me in their resemblance to *Apasis*, but they are easily distinguished, *inter se*, by the marked difference in their external sculpture, the striæ being uninterrupted in *A. steropoides*, but broken and somewhat reticulate in *A. ruptum*.

A. scutellare Pasc.—My specimens from Mudgee and Inverell, N S.W., correspond with the type from Darling Downs, Q., a neighbouring locality. Pascoe only notes the pilose clothing on the legs, whereas in fresh specimens the whole upper surface is clothed with hair, so that it closely resembles *A. pilosum* Pasc., but its sides are less angulate, and the sculpture of the pronotum is different.

A. scytalicum Pasc., from West Australia, is readily identified by its smooth pronotum and bicolorous form. A small specimen marked with an MS. name of Bates', from Fremantle, in the Bates Coll., is probably a male of this species, while a larger form from Champion Bay in the same collection, also labelled with an MS. name of Bates', seems to me to be only a variety of *A. scytalicum*.

A. steropoides Pasc.—I have one specimen given to me by Mr. T. G. Sloane, locality uncertain, which exactly corresponds to Pascoe's type from Victoria (see note above on *A. ruptum*).

A. geminatum Pasc. = *A. punctum* Carter.—An examination of the types of these has proved this synonomy. It also proves the fairly wide range of this insect, my specimens coming from Grafton, Bellinger, and the Clarence, N.S.W., whereas *A. geminatum* is described from Wide Bay, Q. Its combination of small size, square form and very distinct sculpture should distinguish it from others.

A. geniculatum Haag-Rut. = *Seirotrana geniculata* Haag-Rut. This will be more fully dealt with under *Seirotrana*.

Macleay has since added *A. convexiusculum*, *A. monilicorne*, *A. panageicolle*, *A. parvulum*, *A. rugicolle* and *A. viridipenne*, described in his 'Insects from Gayndah.'

A. convexiusculum Macl.—I have two cotypes of this species kindly given me by Mr. Masters; a small species of the *A. calosomoides* type, with obsolete hind angles to prothorax, from Gayndah, Q.

A. monilicorne Macl., differs manifestly in the structure of its antennæ, the shape of its eyes, which are nearly round, as seen from above, though not prominent, and in its sculpture, from all Adelia known to me. It would seem to me to be nearer *Brycopia* than *Adelium*. There are specimens in the Macleay and Australian Museums, of which the latter probably contains the type, but as is usual with Macleay's types, unmarked as such.

A. panageicolle Macl.—Mr. Masters has generously given me two specimens of this interesting little species, which may have to stand for a type of another genus, from its moniliform antennæ, pilose tarsi, and sculpture and shape of prothorax. The pilose tarsi, however, would place it under *Dystalica*, to which it has the nearest affinity.

A. parvulum Macl.—Specimens in the Macleay and Australian Museums. From its rounded eyes it should be referred to *Brycopia*, though in this respect the character shows some modification.

A. rugosicolle and *A. viridipenne* Macl., have already been noticed above.

Mr. Blackburn has described eleven species, viz , *A. æquale*, *A. alpicola*, *A. angulatum*, *A. ellipticum*, *A. inconspicuum*, *A. lindense*, *A. occidentale*, *A. pustulosum*, *A. simplex*, *A. tropicum* and *A. victoriæ*. Through the courtesy of Mr. Blackburn I have been able to examine the types of all except *A. æquale*, *A. simplex* and *A victoriæ*, while Mr. C. French has kindly lent me the type of *A. victoriæ*.

A. alpicola Blackb., occurs on Mount Kosciusko, where I have taken it myself, as well as on the Victorian Alps, of which Kosciusko is really a portion It is certainly of the *A. calosomoides* type, but considerably larger, and that so consistently that, even if it be considered as a variety of that species, it deserves a special name. I have taken a species very much like it in the Blue Mountains, also under Eucalyptus bark, which I have always considered as a variety of *A. geniale* or *A. calosomoides*, but the antennæ and tarsi are not rufous as *A. alpicola* is characterised; but this is the only definite character, except size, by which I can differentiate *A. alpicola* from *A. calosomoides*.

A. angulatum Blackb.—Mr. Blackburn has kindly given me one specimen as a cotype. It is extremely close to *A. angulicolle* of Castelnau, but differs in its thicker edge to pronotum, its wider explanate margin, especially near the anterior angles, which are much more prominent and reflexed than in Castelnau's species. The puncturation of the pronotum and elytra is also more regular and even, and the intercoxal process is without a carinulate edge.

A. ellipticum Blackb.—I have also a cotype of this species from its author. It is a common species in the Richmond and Clarence River district, easily identified by its brilliant colour and smooth elytra.

A. inconspicuum Blackb., a small species from Kangaroo Island, very close to *A. brevicorne* Blessig, but smaller and more coarsely punctured.

A. lindense Blackb.—I took several specimens of this at Mount Barker, W.A., which do not materially differ from the South Australian specimens I have. While approaching *A. auratum* in size and elytral sculpture, its pronotum is more wrinkled, and its form generally narrower than Pascoe's species.

A. occidentale Blackb., from West Australia, is a fine species strongly differentiated from all others by its large and projecting eyes, punctulate but glabrous pronotum, posterior angles acute and projecting outwards, its regularly striate-punctate elytra and its shining black colour.

A. pustulosum Blackb.—Until I was able to examine the type of *A. victoriæ* Blackb., the descriptions of these species led me into much uncertainty as to their identification. Having examined the types of both species, this doubt has been removed. The combination of differences pointed out in the diagnosis* are sufficient to distinguish these otherwise closely similar forms. The type of *A. victoriæ* is apparently male, much mutilated, having only five joints left of one antennæ, the other having disappeared, together with the anterior tarsi and one posterior leg. I have six specimens which I consider identical with *A. victoriæ* from Illawarra, N. S.W. (Bulli and Nowra); and eight specimens which I consider identical with *A. pustulosum* from Gisborne and Bullarook Forest, Vic., and Lambing Flat, N.S.W., while specimens from Mittagong, Gunning, and Forest Reef are intermediate forms, having the wider, more explanate and more coarsely sculptured prothorax of *A. pustulosum* with the widely obtuse hind angle of *A. victoriæ*. As these last appear to be all female, in the absence of any description of the female, I conclude that they are probably sexual variations of *A. victoriæ*.

Champion in 1894 described two species, *A. tasmanicum* and *A. nodulosum*,† whose types I have seen, and whose excellent diagnosis leaves little room for comment.

Lea next added four, *A. capitatum*, *A. heterodoxum*, *A. regulare*, and *A. minutum*,‡ and through Mr. Lea's courtesy I have been able to examine his types.

A. capitatum Lea, is a very distinct form, which I have from Wee Waa, N. S.W., and is apparently widely distributed in the western district of this State.

A. heterodoxum Lea, is also very distinct, though its chief distinction comes from a character omitted in the original description, in that it is clothed throughout, even to the legs, with upright brown pile. While in general form and in the length of the third antennal joint it is similar to *A. tenebrioides* Erichs., it differs from that species in being strongly pilose, and in having its elytral intervals uninterrupted. The third antennal joint is not,

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* These Proceedings, 1891, p.534.

† Trans. Ent. Soc. Lond. Part ii. p.403.

‡ These Proceedings, 1898.

however, quite so long as Mr. Lea's description warrants; when measured by an enlarged tracing it is about equal to the combined fourth and fifth, and less than half the sixth joints.

A. regulare Lea, while approaching *A. brevicorne* Blessig, is, I think, a good species, from its constant parallel form; but so far as colour goes, Blessig records his species as varying from metallic green to black.

A. minutum Lea = *Brycopia minuta* Lea, a fact noted by me.*

To the above I added five species in 1905, and three more in 1906,† *A. helmsi*, *A. reticulatum*, *A. violaceum*, *A. minor*, *A. globulosum*, *A. cœruleum*, *A. nitidum* and *A. punctum*.

A. helmsi Carter, is the same species as that labelled with an MS. name in the Hope Coll.; as also in the Bates Coll. of the British Museum. The original specimens came from the Macleay River, but I have since taken it at Bulladelah, near Port Stephens. It has been long in the Macleay Museum unnamed.

A. reticulatum Carter.—I took the type-specimens at Kurrajong, but have since met with it on Mount Irvine, Blue Mountains.

A. minor and *A. globulosum* have already been referred to *Brycopia* by me.‡ Mr. Ferguson has taken *B. globulosa* lately at North Sydney near Middle Harbour; and I have taken it at Waterfall, N. S.W.

A. punctum Carter, has been shown to be synonymous with *A. geminatum* Pasc.

To these I append below the descriptions of seven more—*A. barbatum*, *A. hackeri*, *A. canaliculatum*, *A. pestiferum*, *A. bicolor*, *A. subdepressum* and *A. rotundum*.

In the Bates Coll. I also noted the following species :—

A specimen labelled with an MS. name of Bates', is probably *A. victoriæ* Blackb., or *A. pustulosum* Blackb., but at the time I was in doubt as to the exact points of difference between these species.

A specimen bearing an MS. name of Bates' is probably *A. lindense* Blackb.

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* These Proceedings, 1905, p.181.

† These Proceedings, 1905, p.181; and 1906, p.259.

‡ These Proceedings, 1906, p.259.

To sum up, we have eighty described species. Of these, *three* are unknown to me—*A. punctipenne* Boisd., *A. rugicolle* Boisd., and *A. carinatum* Blanch.

Ten have been referred to other genera, as follows:—*A. parallelum* Germ., *A. geniculatum* Haag-Rut., *A. congestum* Pasc., *A. repandum* Pasc., to *Seirotrana*; *A. monilicorne* Macl., *A. parvulum* Macl., *A. minutum* Lea, *A. globulosum* Carter, *A. minor* Carter, to *Brycopia*; and *A. panageicolle* Macl., to *Dystalica*.

And the following are considered as synonyms or varieties :—
A. porcatum Fabr. = *A. caraboides* Kirby.
A. licinoides Kirby = *A. cisteloides* Erichs. = *A. helopioides* Boisd.
A. calosomoides Kirby = *A. geniale* Pasc.(?) = *A. harpaloides* Boisd.
A. abbreviatum Boisd. = *A. impressum* Blanch. = *A. latum* Pasc.(var.)
A. virescens Boisd.(?) = *A. brevicorne* Blessig = *A. neophyta* Pasc.
A. angulicolle Casteln = *A. succisum* Pasc.
A. plicigerum Pasc. = *A. rugosicolle* Macl.(var.).
A. striatum Pasc. = *A. viridipenne* Macl.(var.).
A. geminatum Pasc. = *A. punctum* Cav.

The first mentioned have the claim to precedence, except in the case of the doubtful *A. virescens* Boisd.

This brings the present number of the species to fifty-four, of which the following table will afford some guide.

Tabulation of Species.

(N.B.—Size large means larger than 16 mm., medium means from 12-16 mm., small means less that 12 mm.).

Section i. Intercoxal process split in front and more or less truncate : Elytra seriate-punctate, not striate ; intervals flat or slightly elevated. Third joint of antennæ about equal in length to that of the fourth and fifth combined.

A. Not or very little pilose.
Size large.
Colour bronze.
1. Pronotum finely punctate, elytral punctures large, elongate, and nearly continuous.................. ...*A. auratum* Pasc.
Size medium.
. Pronotum longitudinally rugose, elytral punctures more distant.... ....*A. plicigerum* Pasc.
var. *rugosicolle* Macl.

3. Pronotum with thickened edge, elytra with series of round foveæ and small punctures........ ....*A. lindense* Blackb.
4. Sides of pronotum angulate; intercoxal process without carinulate edge.................................*A. angulatum* Blackb.
5. Narrower than preceding; intercoxal process with carinulate edge........................ ....*A. angulicolle* Casteln.

Colour black.

6. Elytral punctures small, with few larger punctures......... *A. æquale* Blackb.

Size small.

Colour dark bronze.

7. Edge of pronotum thickened, margins explanate. Elytra with large and small punctures irregularly arranged in series................... ....*A. vicarium* Pasc.
8. Discolorous. Head and pronotum shining black, elytra dark bronze, pronotum nearly smooth.....*A. scytalicum* Pasc.
9. Brilliant bronze, shining..............................*A. nitidum* Carter.

B. Strongly pilose.

Size large.

Colour greeny-bronze.

10. Hind angles of pronotum defined and rectangular; elytra with alternate intervals raised..................... *A. hackeri*, n.sp.

Size medium.

Colour bronze.

11. Disc of pronotum with large round punctures, sides roundly angulate in middle.........................*A. pilosum* Pasc.

Colour darker than 11.

12. Disc-punctures tending to confluence, sides less angulate. *A. scutellare* Pasc.

Section ii. Intercoxal process marginal, and more or less rounded.

Subsection A. Third joint of antennæ longer than fourth and fifth combined, intervals of elytra elevated.

a. Intervals of elytra regular (not interrupted).

Size large.

Colour black.

13. Elytra sulcate-punctate and sides subparallel....... .... *A. occidentale* Blackb.
14. Elytra sulcate..*A. striatum* Pasc.
var. colour greenish.....*A. viridipenne* Macl.

Size medium.

15. Colour bronze............. ....*A. simplex* Blackb.

Size small.

Colour bronze with violet reflections.

16. Elytral series minutely punctate.................. *A. violaceum* Carter.

Pilose.

17. Elytral series punctate..............................*A. heterodoxum* Lea.

β. Intervals of elytra more or less interrupted.

Size medium.

Colour black or greenish.

18. Elytral intervals near suture generally interrupted,.........
A. porcatum Fabr.
A. caraboides Kirby.

Colour green, subnitid.

19. All elytral intervals interrupted.......................*A. augurale* Pasc.

20. More nitid than 18.. ....*A. aerarium* Pasc.

Colour dark bronze, prothorax sometimes greenish.

21. Elytral intervals interrupted only on sides and apex........
A. similatum Germ.

22. Larger and more convex; pronotum more widely rounded and abruptly contracted at base...... ....*A. obesum* Pasc.

23. Narrower, more elongate and depressed than 21, third joint of antennæ very long..................*A. tenebrioides* Erichs.

Colour blue-black.

24. Elytra impunctate..................... ....*A. tropicum* Blackb.

Size small.

Colour blue.

25. Elytral intervals interrupted only near apex...*A. coeruleum* Carter.

Subsection B. Third joint of antennæ equal in length to fourth and fifth combined.

γ Intervals of elytra raised and more or less interrupted.

Not pilose.

Colour black, nitid.

26. Size medium...*A. capitatum* Lea.

Size smaller.

Colour black, fuscous.

27. Foliate sides of pronotum reflexed, elytral intervals reticulate..*A. reticulatum* Carter.

Pilose.

Colour blue-black.

28. Form somewhat square, pronotum rugosely punctate.......
A. barbatum, n.sp.

δ. Intervals of elytra not raised, elytra seriate-punctate.

29. *A. geminatum* Pasc.
A. punctum Carter.

Subsection C. Third joint of antennæ less than fourth and fifth combined; intervals of elytra flat or slightly convex, never interrupted, striate-punctate. Posterior angles of prothorax generally obtuse, little defined or obsolete.

Colour bronze.

30. Size large, punctures in striæ small, striæ indistinct........ *A. helmsi* Carter.

31. Size smaller, punctures in striæ large, striæ distinct.......... *A. alpicola* Blackb.

32. Size medium, broadly ovate, punctures in striæ small and close.. *A. calosomoides* Kirby.
A. harpaloides Boisd.
(?)*A. geniale* Pasc.

33. Bicolorous. Flatter, narrower, more elongate than preceding. *A. bicolor*, n.sp.

Colour bronze.

34. Convex; pronotum nearly smooth, with hind angles obsolete, large and small punctures in striæ; antennæ of male long..... ....*A. convexiusculum* Macl.

35. Tarsi red; hind angles of pronotum distinct, elytral striæ irregularly punctate, punctures varying in size and distance ....*A. licinoides* Kirby.
A. cisteloides Erichs.

36. Antennæ longer than preceding, hind angles of pronotum produced.. ....*A. ancilla* Pasc.

37. Elongate-ovate; pronotum nearly smooth; shoulders obsolete; punctures in striæ minute and close.....*A. steropoides* Pasc.

38. Form like 37, colour pitchy brown, nitid; striæ broken....... *A. ruptum* Pasc.

Colour brilliant bronze, nitid.

39. Intervals quite flat............ .. ..*A. ellipticum* Blackb.

Size small.

40. Form like *A. calosomoides*, but narrower and coppery; pronotum nearly smooth, punctures in striæ unequal........ *A. reductum* Pasc.

Colour dark bronze.

41. Very convex, hind angles obsolete.........................*A. rotundum*, n.sp.

Elytra pustulose.

Colour dark bronze.

42. Pronotum coarsely rugose, hind angles rectangular........... *A. pustulosum* Blackb.

43. Pronotum less rugose, hind angles widely obtuse................ *A. victoriæ* Blackb.

44. Size smaller, pronotum canaliculate...........*A. canaliculatum* Carter.

Colour lighter.

45. Prothorax subangulate.......................................*A. pestiferum*, n.sp.

Colour violet-bronze.

46. Form depressed and elongate...... ....*A. subdepressum*, n.sp.

Subsection D. Antennæ shorter, generally not reaching beyond base of prothorax in the female; size smaller; third joint of antennæ less than fourth and fifth combined; elytra striate-punctate; intervals flat.

Colour bronze.

47. Short broad form, intervals of elytra with regular shallow impressions..*A. abbreviatum* Boisd.
A. impressum Blanch.

Var. more robust, prothorax more convex...... .....*A. latum* Pasc.

Colour dark bronze.

48. More slender; prothorax evenly rounded at sides, with rounded hind angles; elytral punctures regular...............
A. brevicorne Blessig.
A. neophyta Pasc.
?*A. virescens* Boisd.

Colour black.

49. Elytra more parallel.......................................*A. regulare* Lea.

50. More coarsely punctate than 48, with elytral intervals more convex........... ....*A. inconspicuum* Blackb.

Colour black or pitchy brown.

51. Size small, base of pronotum obliquely foveate..................
A. tasmanicum Champ.

Colour bronze.

52. Form narrow, sides of prothorax subparallel, disc smooth...
A. commodum Pasc.

53. Near 51, with elytral intervals nodulose... ....*A. nodulosum* Champ.

54. Antennæ subclavate, elytra subparallel and glossy.............
A. orphana Pasc.

Adelium barbatum, n.sp.

(Plate iii., fig.1.)

Truncate-ovate, moderately convex, shining; black with a bluish tinge, antennæ and tarsi piceous, abdomen black; upper surface and legs clothed with short upright black hairs.

Head: labrum round, salient and hirsute; epistoma and front densely and rugosely punctate. Eyes large. Antennæ stout and moderately long, third joint equal to fourth and fifth jointly.

Prothorax transverse, half as wide again as long, apex emarginate, anterior angles widely acute and prominent, extending to the eyes; sides widely rounded, widest behind middle, then sinuately narrowed at posterior angles, these turned downwards and outwards forming a subrectangular tooth. Base truncate. Disc densely coarsely rugosely punctate, punctures tending to coalesce and to become striolate on the foliaceous margin (this margin concave and reflexed). The whole pronotum concave and reflexed on the sides. *Scutellum* triangular with apex raised, punctate. *Elytra* wider at base than prothorax at widest; convex, with shoulders round and subrectangular; sides slightly bulging about half-way, apex bluntly acute. Interruptedly striate-punctate, striæ reticulated by transverse lines, forming series of rectangular foveæ, each filled with coarse punctures. Intervals raised, crenate and shining, becoming more interrupted towards the sides and apex (as in *A. porcatum* Fabr.), mere lines of pustules towards apex. Epipleuræ, last two segments of abdomen and legs closely punctate, the rest of abdomen with a few much finer punctures. Fore and intermediate tibiæ slightly curved and thickened at apex, hind tibiæ straight. Whole legs densely pilose. *Dimensions*—♂ 12·5 x 5 mm.; ♀ 14 x 6 mm.

Loc.—Endeavour River, Dawson River, Port Denison, Q. (collected by Mr. G. Masters).

The above insect is unnamed in the Macleay Collection, specimens of which have been courteously supplied me by Mr. Masters. While belonging to the *A. porcatum* and *A. augurale* group, it is easily distinguished from these by its smaller size, different colour, and its pilose clothing, which is thickest on the head and pronotum, and more thinly distributed on the elytra. In size and facies it approaches *A. cœruleum* mihi, from which species it differs widely in colour and its elytral sculpture. In its lateral prothoracic foliation it resembles *A. reticulatum* mihi. The pile is much shorter than in *A. pilosum* Pasc., to which insect it otherwise bears little resemblance.

From *A. tropicum* Blackb., it evidently differs in size and punctate elytra; also of that species Mr. Blackburn says, "third joint of antennæ much longer than the fourth and fifth," whereas in *A. barbatum* it is just equal to those.

A. barbatum is the same species as that labelled with an MS. name in the Bates Coll. A narrower form, also labelled with an MS. name of Bates', I have from the Dawson River, Queensland. This differs from *A. barbatum* in its more angulate-sided prothorax and less pilose clothing. Having only one imperfect specimen I am unwilling at present to describe it.

ADELIUM HACKERI, n.sp.

(Plate iii., fig.2.)

Very broad, subovate, moderately convex, dark coppery-bronze, obscurely shining, slightly pilose; antennæ and tarsi fuscous-brown, with the usual lighter-coloured tomentum on the underside of tarsi.

Head: labrum trapezoidal and prominent, epistoma closely, and front rugosely punctate; at each angle formed by the front with the epistomal ridge is a seta bearing a long hair. Eyes large and widely separate. Antennæ stout and short, not reaching the base of prothorax when set back; third joint as long as the fourth, fifth, and half the sixth jointly; joints 3-10 subovate. *Prothorax* cordate, half as wide again as long, strongly emarginate anteriorly, obtusely pointed anterior angles reaching to the eyes, apex bisinuate, sides widely rounded to the greatest width behind the middle, and crenate on the border (which is raised and thickened near the front angles), then sinuately contracting near the base to meet the prominent subrectangular hind angles. Base truncate. Disc densely rugose, with rugosity generally longitudinal, except on the foliaceous margins, where it is transversely striolate. Thinly pilose with short, upright, black hairs. *Scutellum* large, curvilinear-triangular, with strongly rounded apex, punctate on sides. *Elytra* truncate-ovate, convex, slightly wider (by measurement, though not visibly) than prothorax at its widest; shoulders widely rounded, sides subparallel for half their length, contracting abruptly near the apex.

Interruptedly striate-punctate, the ten striæ on each elytron consisting of long foveæ of varying lengths separated by cross bars on the same plane as the intervals. Alternate intervals, 1st, 3rd, 5th, 7th, sharply raised, having a triangular cross-section, the 2nd, 4th, 6th and 8th having a rounded surface. Basal portion of elytra slightly pilose, as in the prothorax. Epipleuræ wide and coarsely punctate, the legs and last two segments of abdomen finely punctate. On each segment of abdomen are a few scattered setæ, each bearing a long hair, the last segment containing from eight to ten such setæ. Body beneath black and shining. *Legs*: intermediate tibiæ slightly curved, other tibiæ straight. *Dimensions* 17 x 8 mm.

Loc.—Wolfram Camp, N.W. of Cairns, Q. (collected by Mr. H. Hacker).

I have dedicated this species to Mr. Hacker, who has kindly presented me with one specimen. It belongs to the *A. plicigerum* Pasc., and *A. rugosicolle* Macl., group in its elytral sculpture and general facies, but differs from both in its pronounced hind angles and crenate border to prothorax, in its pilose covering, and in its wider and more convex form. It is readily distinguished by its great width as compared with its length. From *A. auratum* Pasc., it differs more widely in its rugose pronotum, and deeper elytral sculpture *inter alia*.

Adelium canaliculatum, n.sp.

(Plate iii., fig.4.)

Oval, moderately convex, dark bronze, shining; palpi, antennæ and tarsi pitchy-brown.

Head flat, with epistomal ridge sharply defined by arcuate groove; finely but sparingly punctured on front, more densely punctured on epistoma. Eyes very large and widely elliptic. Antennæ rather long in the male, with almost linear joints, gradually thickened towards the apex, third joint slightly shorter than fourth and fifth combined, apical joint a little longer and stouter than the tenth. *Prothorax* about one-third broader than long, truncate in front and behind, anterior angles slightly produced and obtuse, rather narrower at base than at apex, sides widely rounded with foliaceous margins having a narrow raised shining border and slightly arcuate towards anterior and posterior angles, the latter widely obtuse but defined. Disc and sides coarsely and rather irregularly punctate with a few larger depressions. Central channel shallow but distinct, not extending to apical border. *Elytra* about two and one-third times as long as the prothorax, and wider than it, shoulders rather squarely rounded, ovate; sides of male little rounded, of female more widely expanded, and sharply contracting to a somewhat pointed apex; striate-punctate, with ten lines of punctures on each elytron, the last on the side; punctures rather small, close and regular in size and distance; intervals flat or very slightly convex, but towards sides and apex having lines of thin, more or less elongate shining pustules; beneath black, shining and finely punctured; intercoxal process margined and truncate, anterior tibiæ very slightly curved, other tibiæ straight; anterior tarsi of male with four basal joints widened in the male. *Dimensions*—♂ 10·5 × 4·5 mm.; ♀ 11 × 5 mm.

Loc.—Botany Bay and Kogarah, near Sydney.

This species comes under Sect. ii.C in my classification, and is nearest to *A. pustulosum* Blackb., from which it differs in (1) smaller size, (2) narrower (in proportion to elytra) and smoother prothorax, (3) prothorax having central canal, (4) finer and more regular punctures in elytral striæ, (5) more ovate shape of elytra, and (6) darker colour. I have six specimens before me, as well as a cotype of Mr. Blackburn's *A. pustulosum*, and the above are only the most easily defined of the many differences that exist between these two species. *A. pustulosum* is altogether a more robust and coarsely sculptured insect, while the channelled prothorax is a rare character in this genus that readily distinguishes this species. From *A. victoriæ* Blackb., it differs in size, colour, canaliculate pronotum, finer sculpture, *inter alia.*

Adelium pestiferum, n.sp,

(Plate iii., fig.6.)

Narrow, elliptic, coppery-bronze, shining; oral organs, tarsi and apical joints of antennæ reddish.

Head : labrum narrow, prominent, epistomal ridge pronounced, frontal disc very concave, the whole coarsely and densely punctured. Eyes large and widely elliptic. Antennæ of male long, with third joint a little less than fourth and fifth combined. *Prothorax* broader than long (in the proportion of 7 : 10), sinuate at apex, with anterior angles well advanced but obtuse, sides widely rounded to meet the subrectangular and well defined hind angles. Base truncate. Disc convex, separated fr m foliaceous sides by a short, deep, curved sulcus, whose continuation forward is indicated by a second small fovea near front angle. Strongly, but not rugosely punctured, with slightly raised vermiculate lines irregularly placed. Medial line is indicated by slight depression. (In one specimen this depression is only shown near base). *Elytra* oval-elliptic, moderately convex, shoulders rounded. Widest in anterior half, then gradually tapering (as in *A. ellipticum* Blackb.), towards apex. Punctate-striate, with intervals strongly pustulated with shining nodules. Abdomen and legs black, shining; posterior intercoxal process rounded, truncate and entire. Anterior femora slightly curved, other femora straight. *Dimensions* 13 x 5 mm.

Loc.—Illawarra, N.S.W., Bulli to Nowra (collected by E. Ferguson and the author).

This species belongs to the class of *A. pustulosum* Blackb., and *A. canaliculatum* Carter. From the former it is readily distinguished by its lighter and unicolorous bronze, by its pronounced hind angles to prothorax, and its more elongate-elliptic form; from the latter it is more strongly differentiated by the shape of prothorax (see Plate iii.), its larger size and brighter colour. It is the most markedly *pustulose* Adelium known to me, the side and apical portions being studded with shining nodules varying in shape from round to elongate, the anterior central intervals only being more or less smooth. The punctures in elytral striæ are unequal in size, those in the striæ nearest the suture being larger and deeper than in the striæ towards the sides.

Adelium bicolor, n.sp.

(Plate iii., fig.5.)

Elongate rather flat; head and prothorax greenish-bronze, shining; elytra reddish-bronze; palpi, antennæ and tarsi reddish-brown.

Head rugosely punctate, epistomal ridge rounded and prominent. Eyes large and prominent. Antennæ of male moderately long, of female much shorter; third joint less than the fourth and fifth combined. *Prothorax* wider than long (3 x 5 mm.), with greatest width behind the middle, with anterior angles slightly produced forward and obtuse, truncate behind; sides widely rounded with foliaceous margins and raised border throughout; thicker on sides than in front and behind. Posterior angles obtuse but defined. Disc finely punctate, with some irregular larger depressions. Median canal faintly defined. *Elytra* a little wider than the prothorax and about three times as long (9 x 5·3 mm.), shoulders widely rounded, sides tapering towards apex; in female elytra more convex, wider and stouter. Striate-punctate, striæ with punctures large, regular and close; intervals smooth, very slightly convex, and without any sign of tuberculation towards apex. Abdomen and sternum black and shining, last segment of former finely punctate. Tarsi of male much wider than those of female. Intercoxal process entire and truncate. *Dimensions*—♂ 14 x 5·3 mm.; ♀ 14·5 x 6 mm.

Loc.—Mount Kosciusko.

This species comes under Subsection C of my classification, and is near the *A. calosomoides* Kirby, type, from which it is distinguished by colour and by its flatter and more elongate-ovate form, less transverse prothorax and larger punctures in elytral series. It is very common on Mount Kosciusko, above 4000 ft. altitude. Fresh specimens show the bicoloration to a marked degree, the bright bronze becoming darker with age. Distinguished from *A. similatum* group by its uninterrupted intervals.

ADELIUM SUBDEPRESSUM, n.sp.

(Plate iii., fig.3.)

Elongate-ovate, rather flat; bright purple-bronze, moderately shining; oral organs, antennæ and tarsi reddish-brown, beneath a darker bronze shining.

Head rather coarsely punctate, epistomal ridge sharply defined behind by arcuate groove. Antennæ elongate in the male, joints lineate, and only slightly thickened towards the apex, third joint about equal to fourth and fifth jointly. *Prothorax* nearly twice as broad as long, very little convex, and widely explanate, with greatest width behind the middle, moderately striate in front, truncate at base, narrower at base than at apex; sides widely rounded, scarcely sinuate near anterior angles, more abruptly converging at posterior angles, the former of these slightly produced and obtuse, the latter obsolete, a narrow raised border throughout strongly defined towards anterior angles, less perceptible elsewhere. Disc very lightly rugose, with shallow punctiform impressions. Central canal faintly impressed on middle portion. A few setigerous punctures on the explanate margins. *Elytra* about as wide as prothorax at widest and about two and a half times as long. Shoulders widely rounded and sharply margined. Disc somewhat flat and depressed at suture, striate-punctate, with ten rows of punctures on each elytron, the last two on the sides, the punctures large, transverse and close; intervals very slightly raised but strongly tuberculate towards sides and apex. Last segment of abdomen strongly punctured. Intercoxal process margined and rounded. *Dimensions*—♂ 14·5 × 5·5 mm.; ♀ 16·5 × 7 mm.

Loc.—Bombala and Moruya, N. S. W.

I am indebted to Mr. Cheesman, of Moruya, for the three specimens I possess. I adopt the MS. name with which I found a similar insect labelled in the Bates Collection of the British Museum with other undescribed Adelia. It is easily recognised by the combination of bright bronze colouring and strongly tuberculate elytra and depressed form.

Adelium rotundum, n.sp.

(Plate iii., fig.7.)

Shortly ovate, dark bronze, sometimes greenish, shining, very convex. Tarsi, palpi and antennæ brown.

Head: front rugosely punctate; epistomal ridge prominent and strongly punctate, punctures large; labrum salient. Eyes large, prominent and coarsely faceted. Antennæ moderately stout and long and both they and the palpi pilose, third joint less than fourth and fifth combined. *Prothorax* convex, width twice the length, greatest width near base, much narrower in front; truncate at base and apex. Front angles widely obtuse and scarcely produced forward; sides strongly rounded and widened towards base, meeting the base in a circular curve without any indication of hind angles. Disc coarsely punctured, punctures large and separate. Two shallow impressed foveæ near base (in female only). Without distinct foliaceous margins, though their position is indicated by a more or less distinct ridge and sulcus, the sulcus never extending beyond half-way from the front. *Scutellum* triangular, with rounded apex, punctate. *Elytra* strongly convex and oval. In the male the width is about the same as the base of prothorax, in the female width is greater than that of prothorax. Disc with about ten striæ on each elytron; these closely punctate. Intervals scarcely raised and minutely punctate. Shoulders widely rounded; sides, in female, gently rounded, in male subparallel to near apex, then narrowing to a blunt apical point. Epipleuræ, femora and apical segment of abdomen finely punctate. Beneath a shining blue-black. *Dimensions*—♂ 10 × 4·5 mm.; ♀ 12 × 6 mm.

Loc.—Monaro, N. S. W. (near Jindabyne; collected by author).

This species is the most convex Adelium known to me, and can be readily recognised by this feature alone, combined with its peculiar prothorax. There is more than the usual sexual difference indicated by size, especially the width of female specimens.

CARDIOTHORAX.

Cardiothorax batesi Carter = *C. aericollis* Pasc.—I would take this, my earliest, opportunity to point out the above synonomy, of which I was made certain by a comparison of my type with Pascoe's in the British Museum. I was certainly misled by Bates' remark as to its being a mere colour-variety of *C. walckenaerii* Hope, whereas I pointed out in my diagnosis of *C. batesi* its several points of distinction from that species; the name *C. batesi* must therefore be sunk.

EXPLANATION OF PLATE iii.

Fig. 1.—*Adelium barbatum.*
Fig. 2.—*A. hackeri.*
Fig. 3.—*A. subdepressum.*
Fig. 4.—*A. canaliculatum.*
Fig. 5.—*A. bicolor.*
Fig. 6.—*A. pestiferum.*
Fig. 7.—*A. rotundum.*

NOTES AND EXHIBITS.

Mr. Carter exhibited his collection of representatives of the genus *Adelium*, comprising a majority of the known species, in illustration of his paper.

Mr. Kesteven exhibited a dissected specimen of *Hyla aurea* which contained in its stomach a somewhat smaller specimen of apparently the same species.

Mr. A. A. Hamilton exhibited a two-flowered specimen of the rare orchid *Adenochilus Nortoni* from Lawson on the Blue Mountains, whereas the type-specimens described by Fitzgerald had the flowers solitary; specimens of *Persoonia angulata* R.Br., from Wentworth Falls, Leura and Katoomba, an extension of the range of a somewhat rare plant; and an example of the Waratah (*Telopea speciosissima* R.Br.) from Waterfall, with pinnatisect foliage of an uncommon character.

Dr. Greig-Smith showed a Schizosaccharomyces, isolated from molasses; and he pointed out the relations which the genus has with the Saccharomycetes and with the Bacteria.

Mr. A. Basset Hull exhibited a series of eggs of the Silver Gull (*Larus novæ-hollandiæ* Stephens) from the gull rookery at Montague Island, displaying two striking mutations in colour. The normal egg is very variable in the shade of the ground-colour, and the markings also vary considerably; but from pale olive-green to deep olive-brown, slightly to heavily streaked or blotched with blackish-brown markings, will do for a general description. The two abnormal varieties exhibited were (A.) uniform pale blue, without any trace of markings: (B.1) glossy white, faintly blotched with pale red and purplish-red suffused markings and a few dull red spots, distributed over the whole shell; (B.2) creamy-white, blotched with purplish-red suffused markings, and larger dull red spots and markings, distributed over the whole shell. Of variety A one specimen (exhibited) was found in a nest together with a heavily blotched normal egg; another was found with two normal eggs, and the clutch of three (exhibited) was forwarded from Montague Island a little later in the season. Of variety B1 the first specimen (exhibited) was found alone in a nest surrounded by dozens of other nests, all of which contained normal eggs. Of variety B2 a pair was found in a nest in the centre of the largest group of nests in the rookery; and a pair (exhibited) was shortly after forwarded from the Island. Such striking departures from the normal colour had not previously been recorded by any of the Australian authorities; but Mr. Tom Iredale, of Christchurch, had met with a blue mutation in the eggs of *Larus ridibundus*, *L. fuscus*, and *L. argentatus*, collected in the North of England, in 1889-90; and also in the eggs of *L. dominicanus* and *Sterna frontalis* in New Zealand.

Mr. Cheel exhibited a series of specimens illustrating the habits and depredations of a leaf-cutting bee (*Megachile* sp.), and of two pollen-collecting bees (*Podalirius cingulatus* Fabr., and *Sarapoda bombiformis* Smith). The contents of a nest in the ground, comprising a good handful of oblong or roundish pieces of the foliage of *Laburnum vulgare* collected by the Megachile were shown, and also a branch of *Solanum xanthocarpum* from a plant which used to fruit freely, but which in recent years had borne no fruit, apparently through being deprived of pollen by the operationsof the pollen-collecting bees. For the identification of the insects, Mr. Cheel expressed his indebtedness to Mr. W. J. Rainbow, F.L.S., of the Australian Museum.

Mr. Goddard exhibited an interesting series of freshwater crustaceans, including species of *Anaspides* and *Phreatoicus*, from ponds on Mount Wellington and Mount Ben Lomond, Tasmania; and examples of freshwater leeches (*Glossiphonia*) from Tasmania and New South Wales.

Mr. Fred Turner exhibited, and offered observations upon various botanical specimens comprising *Salicornia tenuis* Benth., a native saltbush forwarded from Wongalea Station, Gunbar District, with the report that it had recently sprung up, covering an area of six hundred acres; *Grevillea arenaria* R.Br., var. *canescens*, from the Bathurst district, where it was said to be greedily eaten by sheep; and *Panicum tenuissimum* Benth., collected at Rose Bay, Sydney, the most southerly station so far recorded for this grass.

The Secretary, on behalf of Dr. T. L. Bancroft of Brisbane, exhibited a named collection of Queensland mosquitoes, comprising representatives of twenty-four out of the thirty-two species described in the recently published "List of the Mosquitoes of Queensland, &c."(Annals of the Queensland Museum, No.8,1908); and he stated that, at Dr. Bancroft's request, the specimens were to be presented to the Macleay Museum, to supplement the collection which the late Mr. Skuse had studied.

Mr. A. G. Hamilton sent for exhibition a very complete and interesting series of germinating seeds and young seedlings of one of the Mistletoes (*Loranthus exocarpi* Behr), forwarded to him by Mr. C. C. Brittlebank of Myrniong, Victoria.

Mr. Fletcher showed a series of lantern slides prepared from photographs of germinating seeds, and young seedlings of various species of Loranthus; and illustrating the arrangement (into two groups, each of these again divisible into two sections) which the characters of the species studied from the life-history point of view, suggested. As fruits of *L. dictyophlebus*, *L. alyxifolius*, *L. grandibracteus*, and some of the little known brush and scrub Loranths had not been procurable hitherto, the arrangement indicated would probably require modification; and further knowledge was desirable before entering into particulars.

WEDNESDAY, MAY 27TH, 1908.

The Ordinary Monthly Meeting of the Society was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, May 27th, 1908.

Mr. J. H. Maiden, F.L.S., &c., Vice-President, in the Chair.

Mr. L. A Cotton, B.A , B.Sc., Demonstrator in Geology, University of Sydney, was elected an Ordinary Member of the Society.

A letter from Mr. J. R. Garland, the retiring Hon. Treasurer, thanking the Members for their expression of appreciation and good will at last Month's Meeting, and intimating that he was looking forward to meeting them again very soon, was read to the Meeting.

The Chairman announced that, under the provisions of Rule xxv., the Council had elected Mr. J. H. Campbell to be Hon. Treasurer for the current Session.

Circulars detailing the arrangements for the Third International Botanical Congress, to be held in Brussels in 1910, were laid upon the table, and the attention of Members directed to them.

The Donations and Exchanges received since the previous Monthly Meeting, amounting to 9 Vols., 77 Parts or Nos., 16 Bulletins, 3 Reports, and 26 Pamphlets, received from 58 Societies, &c., were laid upon the table.

NOTES AND EXHIBITS.

Dr. C. Anderson exhibited some fine crystals of Rhodonite from Broken Hill, comprising specimens kindly lent by the National Museum, Melbourne, and the Geological Department of Sydney University, with others from the Collection in the Australian Museum. New values for the axial ratios and angles have been obtained, viz. :—

$$a : b : c = 1{\cdot}147922 : 1 : 1{\cdot}831584.$$
$$\alpha = 94^\circ\ 46'; \ \beta = 111^\circ\ 34'; \ \gamma = 85^\circ\ 56'.$$

The values given by Goldschmidt, whose position and axes have been chosen, are :—

$$a : b : c = 1{\cdot}1550 : 1 : 1{\cdot}8317.$$
$$\alpha = 94^\circ\ 42'; \ \beta = 111^\circ\ 27'; \ \gamma = 86^\circ\ 6'.$$

The following new forms were recognised:—(103), (207), (013), $(0\bar{1}3)$, $(0\bar{1}4)$, $(0\bar{1}5)$, $(0\bar{3}7)$, $(\bar{1}\bar{1}2)$, $(\bar{2}01)$.

The corresponding indices for Dana's position are :—(223), (447), $(2\bar{2}3)$, $(\bar{2}23)$, $(\bar{1}12)$, $(\bar{2}25)$, $(\bar{6}67)$, $(\bar{2}01)$, $(\bar{4}\bar{4}1)$.

Dr. Greig-Smith exhibited a culture of a slime-forming rod-shaped bacterium associated with the slime which forms on the household sponge and which is generally ascribed to soap. Similar rod-shaped bacteria are to be found in the slime which forms inside water-cisterns.

Mr. Fred. Turner exhibited botanical specimens, namely, *Linum flavum* Linn., a European plant now acclimatised on the Upper Hunter River; *Panicum spectabile* Nees, the famous "Coapim" of Angola, Western Africa, raised from seed received at the Botanic Gardens, Brisbane, from the Royal Botanic Garden, Kew, London; *Cynodon dactylon* Pers., showing abnormal inflorescence, from the neighbourhood of Maitland, on the Hunter River, the flowering peduncle being surmounted by seven spikes instead of four as usual,—the first time he had seen it in that condition (*vide* Agricultural Gazette of New South Wales, Vol.iv., p.312, for a record of another abnormality). He also referred to the fungus *Lysurus australiensis* C. & M., which had lately sprung up pretty plentifully on a buffalo grass lawn at North Sydney.

Dr. Cleland contributed a "Note on Twists in the Bark of the Jarrah (*Eucalyptus marginata* Sm.)." Of one hundred trees observed in the neighbourhood of Perth, W.A., four showed a decided left twist, sixteen a slight left twist, forty-four were straight, twenty-four showed a slight right twist, nine a marked right twist, and in three the twist was undecided (*i.e.*, irregular). As there appeared to be no indication of a tendency to tree-growth in a spiral direction, the explanation was offered that, when young, a predominant branch probably extended to one or other side and, being played on by the prevailing wind, caused the young stem to become twisted to some extent. Later such a branch may have died and disappeared. The explanation offered seems to be favoured by the fact that contiguous trees are often twisted in opposite directions.

Mr. Fletcher showed specimens of *Loranthus Bidwillii* Benth., from north of the Warrumbungle Mountains, collected by Dr. H. I. Jensen, the host being a species of Pine (*Callitris* sp.); and from near Young, N.S.W., parasitic upon the Black Pine (*Callitris calcarata* R.Br.), collected by Mr. T. G. Sloane. The species was described in the "Flora Australiensis" from Wide Bay, Q., without reference to the host; it was subsequently found in South Queensland upon *Callitris cupressiformis* Vent., by the late Rev. B. Scortechini [Proc. Linn. Soc. N.S.Wales, viii.p.251, 1883]; and recorded for the first time from New South Wales upon *Callitris* sp. by Mr. R. T. Baker from Murrumbo, Goulburn River [*op. cit.* 1896, p.452]. Though not common, the species is evidently fairly widely distributed; and it is of interest because, so far as known, it seems to be exclusively associated with Conifers.

THE BEHAVIOUR OF *HYLA AUREA* TO STRYCHNINE.

By H. G. Chapman, M.D., B.S., Demonstrator of Physiology in the University of Sydney.

(From the Physiological Laboratory of the University of Sydney.)

It has been noted not infrequently that the common Australian frog, *Hyla aurea*, is much less susceptible to the poisonous alkaloid strychnine than the European frog of the genus Rana.

This diminished susceptibility or increased resistance can be most easily shown by a determination of the minimal lethal dose of strychnine for Hyla. The minimal lethal dose for various species of Rana has been measured by various observers. There seems to be a general agreement that this lies between 2 mg. and 5·5 mg. per kilogram of body-weight. Falck* found that to kill a frog with strychnine nitrate at least 2 mg. per kilo must be injected. Sollman,† working in America, gives 5·5 mg. per kilo. as the lethal dose for the frog.

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* Volkmann's Sammlung Klinischer Vorträge, No.69.
† Text-Book of Pharmacology, Philadelphia, 1901, p.171.

To determine the minimal lethal dose for *Hyla aurea*, 108 experiments have been carried out. These have been conducted at different periods of the year to render obvious the effect of the winter and summer seasons. Series of experiments have also been performed to exhibit any differences in resistance between frogs fresh from their native swamps, and frogs from the laboratory tank.

In all cases the strychnine was dissolved as sulphate and introduced into the dorsal lymph sac by a hypodermic needle. The concentration of the solution of strychnine was adjusted to allow the introduction of the poison in less than 1 c.c. of normal salt solution. For most experiments a solution containing 5 mg. of strychnine as sulphate in 1 c.c. fluid was employed. The solution was measured in a pipette carefully graduated into hundredths of a cubic centimetre. The amount for each dose measured by the pipette was then sucked up by the needle and injected. The experiments were conducted in series of six frogs each. These were weighed to the nearest decigram and kept on a board under large glass beakers during the experiment. Moistened cotton wool was placed beneath the beaker. Each twenty-four hours the whole was cleaned to avoid infection of the frogs. The time at which the frogs were injected was noticed and the period between the first spasm and the injection noted. Frequent taps were given to the board on which the frogs were placed to elicit convulsions.

In the earlier series the frogs were not arranged in any order from the point of view of their weight. Later it was thought to be more advantageous to arrange the frogs in such an order that the heaviest frog received the smallest dose per gm. of weight and the lightest frog the greatest dose per gm. of weight. Although the absolute weight of the frog had little or no influence on the ultimate fate of the frog, it appeared that small frogs became convulsed earlier than large frogs.

Certain typical results are tabulated in Table i. in which the weight of the frogs, the dose, and the behaviour are recorded.

Table i.

No.	Date.	Wt. of Frog in gm.	Dose in mg. per gm. of weight.	Dose injected in mg.	Amount of fluid injected in c.c.	Number of minutes between injection and first spasm.	Result.
1	28/11/06	8 gm.	0·006 mg.	0·048 mg.	0·2 c.c.	—	No symptoms of poisoning.
2	28/11/06	8 gm.	0·007 mg.	0·056 mg.	0·22 c.c.	—	No symptoms of poisoning.
3	28/11/06	9 gm.	0·008 mg.	0·072 mg.	0·3 c.c.	—	No symptoms of poisoning.
4	29/11/06	16 gm.	0·009 mg.	0·15 mg.	0·15 c.c.	—	No symptoms of poisoning.
5	29/11/06	23 gm.	0·01 mg.	0·23 mg.	0·23 c.c.	—	No symptoms of poisoning.
6	29/11/06	21 gm.	0·015 mg.	0·31 mg.	0·31 c.c.	51 min.	Recovered by next day.
7	29/11/06	23 gm.	0·025 mg.	0·57 mg.	0·57 c.c.	24 min.	Recovered by next day.
8	30/11/06	11 gm.	0·03 mg.	0·33 mg.	0·33 c.c.	24 min.	Recovered by next day.
9	30/11/06	18·7 gm.	0·04 mg.	0·72 mg.	0·72 c.c.	18 min.	Recovered by next day.
10	3/12/06	13 gm.	0·05 mg.	0·65 mg.	0·13 c.c.	15 min.	Recovered by next day.
11	3/12/06	10 gm.	0·06 mg.	0·6 mg.	0·12 c.c.	7 min.	Recovered by next day.
12	3/12/06	8 gm.	0·07 mg.	0·56 mg.	0·11 c.c.	6 min.	Recovered by next day.
13	3/12/06	19 gm.	0·08 mg.	1·52 mg.	0·3 c.c.	6 min.	Dead in 16 hours.
14	3/12/06	10 gm.	0·09 mg.	0·9 mg.	0·18 c.c.	4 min.	Recovered by next day.
15	3/12/06	12 gm.	0·1 mg.	1·2 mg.	0·24 c.c.	3 min.	Recovered by next day.
16	4/12/06	8·3 gm.	0·11 mg.	0·91 mg.	0·18 c.c.	4 min.	Dead in 21 hours.
17	4/12/06	12 gm.	0·12 mg.	1·2 mg.	0·24 c.c.	5 min.	Dead in 21 hours.
18	4/12/06	13·8 gm.	0·13 mg.	1·79 mg.	0·36 c.c.	4 min.	Dead in 21 hours.
19	13/12/06	18 gm.	0·16 mg.	2·88 mg.	0·58 c c.	4 min.	Dead by next morning.
20	13/12/06	14·8 gm.	0·18 mg.	2·6 mg.	0·53 c.c.	3 min.	Recovered. Spasms present for 120 hours.
21	13/12/06	18·9 gm.	0·2 mg.	3·8 mg.	0·76 c.c.	3 min.	Dead by next morning.

TABLE i.—(*Continued*).

No.	Date.	Wt. of Frog in gm.	Dose in mg. per gm. of weight.	Dose injected in mg.	Amount of fluid injected in c.c.	Number of minutes between injection and first spasm.	Result.
22	14/5/07	24·8 gm.	0·05 mg.	1·24 mg.	0·25 c.c.	6 min.	Recovered by next morning.
23	14/5/07	18·1 gm.	0·07 mg.	1·26 mg.	0·25 c.c.	5 min.	Recovered by 48 hours.
24	14/5/07	15·6 gm.	0·09 mg.	1·4 mg.	0·28 c.c.	4 min.	Dead by 48 hours.
25	15/5/07	19·5 gm.	0·1 mg.	1·95 mg.	0·39 c.c.	7 min.	Dead by 48 hours.
26	15/5/07	18·8 gm.	0·12 mg.	2·25 mg.	0·45 c.c.	4 min.	Dead by 72 hours.
27	15/5/07	17·5 gm.	0·14 mg.	2·45 mg.	0.49 c.c.	4 min.	Dead by 48 hours.
28	20/5/07	19·0 gm.	0·01 mg.	0·19 mg.	0·19 c.c.	53 min.	Recovered by 2 hours.
29	20/5/07	16·6 gm.	0·02 mg.	0·33 mg.	0·33 c.c.	42 min.	Recovered by 4 hours.
30	20/5/07	18·7 gm.	0·05 mg.	0·93 mg.	0·2 c.c.	10 min.	Recovered by next morning.
31	20/5/07	18·4 gm.	0·07 mg.	1·28 mg.	0·25 c.c.	7 min.	Recovered by 48 hours.
32	20/5/07	17·4 gm.	0·09 mg.	1·56 mg.	0·31 c.c.	6 min.	Recovered by next morning.
33	20/5/07	16·2 gm.	0·12 mg.	1·94 mg.	0·39 c.c.	4 min.	Recovered. Spasms present 72 hours.
34	20/5/07	16·1 gm.	0·16 mg.	2·57 mg.	0·51 c.c.	3 min.	Recovered. Spasms present 120 hours.
35	20/5/07	15·0 gm.	0·2 mg.	3·0 mg.	0·6 c.c.	1½ min.	Dead by 140 hours. Spasms present 120 hours.
36	29/5/07	27·1 gm.	0·05 mg.	1·35 mg.	0·27 c.c.	10 min.	Recovered by 48 hours.
37	29/5/07	23·1 gm.	0·09 mg.	2·08 mg.	0·41 c.c.	9 min.	Recovered by 48 hours.
38	29/5/07	22·3 gm.	0·13 mg.	2·9 mg.	0·58 c.c.	7 min.	Recovered by 72 hours.
39	29/5/07	21·5 gm.	0·17 mg.	3·6 mg.	0·72 c.c.	6 min.	Dead by 96 hours.
40	29/5/07	19·4 gm.	0·21 mg.	4·07 mg.	0·81 c.c.	5½ min.	Recovered. Spasms for 96 hours.
41	29/5/07	18·5 gm.	0·25 mg.	4·64 mg.	0·93 c.c.	5 min.	Dead by 48 hours.
42	29/5/07	18·2 gm.	0·27 mg.	4·89 mg.	0·97 c.c.	4 min.	Dead by 16 hours.

Although there are considerable variations, as will be noted later, the minimal lethal dose of strychnine for Hyla is to be expressed in terms of milligrams per gram of body-weight or grams per kilogram of body-weight. The increased resistance to strychnine of Hyla over Rana is therefore very considerable. Of the 108 frogs injected, 48 received doses of less than 0·1 mg. per gm. body-weight. Five died and forty-three recovered. The five which died received 0·02, 0·02, 0·08, 0·09, and 0·09 mg. per gm. respectively. The remaining 60 frogs received doses of 0·1 gm. per gm. or greater doses. Forty-six died and fourteen recovered. The frogs which survived may be classified as follows—three received 0·1 mg. per gm., two received 0·11 mg. per gm., two received 0·12 mg. per gm., one received 0·13 mg. per gm., two received 0·14 mg. per gm., and four received more than 0·15 mg. per gm. body weight.

If we adopt the principles set forth by Falck,* we shall determine the minimal lethal dose by adopting the dose at which an equal number of frogs died and recovered. It is found that this dose lies between 0·09 and 0·10 mg. per gm. body-weight. Table ii. gives a record of the number of frogs injected with each dose, the number which died, and the number which recovered.

During a number of the experiments the sex of each frog was noted. It was thought that as the female frogs weighed heavier than the male frogs owing to the large ovaries, some variation in the toxicity might be observed. No differences were, however, demonstrated in the effects of the doses of strychnine employed.

The difference† in the behaviour of frogs collected in summer (December) and those collected in winter (June) was, however, somewhat marked.

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* *Loc. cit.*

† See Chapman, Proc. Linn. Soc. New South Wales, xxxi. p.362, 1906.

TABLE ii.

Dose in mg. per gm.	No. of frogs injected.	No. of frogs which died.	No. of frogs which recovered.
0·05 mg.	4	0	4
0·06 mg.	2	0	2
0·07 mg.	4	0	4
0·08 mg.	4	1	3
0·09 mg.	8	2	6
0·10 mg.	8	5	3
0·11 mg.	7	5	2
0·12 mg.	7	5	2
0·13 mg.	5	4	1
0·14 mg.	6	4	2
0·15 mg.	4	2	2
0·16 mg.	4	3	1
0·17 mg.	3	3	0
0·18 mg.	4	3	1
0·19 mg.	2	1	1
0·20 mg.	4	4	0
0·21 mg.	2	1	1
0·23 mg.	1	1	0
0·25 mg.	1	1	0
0·27 mg.	1	1	0

Sixty-six experiments were performed with summer frogs. Thirty-seven frogs received doses of more than 0·1 mg. per gm. body-weight. Of these four survived. Thirty-six experiments were performed with winter frogs. Eighteen received doses of more than 0·1 mg. per gm. body weight. Of these eight recovered. It would thus appear that winter frogs were more resistant than summer frogs. A number of observations were made on frogs which had been more than two months in the laboratory tank. It appeared that the resistance to strychnine was slightly diminished, but the number of experiments was too small to obtain sufficient numerical data to calculate a minimal lethal dose. Experiments 22 to 27 in Table i., represent part of the series with frogs from the laboratory tank, and experiments 24 to 42 represent part of the series with frogs caught in the Botany swamp a few days previous to injection.

The behaviour of *Hyla aurea* after the introduction of strychnine was characteristic when the dose reached a certain value.

As in the European frog, convulsions were first noted when the dose reached about $\frac{1}{6}$ of the minimal lethal dose. With Hyla the smallest dose recorded in the experiments as producing spasms was 0·01 mg. per gm. body-weight. The average figure was 0·015 mg. per gm. body-weight. As the dose was increased the convulsions appeared sooner after the injection of the alkaloid. Table iii. gives the result of such a series.

Table iii.

No.	Weight of frog in gm.	Dose in mg. per gm.	No. of minutes between injection of strychnine and the onset of spasms.
1	19 gm.	0·01 mg.	53 min.
2	—	0·02 mg.	42 min.
3	18·7 gm.	0·05 mg.	10 min.
4	18·4 gm.	0·07 mg.	7 min.
5	17·7 gm.	0·08 mg.	6 min.
6	17·4 gm.	0·09 mg.	6 min.
7	16·7 gm.	0·10 mg.	4½ min.
8	16·4 gm.	0·11 mg.	4 min.
9	16·2 gm.	0·12 mg.	4 min.
10	16·1 gm.	0·16 mg.	3 min.
11	15·6 gm.	0·18 mg.	2½ min.
12	15·0 gm.	0·20 mg.	1½ min.

With a small dose such as 0·01 mg. per gm., the convulsions occurred after 53 minutes. The spasms could be elicited for 30 minutes, and the frog then appeared quite recovered. As the dose increased the duration of the period in which spasms might occur was lengthened. In the determination of the period during which a stimulus produced general convulsions, the frogs were stimulated at first every 15 minutes, later every hour. When the dose was increased to 0·05 mg. per gm. body-weight the frog rapidly passed into a condition of complete paralysis. No stimulus, either thermal, mechanical, or electrical, caused any reflex response, though electrical stimuli caused local contractions. This state of paralysis was always preceded by a period of from 1 to 5 minutes during which spasms might be reflexly produced.

When, however, the dose of strychnine was large, no spasms were noted unless the frog was stimulated at frequent intervals. With doses of 0·1 mg. per gm. and upwards, paralysis was complete in 8 to 3 minutes. When no external stimulation was applied, the frog was noted to gradually sink down until its ventral surface became parallel to the board on which it sat. The fore limbs bent up slowly as if they were unable to support the weight of the body. If at this stage the frog was gently turned on to its back, it made feeble efforts to return to its natural posture. The efforts not infrequently caused a spasm. If the frog was unable to regain the natural position it lay quiet on its back. In a few seconds stimulation would fail to produce any reflex response. The movements of respiration and swallowing ceased, but the heart beat was vigorous. Gradually the heart beat became less, until extreme care was necessary to detect it. In fact on several occasions the decision that a frog was dead was recorded, a decision that had to be altered when the frog subsequently showed signs of life. The period of paralysis endured from three to twenty-nine hours in these experiments. Many frogs which died did not recover from the stage of paralysis. With the majority of frogs, after a number of hours the application of a strong external stimulus brought about a reflex. Soon the threshold value of the stimulus was lowered so that even a slight stimulus produced a wide-spread spasm. In this stage the frog (Hyla) showed an appearance identical with that observed in the typical convulsive stage in Rana. This stage lasted many hours. In one case the spasms endured during 120 hours before the frog died. Two other frogs recovered after the spasms had recurred intermittently for 120 hours. Between the spasms the frog lay in a paralytic condition superficially not unlike that of the initial paralysis.

In order to determine the condition of the frog during the stage of paralysis, certain experiments were made on the excitability of the muscles and nerves of the poisoned frog.

A pithed frog, weighing 16·2 gm., received 1·62 mg. strychnine as sulphate dissolved in 0·33 c.c. salt solution. Four minutes after the injection of the strychnine into the dorsal lymph sac, the frog exhibited spasms. Four minutes later the frog was completely paralysed. The sciatic nerve was exposed in the thigh by an incision and was placed on electrodes. On stimulating the nerve with single induced shocks or with the faradaic current no contractions of muscles were seen. A standard Du Bois Reymond inductorium and one bichromate cell were employed. The secondary coil was placed directly over the primary coil. On placing the electrodes directly upon the muscles contractions were elicited even when the secondary coil was separated 22 c.m. from the primary coil. Five similar experiments were carried out with exactly similar results. These observations suggested that the strychnine was producing an action upon the receptive substance* between the nerve endings and the muscle fibres. Another experiment was therefore performed. A frog which weighed 17 gm. was taken and the cerebral hemispheres crushed with forceps. The right sciatic nerve was exposed in the thigh and a ligature passed beneath the nerve. The ligature was then tied around all the structures of the thigh except the sciatic nerve. The ligature was placed as near to the knee-joint as possible. The frog then received 1·7 mg. strychnine as sulphate hypodermically into the dorsal lymph sac. After twenty-five minutes nerve-muscle preparations (gastrocnemius-sciatic combination) were made from each leg. On stimulation of the left sciatic nerve there was no response in the gastrocnemius muscle even when the secondary coil was pushed home. With the right sciatic nerve the minimal point of stimulation of the right gastrocnemius muscle for single induced break shocks was with the secondary coil 12 c.m. from the primary coil. Contractions of the left gastrocnemius muscle were first observed with single induced break shocks when the secondary coil was 15 c.m. from the primary coil. A Du Bois Reymond standard inductorium and one bichromate cell were used in these experiments. Repetitions of this experiment yielded like results.

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* Langley, Journ. of Physiol. xxxiii., 374, 1905.

It may be concluded that this effect of strychnine is manifested on the receptive substance between the nerve fibres and the muscle fibres. The direct irritability of the muscle fibres is probably unaffected. In other words, from this point of view, Hyla reacts similarly to strychnine and curare.*

Further corroboration of this opinion was obtained by experiments conducted for me in vitro by Messrs. Foy, Schmidt, and Macintosh, students in medicine. For their assistance I wish to express my thanks.

Nerve-muscle preparations were dissected from frogs in pairs and immersed in solutions of strychnine in such a way that the nerve of one preparation and the muscle of the other preparation were suspended in the solution. The stimulus which just caused a contraction when applied to each nerve and each muscle was recorded at appropriate intervals. Faradaic currents were employed from a standard inductorium and one bichromate cell.

The first series consisted of eight experiments with a solution of 1 part of strychnine in 10,000 parts of normal saline solution. About 5 c.c. of this solution were used in each experiment. The abridged results of one such experiment are recorded in Table iv.

Table iv.

The figures represent the distance in c.m. between the primary and secondary coils at the minimal response.

Time of immersion.	Muscle in solution of strychnine.		Nerve in solution of strychnine.	
	Muscle in	Nerve out	Muscle out	Nerve in
3 min.	9 c.m.	37 c.m.	18 c.m.	9 c.m.
6 min.	9 c.m.	37 c.m.	18 c.m.	10 c.m.
9 min.	9 c.m.	35 c.m.	16 c.m.	9 c.m.
12 min.	8 c.m.	24 c.m.	—	8 c.m.
15 min.	7 c.m.	no response.	14 c.m.	9 c.m.
30 min.	6 c.m.	no response.	17 c.m.	9 c.m.
57 min.	5 c.m.	no response.	14 c.m.	10 c,m.
72 min.	6 c.m.	no response.	13 c.m.	12 c.m.

* In recent practical classes, strychnine replaced curare in the repetition of Claude Bernard's experiment on muscle-irritability.

From this Table it appears that the muscle immersed in strychnine retained its excitability until the end of the observation (72 minutes), although after 12 minutes the muscle could no longer be stimulated through the nerve. When the nerve was immersed in the solution, little change in excitability was noticeable even after 72 minutes. The seven other experiments showed concordant results with the one recorded. The muscle immersed in the solution of strychnine ceased to be excited through the nerve in 11, 15, 27, 26, 21, 51 and 53 minutes respectively.

A second series was carried out with a solution of 1 part of strychnine as sulphate in 1000 parts of normal saline solution. Nine experiments were performed. Results were obtained similar to those with a 1 in 10,000 solution of strychnine. After a varying interval the muscle immersed in the poison ceased to be excitable through the nerve. This point was reached in 36, 42, 42, 30, 18, 24, 28, 18 and 21 minutes respectively. It is noteworthy that increase in the concentration of strychnine ten-fold did not diminish the period in which the receptive substance of the muscle was paralysed. If these results are compared with those observed in the living entire frog it is noted that, with doses greater than 0·05 mg. per gm. body-weight, paralysis results in less than 15 minutes. In other words, with a possible concentration of 1 in 20,000 in the tissues the receptive substance is rendered inexcitable through the nerve-endings. With possible concentrations of 1 in 10,000 and 1 in 5,000 the paralysis is complete in 5 minutes. The absorption of a considerable quantity of strychnine is probably a matter of hours. As yet no measurements have been made concerning the rate at which the strychnine leaves the dorsal lymph sac. It is, however, evident that a very much lower concentration than 1 in 20,000 in the tissues is adequate when brought in efficient contact with the receptive substance by means of extra-capillary lymph, to paralyse the receptive substance, or that the receptive substance possesses an affinity for strychnine whereby the concentration of strychnine in the receptive substance is raised above that in the remainder of the tissues.

Summary.—The minimal lethal dose of strychnine for *Hyla aurea* is 0·1 mg. per gm. body-weight. The lethal dose is somewhat higher in those frogs gathered in winter than in those gathered in summer. The lethal dose is unaffected by the sex of the frog.

The receptive substance of the muscles of *Hyla aurea* is sensitive to strychnine, so that the frogs show with appropriate doses typical curare-paralysis. The prominence of this action produces a characteristic type of poisoning in Hyla.

In conclusion I would express my thanks to Professor Anderson Stuart in whose laboratory this research was undertaken.

NOTES FROM THE BOTANIC GARDENS, SYDNEY

No. 13.

By J. H. Maiden and E. Betche.

DILLENIACEÆ.

Hibbertia fasciculata R.Br. var. clavata, n.var.

Ranges on the banks of Bylong Creek, Goulburn River (R. T. Baker; November, 1892).

Apparently an erect shrub of more than one or perhaps more than two feet in height, nearly glabrous. Leaves much fascicled, the longest exceeding half an inch in length, all slightly and rather abruptly broadened at the apex and occasionally slightly bilobed.

This new variety is sharply distinguished from the type by the spathulate or clavate leaves. As in the type, the leaves are more or less concave with incurved margins; in the narrow-leaved normal forms this is only apparent on close inspection under a lens, but the broad apex in our new variety makes it very apparent. The leaves are occasionally completely doubled up, so that the term clavate appears more appropriate than that of spathulate.

We have to thank Mr. Baker for permission to describe the specimen collected by him.

MENISPERMACEÆ.

Tinospora smilacina Benth.

Acacia Creek, Macpherson Range (J. L. Boorman; February 1905). New for New South Wales.

Previously recorded from Queensland and North Australia. We have to thank Dr. L. Diels, of Berlin, for confirming our determination. Mr. Boorman's specimens are in fruit only, and the leaves are so considerably smaller and of thinner texture than the North Australian specimens in the Sydney Herbarium that we doubted whether the Acacia Creek specimens did not rather belong to an undescribed species. The only localities Mr. Bailey gives in his 'Queensland Flora' are "Cape York" and "Thursday Island"; but a plant growing in New South Wales, on the Queensland border, is likely to be found also in dense brush extending up to Brisbane, and has been probably overlooked by Queensland collectors.

TILIACEÆ.

Elæocarpus Baeuerlenii Maiden & Baker.

We published in these Proceedings for 1898 (xxiii., 772) a note on the synonymy of *E. Bäuerlenii* and pointed out that *E. longifolius* C. Moore, had priority.

We find now, in the 'Index Kewensis' (a work not published in 1898), that there is an *E. longifolius* Blume, from Java, and another from Burma similarly named by Wallace. Being earlier than Moore's name, Moore's name must fall, and *E. Bäuerlenii* Maiden & Baker stands.

SAPINDACEÆ.

Cupania (Cupaniopsis) Dunnii, n.sp.

Acacia Creek, in montibus Macpherson Range (W. Dunn; September mensis MDCCCCV florens; November mensis MDCCCCVII fructum ferens).

Arbor fruticosa, circiter quadraginta pedes alta, glabra in omnibus ejus partibus. Folia cum duobus oblongo-lanceolatis obtusis foliolis 2½-3½" longa. Flores pauci, in brevibus et axillaribus v. terminalibus paniculis ut videtur dioicis. Sepala imbricata, orbicularia, nonnihil ciliata plus 1‴ per medium. Petala brevibus unguibus, angustiora quam sepala et minime lata, intrinsecus duobus auriculis inflexis coloris aurei ad fundum laminae, unguis et margo inferior ciliati. Petala in pistillatis floribus absunt. Stamina 7-8, breviter inserta, filamenta ciliata. Discus capillaris. Ovarium triloculatum, uno ovulo in singula cella. Capsula tribus angulis obtusis, prope aequa ad apicem, aperiens loculicide, glabra in parte exteriore et intus. Semina ovata, crasso arillo formato simili poculo ad fundum.

A bushy handsome glabrous tree about 40 feet high with a stem-diameter of about 18 inches. Leaves with two leaflets on a petiole $\frac{1}{2}$ to $\frac{3}{4}$ inch long; leaflets oblong-elliptical, obtuse, $2\frac{1}{2}$ to $3\frac{1}{2}$ inches long and about $1\frac{1}{2}$ inches broad, dark and shining on the upper side, paler below. Flowers in axillary or terminal few-flowered panicles not above $2\frac{1}{2}$ inches long in the specimen seen, on short pedicels, unisexual as far as seen, the staminate flowers with a rudimentary ovary, the pistillate ones with only a few or no fertile stamens, and apparently without petals—unless the petals drop off in a very early state. Sepals orbicular with thin slightly and sparingly ciliate edges, otherwise glabrous, imbricate, rather above 1 line in diameter. Petals shortly clawed, somewhat smaller than the sepals, nearly as broad but narrower, on the inner side with two inflexed orange-coloured auricles at the base of the lamina above the claw, the claw and the lower edge ciliate. Stamens 7 to 8, shortly exserted, with ciliate filaments. Disk hairy. Ovarium glabrous, 3-celled, with 1 ovule in each cell. Capsule obtusely 3-angled, nearly flat at the top, opening loculicidally in 3 valves, orange-coloured, glabrous outside and inside, expanding to about 1 inch in diameter when open. Seeds ovate, almost black, with a thick cup-shaped greenish-yellow arillus at the base, not $\frac{1}{4}$ the size of the seed.

Our new species is allied to *C. anacardioides* A. Rich., or perhaps closer to *C. Wadsworthii* F.v.M., but is so well distinguished from both that we need not point out the distinctions. In general appearance it resembles more *Cupania semiglauca* F.v.M. (*Guioa semiglauca* Radlk.), but the fruits and seeds are very different. According to Prof. Radlkofer's classification of Sapindaceæ, it belongs to the genus *Cupaniopsis*, to which belong three other species from New South Wales, viz., *C. anacardioides*, *C. Wadsworthii* and *C. serrata*.

LEGUMINOSÆ.

Isotropis atropurpurea F.v.M. New for New South Wales.

Bingara (J. L. Boorman; September, 1907); Manilla (G. A. Higgins; October, 1907).

Previously recorded only from South-West and North Australia. Its New South Wales habitat is, as far as known at present, the rocky tableland between the headwaters of the Gwydir and Namoi Rivers, an area roughly estimated at about 80 to 100 miles square. At Bingara it is a dense shrub, 2 or 3 feet high, growing between boulders and in crevices of rocks; near Manilla it grows in gravelly Box and Apple-tree country, about 2 feet high, but attains a height of 6 feet, according to Mr. Higgins, in another locality near Manilla. The distribution of this plant in Australia, so far as we know it at present, is very curious. It grows apparently gregariously, covering acres, but the patches are thousands of miles apart so far as present records go.

Bossiæa rhombifolia Sieb. var. concolor, n.var.

Araluen (J. L. Boorman; August, 1907).

The typical *B. rhombifolia*, common in sandy and sandstone country, has yellow flowers with a dark keel; the new variety has flowers entirely yellow. According to the collector's field notes, it grows together with the typical form, but is rarer, much more slender in habit, and the foliage has a more glaucous tint.

Aotus villosa Sm.

A form with all yellow flowers. Narrabri (J. L. Boorman; August, 1907).

This is a precisely parallel case with the yellow-flowering *Bossiœa* mentioned above. The same unknown influence (perhaps the colour-sense of some particular insect) which caused *Bossiœa rhombifolia* to depart from the usual colour of its flowers, has probably been at work in the yellow form of *Aotus villosa*. Also in *Aotus* both forms are found together in the same locality, and the form with a dark keel is also more common and more robust in habit.

The discovery of the two forms of *A. villosa* found growing together in Narrabri is of interest in that it settles the doubt about the colour of its flowers. The three New South Wales species of *Aotus*, viz., *A. villosa* Sm., *A. mollis* Benth., and *A. lanigera* A. Cunn., are closely allied, and pass so much into each other that it is impossible to draw sharp lines of distinction between all forms. Bentham draws a sharp distinction between *A. villosa* and *mollis* on the one hand and *A. lanigera* on the other, from the colour of the flowers. According to his Key to the Species of *Aotus*, the two former have yellow flowers with a dark keel, and the latter has all yellow flowers; but we have so often met with forms of *Aotus* with all yellow flowers, which we could not reconcile with *A. lanigera*, that we attached little systematic importance to the colour-character. The Narrabri specimens definitely prove that the flowers of *A. villosa* vary in colour from all yellow to yellow with a dark keel; and to this we may add a third not uncommon form with yellow wings and keel, but a dark zone in the standard. *A. mollis* seems to have always a dark keel, and *A. lanigera* has always entirely yellow flowers.

The three New South Wales species should not be kept up as distinct species; in our opinion, they cannot be separated by a single sharp character; it is all a matter of more or less recurved margins of the leaves, or a more or less dense or loose tomentum, or smaller or larger flowers, etc. We have in the Sydney Herbarium typical specimens of all the three species, and they look certainly distinct enough; but the transition-forms are numerous and some are so accurately intermediate between two species that it seems a matter of caprice to place them with one or the other species.

PULTENÆA CAMBAGEI, n.sp.

Torrington, Deepwater, Nova Anglica (in paludibus, R. H. Cambage; September mensis MDCCCCVII).

Frutex erectus, circiter duos pedes altus, parce ramosus. Rami tenues, fere teretes, ramusculi pubescentes. Folia glabra, alterna, erecta, angustato-linearia, longa circiter quartam partem unciae, concava. Stipulæ absunt. Flores circiter viginti in capitulo terminali. Bracteolae parvae, lineares, insertae fere sub calyce, sed disjunctae, dense ciliatae albis capillis. Calyx pilosus, circiter sesquilineam longus. Petala flava praeter vexillum nubilum; vexillum circiter altero tanto longior quam calyx est; carina et alae nonnihil breviores. Stamina disjuncta. Ovarium dense pilosum. Fructus non vidimus.

An erect shrub up to 2 feet high, usually single-stemmed, with slender nearly terete branches, the young ones covered with appressed white hairs, the adult ones quite glabrous. Leaves alternate, erect, narrow-linear, about ¼ inch long, concave, the upper ones occasionally almost terete and channelled above, the lower ones often broader with less incurved margins, approaching to narrow-lanceolate, obtuse or somewhat acute, glabrous and equally green on both sides, shortly petiolate, without any stipules. Flowers very shortly pedunculate, up to 20 together in terminal heads within small densely hairy involucral bracts. Bracteoles small, linear, inserted close under the calyx but free from it, densely ciliate with white hairs. Calyx about 1½ lines long, reddish, covered with white hairs, the two upper lobes broader and united higher up. Petals yellow, except the dark-coloured standard, the standard about twice as long as the calyx, keel and wings rather shorter. Stamens all free. Ovary densely hairy, with a short style hooked at the top. Fruits not seen.

We have little doubt that this species is correctly placed with *Pultenæa*, but still the question whether it should not rather be referred to *Phyllota* may be left open until ripe seeds are obtained. The two genera are distinguished by the following characters :—

Phyllota.—Stipules usually absent, rarely minute. Stamens more or less united at the base with the petals or to each other. Seeds without strophiole.

Pultenæa.—Stipules usually conspicuous, rarely absent. Stamens free. Seeds strophiolate.

The stamens are quite free in *Pultenæa Cambagei*, therefore it should be placed with *Pultenæa* in spite of the absence of the stipules. If the seeds turn out to be strophiolate, its position in the genus *Pultenæa* is confirmed; but even if the seeds should turn out to be without a strophiole, it might be placed with equal reasons with *Pultenæa* as with *Phyllota*. The two genera pass into each other, and our new species is more or less a connecting link. Its nearest natural affinity seems to be with *P. subumbellata* Hook., which has the same inflorescence, similar flowers and no stipules, but has different leaves and a different habit. According to Bentham's classification in the 'Flora Australiensis,' in which more stress is laid on the shape of the leaves, it should be placed next to *P. echinula* Sieb., from which it is readily distinguished by the smooth leaves without stipules. It is also allied to the Tasmanian *P. diffusa* Hook. f., which F. v. Mueller removed to *Phyllota* in spite of the free stamens; but our species has a terminal inflorescence, and *P. diffusa* has the flowers in the axils of the upper leaves as usual in *Phyllota*. In spite of its various affinities, *P. Cambagei* is a well-marked species, impossible to unite with any described species, either of *Pultenæa* or *Phyllota*.

PULTENÆA CINERASCENS Maiden and Betche, these Proceedings, xxx. 361(1905).

Narrabri (J. L. Boorman; August, 1907).

The species was described by us two years ago, from specimens collected at Warialda and Coolotai (25 miles to the north), on the other side of the Nandewar Ranges from Narrabri.

In addition to this new locality, we have to record two other Pultenæas collected by Mr. R. H. Cambage (Gilgandra, October, 1904; and Scone, August, 1907) which we can regard only as connecting links between *P. cinerascens* and *P. microphylla* Sieb. The typical forms of the two species are so distinct that nobody would think of uniting them; but the difference is chiefly in habit and leaves, with hardly a marked difference in the flowers and inflorescence. *P. cinerascens* is an erect shrub with clustered, linear, rather acute leaves; and *P. microphylla* is a diffuse shrub, with scattered, more or less cuneate leaves. Mr. Cambage describes his Scone specimens as from a small shrub about 2 feet high, erect, but with a somewhat spreading head. This plant has also a somewhat cinerascent appearance like the true *P. cinerascens*, but the leaves are not clustered, and are more like some of the forms of *P. microphylla.* The Gilgandra specimen is like the Scone specimen, but without the silvery hairs, and therefore nearer to *P. microphylla.*

These numerous intermediate forms in nearly all of the larger and in many of the smaller genera constitute a great difficulty with which Australian botanists have to contend. Of course it is well understood at the present day that all species developed gradually from a common ancestor, and that connecting links are therefore to be expected, unless they have died out; but it seems probable that no flora on earth is in such an unsettled state as the Australian flora. If we were to unite all species between which intermediate forms can be found, we should have to unite *Boronia mollis* and *Fraseri* with *B. ledifolia*; and to reduce such genera as *Leptospermum*, *Callistemon*, *Stipa*, *Aristida*, and many others to very few species; but this is neither practicable nor expedient, and we must draw arbitrary lines.

In view of this unsettled state of the flora, some of the excellent recent monographic works published in Engler's 'Pflanzenreich' are rather bewildering to Australian botanists, in the number of new species described. For instance, the numerous new species of Australian *Haloragis* may be well enough defined in the herbaria of Berlin and Vienna; but they are very bewildering to the botanist working in the field, who meets with the numerous transition-forms which he can place neither with one nor the other of the described species. Of course even the best settled of the Australian States is imperfectly explored botanically; in fifty years' time the men who come after us will see clearer and solve many of the difficulties which present themselves to us. In doubtful cases we can now only record our difficulties, and honest and careful expressions of opinion may have value, even if later they prove to be erroneous, since they will help to a better understanding of the flora.

KENNEDYA RETRORSA Hemsl., Bot. Mag. t.8144(1907).

Mount Dangar, Gungal near Merriwa (J. L. Boorman; September, 1904).

The Mt. Dangar specimens were erroneously determined by us as *K. procurrens* Benth., a rare and imperfectly described plant. The error was detected at Kew, where the type-specimens of *K. procurrens* are kept. In these Proceedings (Vol. xxix. 1904, p.738) we published a note on the supposed rediscovery of a rare *Kennedya*, and the plant referred to is that described by Hemsley as a new species.

ACACIA BAUERI Benth.

Wentworth Falls, Blue Mountains (W. Forsyth; January, 1907).

A new locality for a rare plant. Previously recorded New South Wales localities are, Port Jackson district, Byron Bay and Richmond River, all coast localities. The phyllodia of the Blue Mountain specimens are irregularly verticillate, and rough with minute asperites.

ACACIA FARNESIANA Willd.

Scone, ½ mile on Aberdeen Road (J. H. Maiden; November, 1907).

Most eastern locality recorded.

MYRTACEÆ.

MELALEUCA HYPERICIFOLIA Sm.

Wentworth Falls, 500 feet down (W. F. Weeks; July, 1906 : W. Forsyth; January, 1907).

An interesting locality for a plant generally known as a coastal species.

COMPOSITÆ.

Helichrysum bracteatum Willd.

Torrington, near Deepwater, in swamps (H. Deane; March, 1907).

A remarkable form with strictly radical leaves, stem-leaves reduced to long linear sessile bracts, crowded under the flower-head.

CONVOLVULACEÆ.

Ipomœa heterophylla R.Br. New for New South Wales.

Moree (J. T. W. Scott; February, 1907).

A species recorded from South Australia, Queensland and North Australia, but not previously collected in New South Wales.

LABIATÆ.

Prostanthera teretifolia, n.sp.

Torrington, in glabris saxosis graniticis (R. H. Cambage, September mensis MDCCCCVII).

Frutex erectus, tres usque ad quattuor pedes altus, coloris obscure viridis propter squamas tenues et exalbidas quae ramos, folia tenera, calycesque tegunt. Folia lineari-teretia, striata infra, circiter quinque lineas longa. Flores solitarii in axibus foliorum breviter pedicellati, sine bracteis. Calyx vix duas lineas longus, tubus striatus, lobi super fructum interclusi, glaber in parte interiore et exteriore. Corolla indica expandit fere ad partem mediam unciae longitudine. Antherae brevibus adjunctis ad omnes cellas, omnes multo breviores quam cellae et longitudinis aequalis. Fructus non vidimus.

An erect dense shrub of dull green colour, about 3 to 4 feet high, the branches, young leaves and calyces covered with minute thin whitish scales, otherwise glabrous. Leaves linear-terete, grooved on the underside, about 5 lines long, obtuse, shortly petiolate and often appearing clustered from the shortness of the leafy side-shoots on which they are crowded. Flowers shortly pedicellate, solitary in the axils of the leaves, without any bracts. Calyx hardly 2 lines long, the tube striate, the lobes closed over the fruit, the lower lobe slightly longer and narrower, glabrous inside and outside. Corolla purplish-blue, large, apparently spreading to nearly ½ inch in length when fully out. Anthers with short appendages on each cell, all many times shorter than the cells and of equal length. Style long. Ripe nuts not seen.

This new species belongs to Bentham's Series Convexæ of Section Euprostanthera. It should be placed in the system next to *P. empetrifolia* Sieb.; but it is really not closely allied to any described species, and is readily distinguished by the characters given above. The leaves are not "terete" in the strict meaning of the word, but they appear so at first sight, and approach nearer to terete than in any other species of the genus.

URTICACEÆ.

For FICUS STENOCARPA Warb., these Proceedings, xxxi. 738 (1906), read FICUS STEPHANOCARPA.

CYPERACEÆ.

KYLLINGIA TRICEPS Rottb. New for New South Wales.

Port Jackson district (J. L. Boorman; April, 1907).

We have to thank Mr. S. Kneucker, the editor of the Cyperaceæ exsiccatæ, for the determination of this species. It is common in the Port Jackson district, but is probably mixed up also in other herbaria with *K. monocephala* Rottb., and *K. cylindrica* Nees. Herr E. Palla writes on the printed labels issued with Kneucker's exsiccatæ :—"Those species of Kyllingia whose headlets are whitish are frequently mixed up with each other. *K. monocephala* is distinguished from all others by the winged keel of the glumes, and also by the white anthers, a character I have never seen mentioned in the literature of this species; the anthers of all other species are yellow. *K. triceps* is distinguished from its nearest ally, *K. cylindrica* Nees, by the fruit which is from elliptical to narrow-elliptical in *K. triceps*, and nearly or quite orbicular in *K. cylindrica*."

From these notes we revised our species of Kyllingia and found *K. triceps* quite common in the Port Jackson district; but all other specimens in the Herbarium are from Queensland stations. Palla's description of *K. monocephala* as having a "winged keel" seems not to be a happy one; Bentham describes the glumes as "acutely keeled," an expression that seems to us much more applicable; in none of our specimens is the keel so acute that we should call it "winged," and we find the character by no means a sharp one.

Bentham describes the nuts of *K. cylindrica* as "very dark" and those of *K. triceps* as "pale." Palla ignores the colour of the nuts, and it seems to us the colour depends solely on the degree of ripeness of the nuts; we have found pale and dark nuts in both species.

SCIRPUS STERILIS, n.sp.

Narrabri Occidentalis in sterili arenosâ terrâ (J. L. Boorman; menses Junius et September MDCCCCVII).

Planta annua caespitosa caulibus gracillibus, teretibus, costatis, sex usque ad octo uncias altis. Folia plerumque duo ad fundum caulis, lamina lineari-tereti minus duas uncias longa, et vagina brevi, striata simile cauli. Spiculae numerosae, saepe plus triginta, in racemo terminali qui circiter partem mediam unciae per medium occupat, bracteis foralium parvis et subulatis, plerumque in racemo celatis. Spiculae mutabilissimae, longissimae, circiter quinque lineas longae, duodecim floribus. Bracteae florentes subfuscae, carina crassa coloris pallidioris et lateribus nervis carentibus. Setae hypogynae absunt. Unum stamen solum. Stylus tribus ramis. Caryopses maturae subfuscae, tribus angulis, læves; caryopses steriles albae, circiter dimidio minae quam caryopses fertiles.

A densely tufted annual, with slender terete ribbed stems, 6 to 8 inches high when full grown, interspersed with shorter stems. Leaves generally two at the base of the stem; the lamina linear-terete, the longest seen under 2 inches long, minutely denticulate with small asperities only visible under a lens, the sheath striate like the stem and generally much under 1 inch long. Spikelets numerous in a terminal cluster, the longest heads about ½ inch in diameter with more than 30 spikelets, the involucral bracts small and subulate, shorter than the matured heads and generally concealed in the spikelets. Spikelets variable in length, with from a few to above 12 flowering glumes, the longest about 5 lines long. Flowering glumes pale brown with a thick, lighter-coloured keel terminating in a short straight or slightly recurved point, the keel smooth but occasionally very slightly denticulate, the sides nerveless. No hypogynous bristles. Stamens 1 only in all spikelets examined. Style-branches 3. Mature nuts pale brown, three-angled, smooth; sterile nuts white, empty except for a shrivelled-up ovule, about one-half the size of the fertile nuts.

The species is not closely allied to any Australian *Scirpus* described in the 'Flora Australiensis'; its position in the system is near *S. inundatus* Spreng. The most characteristic feature in the new species is the numerous sterile nuts. In Mr. Boorman's specimens, collected in June, we found only sterile nuts; but when he returned in August to the locality and brought large quantities of specimens, we found a few solid fertile nuts. The numerous unfertilised nuts may be caused by local circumstances, and the specimens may be abnormal.

SCRIPUS CERNUUS Vahl, var. AUSTRALIENSIS, n.var.

Cobham Lake (W. Bäuerlen; September, 1887).

A small annual with setaceous stems 1 to 3 inches high. Leaves very short, hardly longer than the sheath. Spikelets terminal, single or more generally in pairs, hardly above 1 line long. Involucral bract generally solitary, about $\frac{1}{4}$ of an inch long, spreading or continuing the stem so that the terminal spikelets appear lateral, occasionally with a second short bract. Glumes light-coloured, not numerous, ovate, rather acute, with a broad keel and veinless almost transparent sides. No hypogynous bristles. Stamens solitary in the few spikelets we could examine. Style-branches 3. Nut ovoid, about one-half as long as the glume, 3-angled, smooth on the sides.

So many botanists have examined this plant, and we have made use of their observations, that we can only technically claim to be the authors of the variety.

When Mr. Bäuerlen collected the specimen 20 years ago, it was sent for determination to Baron von Mueller who regarded it as a new species, and gave it an MS. name, but never published a description, though he briefly described it in the Melbourne Herbarium. The late Mr. Luehmann sent us a copy of the following original description by Mueller, but mispelled in part, and past full recognition of his meaning—" Culmis 3-8 cm. longis, capillaceis, monocephalis; spiculis 2-1 bracteatis, 4 mm. longis; glumis ovatis, subacutis, acute carinatis, teneris, minute acantala [?], leve straminea aut brunescente."

" *S. cartilagineus* Benth., Fl. Austr. Vol.7, p.328, partim.

S. inundatus Benth., Fl. Austr. Vol.7, p.329, partim.

W. Australia : Swan River, Drummond.

Victoria : Murray River, F.v.M.; Bugle Range, F.v.M.

N. S. Wales : Cobham Lakes, W. Bäuerlen."

The mark of interrogation at the word acantala is ours; though we have not seen the original label, Mr. Luehmann insisted that the word is a correct copy.

The Baron's MS. name cannot be maintained, as there are already three other species with the same name in the 'Index Kewensis,' though all are synonyms; and it is not advisable to add a fourth to the number.

In 1902 Mr. R. T. Baker sent specimens to Kew for determination. Mr. C. B. Clarke, the well-known authority on Cyperaceæ, declined to describe it, but he kindly gave his advice that it might be regarded as a form of *S. cernuus* Vahl, a cosmopolitan species, from which it differs only in trifling points, as its very small nut and apiculate glume; though, on the other hand, so many species of *Scirpus* have been described on trifling differences that it might be described as a new species without inviting adverse criticism.

Mr. Baker kindly placed the correspondence and the plant at our disposal. Mr. C. B. Clarke came to the same conclusion as F. v. Mueller, though he had not seen his MS. description, that Bentham included the plant under *S. cartilagineus* and under *S. inundatus*, though it will not match either.

SCIRPUS KOCHII, n.sp.

Cowcowing, Australia Occidentalis (Max Koch; September mensis MDCCCCIV).

Planta annua caespitosa caulibus fere filiformibus et costatis, maxima altitudo sex unciæ. Folia setacea, brevissima, vagina brevis et coloris badii. Spiculae sesquilineam usque ad plus quam duas lineas longae, plerumque tres usque ad quinque in racemo terminali. Bractea foralium plerumque una sola, quae expandit vel erecta est, et variat a breviore quam spiculae usque ad fere unam unciam longa. Bracteae florigerae irregulariter in quinque ordinibus ordinatae, fere ovatae, carina firma et fusca continuata in acumine brevi et recto vel curvatiore, latera pallida, pellucida, omnino nervis carentes, sigillatim rugosa. Setae hypogynae absunt. Stamina non vidimus. Stylus tribus ramis. Caryopsis ovata, lævis, tribus angulis distinctis coloris schistacei, circiter tertia pars tam longae quam bracteae florigerae.

A small tufted annual at the most 6 inches high, with slender almost filiform ribbed stems and shorter setaceous leaves; the short sheath at the base of the stems reddish-brown. Spikelets $1\frac{1}{2}$ to above 2 lines long, generally 3 to 5 together in a terminal cluster. Involucral bracts mostly 1 only, spreading or erect, generally somewhat longer than the cluster of spikelets, but occasionally shorter, or nearly 1 inch long. Glumes numerous, irregularly arranged in five rows, almost ovoid, strongly keeled, the brownish keel produced into a short straight or slightly recurved point, the sides pale and quite nerveless, transparent, minutely rugose. No hypogynous bristles. Stamens not seen. Style-branches 3. Nut ovoid, smooth, prominently 3-angled, about $\frac{1}{3}$ as long as the glumes, of a pale slate colour.

This graceful *Scirpus* is nearly allied to *S. cartilagineus*, but the small nuts and the transparent glumes without any side-nerves distinguish it sufficiently from this species and all its forms.

RHYNCHOSPORA AUREA Vahl. New for New South Wales.

Connungra, near Mt. Lindsay (J. L. Boorman; March, 1904).

A common tropical plant spread over the warmer regions of the whole globe. In East Australia it was previously recorded as far south as Brisbane. Our New South Wales locality brings it some 50 miles further south.

GRAMINEÆ.

ANDROPOGON BREVIFOLIUS Swartz (*A. fragilis* R.Br.). New for New South Wales.

Narrabri West (J. L. Boorman; June, 1907).

Recorded previously from Queensland and North Australia, not further south than the Endeavour River. The Narrabri specimens agree exactly with R. Brown's type-specimens from the Endeavour River. R. Brown described it erroneously as a new species, but it is now recognised to be identical with *A. brevifolius*, common in India and distributed over the tropics of the globe.

POA COMPRESSA Linn. New for Australia.

Blackheath, Blue Mountains (W. Forsyth; January, 1907).

This is a grass from the temperate Northern Hemisphere, not previously recorded from the Southern Hemisphere so far as we know. In appearance it is much like a starved specimen of *P. saxicola* R.Br. We have to thank Prof. E. Hackel (through Prof. A. J. Ewart) for the determination.

CONTRIBUTION TO OUR KNOWLEDGE OF AUSTRALIAN *HIRUDINEA*.

Part i.

By E. J. Goddard, B.A., B.Sc., Junior Demonstrator in Biology, Sydney University.

Introduction.—The freshwater Rhynchobdellidæ of New South Wales, in fact the Hirudinea of Australia generally, have so far been neglected. Although search proves that the Hirudinea are well represented in Australia, the only account of any of these for a number of years is that given by Miss Lambert in connection with the Land Leech *Philæmon pungens* in 1897. The small size of the animals and their conditions of life no doubt in some way account for the neglect which they have suffered, inasmuch as they would not be readily recognised as "Leeches" by any one not interested in our freshwater fauna, and hence they would not enjoy the prominence bestowed on the common Leech, *Hirudo quinquestriata.*

The field is sufficiently fruitful to warrant successful investigations.

The present paper deals with some Leeches belonging to the family *Glossiphoniidæ*, two species being members of the type genus, *Glossiphonia* (syn. *Clepsine*), the third specimen described constituting a new genus.

As the group is a very interesting one from several standpoints, I resolved, in taking advantage of Dr. Hill's kindness in giving me some fine specimens which he had collected, to attempt some work on the group.

I would here express my great indebtedness to Professor Haswell for placing at my disposal any literature which he possessed, and for his kind encouragement in every way.

I would also take this opportunity of expressing my thanks to Dr. Hill for his kindness in placing the specimens at my disposal.

Methods.—Corrosive sublimate proved an excellent fixative with these specimens, and I find that Castle advises the use of that reagent in fixing Glossiphonids. Specimens fixed in Zenker's fluid show a certain amount of distortion as regards the cellular elements. Entire specimens cleared in cedar oil gave me much help preliminarily in the study of the gross anatomy of the digestive system.

Castle* recommends iron-hæmatoxylin as the best stain for sections; and I found sections so stained to outclass those stained with other reagents. The strongly developed musculature offers good material for a counter stain with eosin.

The specimens were imbedded in paraffin by the benzole method after having been cleared in cedar oil, and good results were thus obtained.

The genus *Glossiphonia* (*Clepsine*) is well represented as regards species in North America and Europe, where much work and attention have been given to them by Whitman, Castle, Apathy, Grube, Mueller, Oka and others.

In 1900 Dendy and Olliver described what was regarded as a biannulate species of *Glossiphonia* from New Zealand, but later it was found to be a species of *Microbdella* Moore.

The species of *Glossiphonia* described in this paper constitute, I believe, the first record of the genus from Australia. Lately I have obtained other species from Tasmania and the mainland, so that the species is a really very widely distributed form.

Glossiphonia is characterised among the Glossiphonid Rhynchobdellidæ by the triannulate nature of the somite and broad flat body which is rolled into a ball when disturbed after the

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* Bull. Mus. of Comp. Zool. Harvard Coll. Vol.xxxvi. p.18.

fashion of Oniscus. The young are carried about attached to the concave ventral surface of the adult, this surface acting as a marsupium or brood pouch. The individuals occur in ponds and slowly moving fresh water, under stones, beneath the bark of submerged and floating timber, and parasitic on molluscs, etc.

Glossiphonia australiensis, sp.nov.

This species was obtained by Dr. Hill in a creek near Oberon, N. S.W. The species is of much interest from a phylogenetic standpoint, and well deserves a specific name indicative of its locality of occurrence.

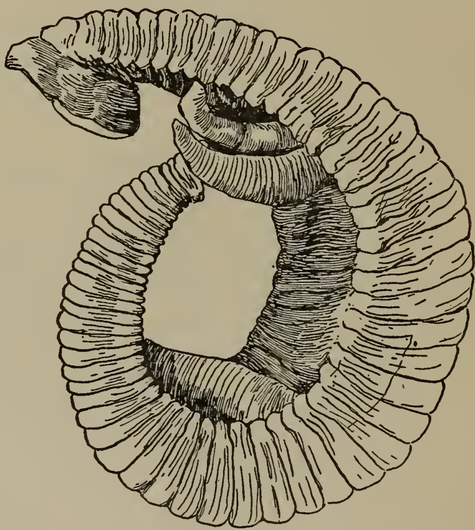

Fig. 1.—*Glossiphonia australiensis*, sp.n.

Internal view showing three young ones attached to the concave ventral surface. The number of annuli can be easily made out, and the anus seen between the ultimate and penultimate rings. Note also the roughness of the surface. (Drawn from a photograph).

External characters.—The body resembles in its general form that of most other species of the genus. It is broadest about the middle of its length, tapering towards the anterior and posterior ends. The anterior extremity is slightly wider than the "neck" in the preserved specimens, but this may be due to contraction.

The length of adult individuals when fully extended is about 15 mm.; in a state of contraction about 10 mm. The width in the middle region of the body is about 5 mm.

The body in a state of contraction is concavo-convex in section. The surface is rough and devoid of papillæ when viewed macroscopically. In section, however, the skin is seen to be covered by a large number of papillæ due to outpushings of the cuticle with the underlying epidermis and subepidermis.

I am not in a position to say whether these papillæ are innervated or not, or whether they are of any segmental significance in connection with somite-limits.

Unfortunately as I have been unable to procure living specimens I cannot make any detailed remarks concerning the colour and pattern-ornamentation of the species. The preserved specimens were of a flesh colour, and Dr. Hill informed me that they differed in no way from the living specimens as regards colouration. The body is quite opaque, and this feature prevented me in the first place from regarding the species as *Glossiphonia heteroclita*, which it closely resembles in other features, unique among which is that of closely approximated genital apertures which in *G. heteroclita* are said to be actually united.

The annuli are distinct and well marked off from one another. The total number is seventy, sixty-three of them lying behind the anterior sucker. The annuli are of greatest extent in the middle region of the body, gradually diminishing in size as they approach the anterior and posterior regions of the body.

As in all species of *Glossiphonia*, the total number of somites is thirty-four. This I have determined in the species under description by making a count of the number of nerve-capsules The first, second, and third somites are uniannulate, the fourth biannulate, and most of the others triannulate.

Eyes six in number; the first pair, which are situated on the second annulus, being much smaller and closer together than the second and third pairs. The second and third pairs of eyes are situated on the third and fourth annuli respectively. They are large in size and the members of each pair widely separated. The second and third eyes on each side are closely approximated. The anterior pair are directed forwards and toward the side of the body; the second pair toward the side and slightly backward; the posterior towards the posterior region of the body.

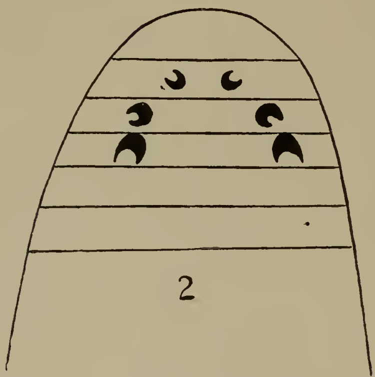

Fig. 2.—*Glossiphonia australiensis*, sp.n. Anterior end, showing the position of the eyes.

The anterior sucker is constituted by seven annuli. The anus is situated on the dorsal surface between the penultimate and ultimate annuli.

Genital apertures.—When first examining the species I was inclined to regard the genital apertures as united. This condition obtains in *Glossiphonia heteroclita*, which is unique in that respect among species of *Glossiphonia*. On making a closer examination with the aid of sections, I found that the apertures were distinct but separated by a single annulus—the twenty-ninth—which is much diminished in importance. The two apertures open into a depression with tumid lips which lies behind a small clitellum-like swelling on the ventral surface, between the twenty-eighth and thirtieth annuli. Probably one would be enabled to see these separate apertures if an examination were made of a perfectly extended organism.

The male aperture, then, lies between the twenty-eighth and twenty-ninth annuli, the female aperture between the twenty-ninth and thirtieth. From a study of transverse sections one might readily fall into the error of describing the genital apertures as united, to such an extent has the twenty-ninth annulus been diminished on the ventral surface.

In describing the position of the genital apertures in *Glossiphonia heteroclita*, Blanchard says, "Porus genitalis masculus inter annulos 25-26, vulva inter annulos 27-28 hians."

Castle, in his carefully written account of the Fresh Water Rhynchobdellidæ of North America, says "Blanchard is certainly in error in his description of the position of the genital apertures," and points out that there is a single united aperture situated between the twenty-eighth and twenty-ninth annuli.

Body-wall and body-substance.—Much has been written on this subject. Bourne has given an excellent description in a comparative way of the important genera of the Hirudinea. I do not hope to add any great amount of information to Bourne's account, but intend to furnish some notes of specific character which may be of some use in connection with that already published.

The body-wall consists of five layers—cuticle, epidermis, dermis, circular muscle fibres, longitudinal muscle fibres.

The cuticle calls for no special remark beyond that it is produced into a great number of microscopic papillæ into which rise corresponding projections of the epidermis and dermis. No nerve connections could be made out, but they possibly may have some tactile or sensory function, or again may be due to the state of contraction of the organism.

The epidermis consists of a single layer of columnar cells with a fairly large nucleus. Some of the cells are enormously enlarged to form large pear-shaped glands which are sunken to a great depth from the main epidermal layer so as to lie on the external surface of the circular muscle mass which lies beneath the dermis and imbedded in the dermis. The glands contain a finely granular substance which, like the glandular cells themselves, takes an intense stain with hæmatoxylin. The glands are much more abundant in connection with the dorsal than with the ventral surfaces. In the dorsal and the latero-ventral regions one makes out clearly two distinct tiers of epidermal glands, one tier being deeply seated, the other more superficially situated and consisting of much smaller elements than the former. In the region of the clitellar swelling, which lies in front of the genital apertures, the glands are absent, and we find the same condition for some distance on either side of this swelling.

The dermis is of considerable thickness, and consists of a matrix in which occur numerous cells with a large nucleus, and also diagonal muscle fibres. These fibres are, according to Bourne, absent in the species which he examined. The cells mentioned above as occurring in the matrix constitute the "excretophores" of other species of *Glossiphonia.*

The circular muscle fibres form a layer equal in thickness to the combined epidermis and dermis.

The longitudinal muscle fibres are arranged in masses beneath the circular fibres, the groups being separated from each other by dorsi-ventrally directed fibres. These longitudinal fibres show very distinctly, in their cortical position, the striations seen in the other members of the Hirudinea.

The body-substance consists of a vacuolated mass, scattered in which are the complex series of sinuses, various kinds of corpuscular cells, and the salivary glands.

The salivary glands far exceed in size any other cellular elements in the body, with the exception of the ova. In sections they appear as chains of large oval or spherical cells deeply stained. They extend in each side of the body from the anterior limits of the ventral nerve cord to the posterior extremity of the ovaries, and thus form very conspicuous elements.

Fat cells are abundantly distributed through the body, inasmuch as abundant cellular elements occur containing a nucleus and very scant cytoplasm.

Graf has attributed to the "excretophores" an excretory function, thinking that they take up excretory products in the deeper portions of the body and then travel towards the surface of the body and disintegrate. With this belief I am in accord. The great abundance of these cells and the great diminution in the development of the nephridia in *Glossiphonia australiensis* incline me to think that the "excretophores" have the function of excretion dependent upon them. They occur abundantly in close connection with the blood sinuses, which perhaps is of further significance.

Connecting the ventral and dorsal body walls are masses of dorsi-ventral muscle fibres. In the posterior region behind the stomach these muscles are more obliquely arranged, and constitute the bulk of the body substance.

One can differentiate between a group which runs on either side of the pharynx, and others more laterally situated. Those situated on either side of the pharynx in places form the lateral boundaries of the ventral lacuna; in other regions they divide that lacuna into median and lateral divisions. In effecting this division they do not form continuous sheets, but occur as bundles, an arrangement which may be of metameric significance.

Sinuses and coelome.—Possibly no Leech presents more interest than *Glossiphonia* in the study of the coelome and its remains. That the sinuses represent the remains of a coelome, is prettily borne out by the occurrence in these channels of large nucleated cells which in every probability represent the remains of a coelomic epithelium, as pointed out by Bourne. These elements do not occur in the vessels, and thus additional weight is given to this argument.

The details of the system of sinuses agree very closely with those of other species, and call for no special remark, owing to Oka's work in that connection.

Digestive canal.—The mouth is situated in the anterior portion of the oral sucker, and lies in the third somite of the body, which is the position most common in other species. The mouth leads dorsally into the pharyngeal sac. The wall of this sac is folded and its lumen circular in cross-section. The anterior region of the sac runs from the mouth to the central portion of the central portion of the body-substance, and thence extends backward through the brain-mass.

The proboscis lies within the pharyngeal sac, and extends through the greater part of its extent, occupying the area of about twenty annuli. The posterior region of the proboscis becomes attached to the wall of the pharyngeal sac which surrounds the whole of the proboscis except a small part at the posterior extremity, occupying about two annuli.

The wall of the pharyngeal sac consists of a layer of flattened epithelial cells which are found to be continuous with the epidermis of the body. It is quite devoid of the glandular elements which occur as modified epidermal cells in the body-wall.

The wall of the proboscis comprises five distinct elements :—

(1) *Pharyngeal epithelium*, consisting of a single layer of minute flattened cells.

(2) *Radial muscles*, occupying a great portion of the pharyngeal wall which passes out between the circular muscle elements, and then becoming dilated to abut on the epithelium of the external surface of the proboscis.

(3) *Circular muscles*, forming three crescentic masses lying, together with the radial muscles, in the triangular areas formed by the contour of the inner wall of the proboscis.

(4) *Longitudinal muscles*, occurring as bundles scattered among the outer portions of the radial muscles, which occupy the greater part of the region in which the longitudinal muscles occur.

(5) *External epithelium*, consisting of flattened cells, continuous at the posterior end of the pharyngeal sac with its wall, and so representing portion of a modified epidermis.

The proboscis leads posteriorly into the œsophagus. When the proboscis is retracted, the œsophagus appears as a tube running parallel and dorsally to it, and extending through about eleven annuli. Its wall is very much folded, and quite different in character from that of the proboscis and crop. The internal lining layer consists of cells which take a vivid blue stain with hæmatoxylin. This layer is very much folded, reminding one of the general appearance of the pharyngeal sac when the proboscis is retracted. The folding of the layer is due to the contraction of the œsophageal muscles when the proboscis is withdrawn. The muscles of the wall of this portion of the digestive system consist of circular muscle fibres immediately external to the lining epithelium, and an outer mass of longitudinal muscle fibres. The main differences in the constitution of the walls of the proboscis and œsophagus are—(1) There is an abundant radial musculature in the wall of the proboscis. (2) The longitudinal muscle fibres are arranged less compactly in the proboscis than in the œsophagus. (3) The lining epithelium of the proboscis is less definitely developed than in the case of the œsophagus.

The crop is a thin-walled sac extending backwards from the œsophagus as far as the fiftieth annulus. It lies close to the dorsal body-wall owing to the enormously developed ventral median lacuna in this region. It gives origin to six pairs of diverticula, as is the case in *Glossiphonia heteroclita.* In the young individuals found attached to the adult and evidently about to become free, only five such diverticula are present, the sixth pair being developed later anterior to these five. This last-developed pair of diverticula is quite permanent in character, and not merely due to a temporary dilatation of the crop, as is found to be the case in some species. Each cæcum is connected with the crop by a slender passage in the adult, but in young individuals no well marked connecting passage can be discerned, as distinct

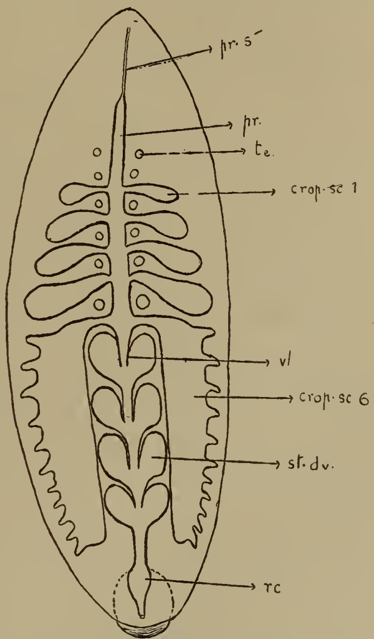

Fig.3—*Glossiphonia australiensis*, sp.n.*

* Fig.3.—*Glossiphonia australiensis*, sp.n. Young individual showing the digestive system, and the position of the six pairs of testes.
pr.s., proboscis sac—*pr.*, proboscis—*te.*, testis—*crop sc. 1*, second pair of crop cæca of adult—*vl.*, valve between crop and stomach—*crop sc. 6*, last pair of crop cæca—*st. dv.*, stomach diverticulum—*rc.*, rectum.

from the main portion of the pouch. The cæca are directed towards the ventro-lateral region of the body. They increase in size and importance as they approach the posterior end of the body, the smallest pair being most anterior, the largest most posterior. The first five pairs are simple in outline, but the sixth pair gives rise to a great number of secondary cæca, and extend on either side of the stomach from the forty-fourth to the sixtieth annuli. The walls of the crop and cæca consist of a lining epithelium of large columnar cells, with conspicuous spherical nuclei, and an external inconspicuous layer of circular muscle fibres. The structure of the wall is such as would best serve the crop and cæca in the function of storing food material. The longitudinal muscles, so strongly developed in connection with the œsophagus, are not represented in the crop and cæca.

The stomach gives off four pairs of diverticula which are auricular in shape and not elongate as in *Glossiphonia heteroclita*. The contents of the stomach are quite different from those of the crop. Whereas, in the crop, there is present a mass of muscle material, etc., obtained by the carnivorous character of the species, in the stomach there is found a clear mass as the result of digestive changes. The passage of the material from the crop to the stomach is regulated by a valve-like structure situated at the junction of the crop and stomach. The portion of the crop lying behind the point of origin of the last pair of cæca becomes intimately connected with the antero-mesial wall of the first pair of stomach diverticula; and this portion of the united common wall of the stomach and intestine projects into the cavity of the stomach, preventing material from passing forwards from the stomach to the crop, and, at the same time, regulating the passage of food from the crop to the stomach.

The rectum is a pear-shaped chamber opening to the exterior at the anus, which is situated between the sixty-ninth and seventieth annuli.

The epithelial lining of the stomach takes a very deep stain with hæmatoxylin. The cells of this layer are tall and columnar, with a spherical centrally situated nucleus.

Surrounding the diverticula of the stomach and so lying between them and the last pair of crop cæca, is a very strongly developed series of blood-channels. This great development, together with the ultimate connection of the channels with the stomach epithelium, points to the stomach as being functional both in digestion and absorption.

The wall of the intestine consists of a much folded epithelium of columnar cells, external to which are circularly arranged muscle-fibres. The blood-channels previously mentioned in connection with the stomach are not present in the immediate neighbourhood of the intestine, and so probably the rectum is connected solely with the function of egestion.

Reproductive organs.—The species is protandrous. In examining sections of young individuals which were attached to an adult, it was found that mature testes were present but ova were not. In the case of one adult specimen which had a number of young individuals attached to its ventral surface, it was found that the testes were mature, the organ appearing as a hollow chamber in which sperm groups were abundant. No ova were present in the ovary. Another adult specimen showed the testes as solid capsular masses in which there was a stroma-like matrix containing small blood-channels and groups of sperm-elements. In the ovarial chambers were present a great number of ova.

Female organs.—The ovaries are a pair of asymmetrical sacs extending backwards from the genital aperture in the median lacuna, ventral to the digestive tube. The vagina, which is the most anterior part of the female apparatus common to both sacs, appears to be filled with a mass of connective tissue previous to the laying of the eggs. It extends as far as the first pair of crop-cæca, lying in the ventral lacuna which, in this region, is narrow and bounded laterally by groups of strongly developed dorsi-ventral muscles which extend down the sides of the proboscis-sac. Opposite the point of origin of the first pair of crop-cæca the vagina passes into the anterior part of the ovaries. Here the ventral lacuna becomes much wider owing to the disappearance of the dorsi-ventral muscles.

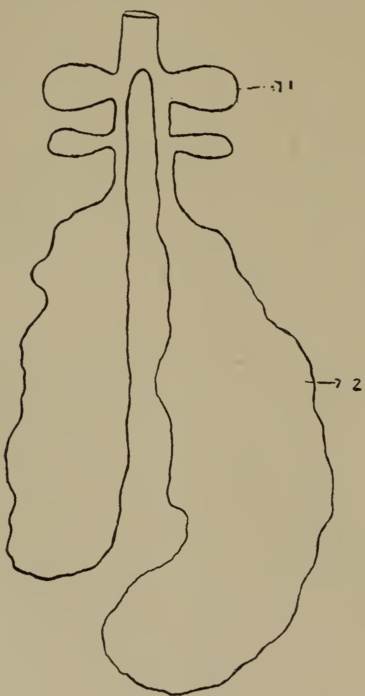

Fig. 4.—*Glossiphonia australiensis*, sp. n. Diagram of female organs.

The ovaries are large hollow sacs lying in certain regions in the large ventral lacuna, in other regions in the lateral portions of this lacuna according as the dorsi-ventral muscles are absent or present. Each ovary consists of three pouches, the first pair of which arises at its anterior extremity. These pouches are compressed antero-posteriorly, and appear oblong in transverse sections. They lie in lateral horns of the ventral sinus. The second pair of pouches lies in the median sinus itself, and resembles the anterior pair except that the pouches are smaller. The third pair of pouches constitutes the main portion of the ovaries. Whereas in the first and second pairs the wall is quite regular in outline, in the third pair the wall is much folded and irregular in outline. They arise at the point at which the proboscis passes into the œsophagus, and extend as far as the stomach. The ventral lacuna is here enormously developed, the dorsi-ventral measurement representing fully one-half the thickness of the section. The ovaries in this region, when the ova are stained with hæmatoxylin, form the most imposing structures in the body. The right ovary extends for some distance beyond that on the left side. They do not lie symmetrically, the right ovary at intervals passing across partly into the left portion of the lacuna, and vice versâ.

That the pouches represent permanent structures, and not mere temporary dilatations due to the pressure of a large number

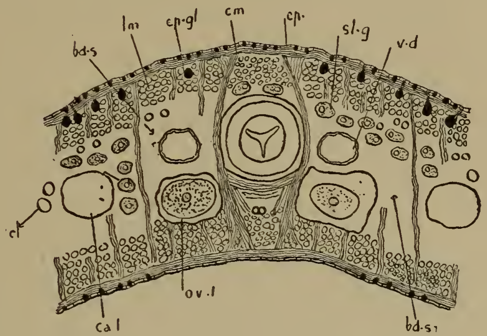

Fig. 5.—*Glossiphonia australiensis*, sp.n.
Transverse section passing through the first pair of ovarial pouches. Compare (3) fig. 7 and (1) fig. 4. (References as in fig. 6).

of eggs during the seasons of the year, is proved by the regular shape and symmetrical development of the first two pouches; and also by the way in which they lie in the ventral sinus, sometimes being cut off from the main portion of that cavity by the dorsi-ventral muscles.

Male organs.—The testes are arranged in six pairs.

In their early condition and during a season, as already mentioned, they are solid spherical organs containing abundant blood-supply. They lie immediately external to the ventral lacuna and imbedded in the body-tissue, and about half-way between the dorsal and ventral surfaces. Later they appear as crescentic hollow chambers containing abundant groups of sperms, the concave side of the testes facing towards the lacuna and crop.

The first pair lie immediately anterior to the point of origin of the first pair of crop-cæca. The others occur between the successive cæca, the sixth pair lying in front of the last pair of crop-cæca.

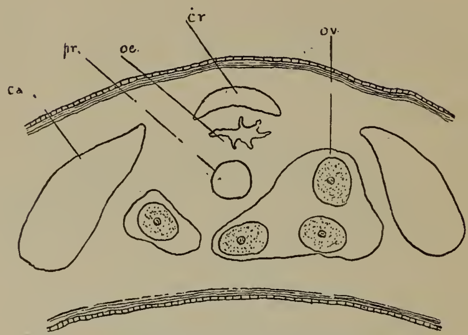

Fig. 6.—*Glossiphonia australiensis*, sp.n.

Transverse section passing through the crop, œsophagus, and retracted proboscis; and through the terminal portion of the ovary.

bd. s., body substance—*ca.*, crop cæcum—*ca. 1*, one of first pair of crop cæca—*cl.*, cœlomic sinus—*cr.*, crop—*cm.*, dermis + circular muscle—*ej.d.*, terminal horns of ejaculatory ducts—*ep.*, epidermis—*ep. gl.*, deep epidermal glands—*l.m.*, longitudinal muscle—*m.p.*, male genital aperture—*oe.*, œsophagus—*ov. 1*, first pair of ovarial pouches—*ov.*, terminal portion of ovary—*pr.*, proboscis—*pr. s.*, proboscis sac—*sl. g.*, salivary glands—*v.d.*, vas deferens.

In the species of *Glossiphonia* in general, the male genital ducts consist of a number of vasa efferentia which lead into a

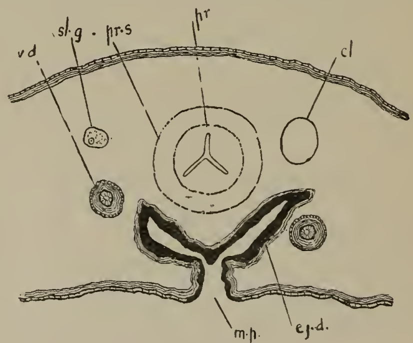

Fig. 7.—*Glossiphonia australiensis*, sp.n.
Transverse section passing through the male genital aperture.
(References as in fig. 6).

main collecting tube, or vas deferens, in each side of the body.

The vasa deferentia wind about in the ventral lacuna, and eventually pass into the seminal vesicles, which grade into the ejaculatory ducts each of which expands terminally into a thick-walled "horn" which, uniting with the terminal "horn" of the other side, opens to the outside by the male genital aperture. The junction of the terminal "horn" and ejaculatory duct, Whitman has shown to be the formation and extrusion of the spermatophore.

In *Glossiphonia australiensis* there are some points of difference from other species. The "horn" and the ejaculatory portions of the vasa deferentia are exceedingly thick and muscular. From the male genital aperture there is a narrow passage leading vertically to the junction of the two terminal horns. Each horn is spindle-shaped, and directed obliquely upwards, outwards, and forwards to lead into the ejaculatory duct. This duct turns towards the ventral side, and runs back in that position as far as the level of the male aperture, where it turns sharply towards the dorsal side. It now runs for some distance between groups of dorsi-ventral muscles in a space which represents a cornual and anterior prolongation of the median lacuna; on a level with the lumen of the proboscis.

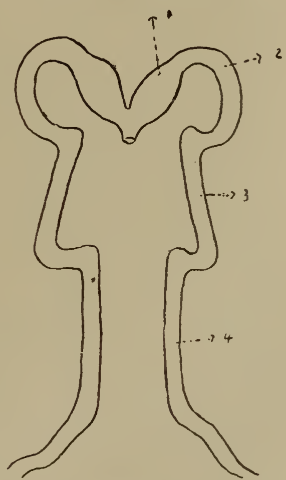

Fig.8.—*Glossiphonia australiensis*, sp.n. Diagram of male reproductive ducts.

On reaching the region of the first ovarial pouches it turns sharply again to the dorsal side, and runs immediately dorsal and parallel to the pouch on each side of the body in the large lacuna which is here crescentic in shape, and surrounds the proboscis laterally and ventrally. In the region of the first pair of testes it turns sharply so as to run obliquely downwards and outwards to the testes. From here no further traces of the male ducts can be found. Unlike other species of *Glossiphonia* there are no winding vasa deferentia in the median lacuna, and there appears to be a connection between the genital ducts and the digestive tube.

Nervous system.—As in all species of *Glossiphonia* there are twenty-one ganglia in the ventral nerve-chain. In connection with the constitution of the brain, I have been able to make out, from the study of the nerve-capsules, that the brain is composed of six fused ganglia. Oka has stated that he finds in the brain of *Glossiphonia* always thirty capsules, and he comes to the conclusion that it represents five fused ganglia. My conclusions are in accord with those of Whitman and Castle. As Castle has pointed out, Oka has possibly overlooked altogether the capsules of somite i., which lie anterior to the supra-œsophageal commissure. The posterior ganglionic mass represents seven fused ganglia.

Owing to the excellent work of Whitman, Castle, and Oka on the metameric constitution and ganglionic structure I cannot add anything of special interest in connection with the structure of the nervous system.

From the study of the nervous system it is seen that the body consists of thirty-four metameres, twenty-one of which are represented by the distinct ganglia of the ventral nerve-cord.

Nephridia.—These are very much reduced and inconspicuous structures. No traces of the nephridial funnels have been seen in section, and no well marked nephridiopores. The exact number of nephridia I have been unable to determine; and I can find no mention of the number in connection with the closely allied species, *Glossiphonia heteroclita.*

Castle mentions in his account of the Fresh-water Rhynchobdellids of North America the number of nephridia in all the species except in *G. heteroclita.* Unfortunately I am not in possession of specimens of this species, and so cannot at present make any comparative remarks.

Oka and Bourne have written a good deal in connection with the nephridia in general, and I find in this species differences quite marked from others. I hope later to deal at further length with the nephridia when I have obtained other species for comparison.

As far as I can make out at present, the nephridia in this species are evidently disappearing; and in this feature, coupled with the fact that the so-called "excretophore" cells are very large and exceedingly abundant in the organism, lends some special interest to the question.

Blood-system.—The blood-system of *Glossiphonia* has been so thoroughly worked out by Oka, that very little can now be added to our knowledge of that system. In general arrangement the system in this species agrees very closely with that in other species of the same genus. One conspicuous feature is the very well developed channels in connection with the diverticula of the stomach. As already stated, the intimate relation of these vessels with the diverticula of the stomach seems to point to the conclusion that the stomach functions in connection with digestion and absorption.

GLOSSIPHONIA INFLEXA, sp.nov.

A single specimen of this species was obtained by Mr. H. L. Kesteven near Waverley, Sydney.

The body is broad and flat, and of a pale sage-green colour. It is semitranslucent. The marginal portion of the body is very thin, and in the preserved specimen folded under the ventral surface.

The length in an unextended condition is 14 mm., the breadth 4·5 mm.

The surface is very smooth, and the annulations are not very distinct, except near the margins of the body, and at the anterior extremity. The total number of annuli is seventy.

No eyes are present, and sense papillæ are present only in the middle body-region, where they occur on every third annulus.

The anus is situated on the dorsal surface of the last annulus, and has a much folded contour.

The genital apertures are united, the common pore being on the twenty-eighth annulus immediately behind a clitellar swelling

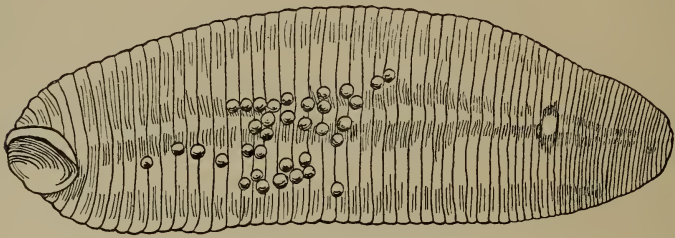

Fig. 9.—*Glossiphonia inflexa*, sp.n.
Ventral view showing the clitellum, and the reproductive aperture immediately behind it.

which extends from the anterior border of the twenty-seventh to the middle of the twenty-eighth annulus.

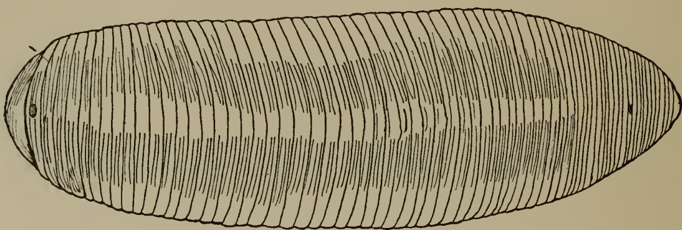

Fig. 10.—*Glossiphonia inflexa*, sp.n. Dorsal view.

Attached to the ventral surface were thirty-five eggs arranged singly.

SEMILAGENETA, gen.nov.

Body thick, pear-shaped; dorsal surface convex, ventral surface flat. Somites denoted partly by papillæ, partly by sulci. Somites triannulate in the greater part of the body, and twenty in number, as seen on external examination.

SEMILAGENETA HILLI, sp.nov.

This leech was obtained in freshwater near Oberon, N.S.W., by Dr. J. P. Hill.

In the extended condition it is pear-shaped in outline, with a convex dorsal, and flat ventral surface. The greater portion of the ventral and dorsal surfaces are marked with grooves which divide the body into areas corresponding to the somites, as is found on more detailed examination.

The colour is a pale green.

The anterior portion of the body possesses numerous sets of sense papillæ.

The first somite is uniannulate, the second biannulate, and the remaining somites triannulate.

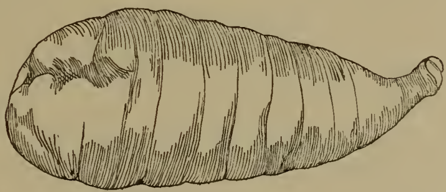

Fig. 11.—*Semilageneta Hilli*, gen. et sp. n.
Dorsal view. (Drawn from a photograph).

The head is constituted by eight annuli, the ninth annulus forming the posterior margin of the anterior sucker. Around the margin of the sucker, and on each of the annuli composing it are papillæ which are much larger than the other sensory papillæ, and probably represent goblet organs.

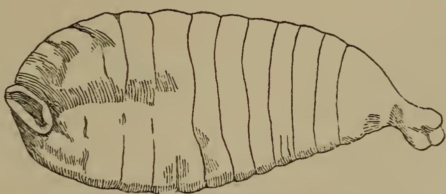

Fig. 12.—*Semilageneta Hilli*, gen. et sp. n.
Ventral view. (Drawn from a photograph).

The sense papillæ occur on the first annulus of each somite, as Whitman found to be the case in the leeches he examined. Castle, however, in his careful work on American Rhynchobdellids, came to the conclusion that the papillæ denoted not the first but the middle annulus of a somite as far as the species of *Glossiphonia* are concerned. That this is not the case in the genus here described can be seen by glancing at fig.13.

The first somite is uniannulate, and has on its dorsal surface six papillæ. The second somite is biannulate, and has six papillæ on the first annulus. The two papillæ nearest the mid-line are much larger than the lateral pairs. The remaining somites are triannulate. In the third and fourth somites the sense papillæ are similar to those of the second somite. The papillæ are similarly arranged on somites v.-xi. inclusive, but are all of the same size and much smaller than on the preceding somites. Behind the eleventh somite the papillæ disappear; and the somites are distinctly marked off by definite sulci, producing a lobed margin, as can be seen in figs.11-12. Nine such somites can be made out behind the eleventh in dorsal view. The sulci do not reach the mid-line, and along that region is a well marked ridge. The nineteenth somite is wedged in between the eighteenth and twentieth in a peculiar fashion.

The total number of annuli is sixty-eight, sixty lying behind the posterior margin of the oral sucker. The annuli of somites eleven to eighteen inclusive are much larger than those of the remaining portion of the body, and increase gradually in size as they pass backwards from the eleventh somite. The annuli of the first eleven somites are very distinctly marked off from one another, the division in the case of the others being denoted by a fine line. The arrangement of the papillæ indicates that the somites in the greater part of the body are triannulate. This is corroborated by the arrangement of the ganglia in the ventral nerve-cord. In making an incision in the organism preparatory to imbedding in paraffin, I exposed portion of the nerve-cord and found that three ganglia thus seen each supplied three annuli.

If, as Castle found in species of *Glossiphonia*, the sense papillæ occurred not on the first annulus of a somite but on the middle one, it would be found that the first somite would be uniannulate, the second uniannulate, and the third triannulate; or the second biannulate, and the third biannulate, the remaining somites being triannulate. This arrangement would leave the last annulus of the somite, which I have labelled xi. (fig. 13) unaccounted for,

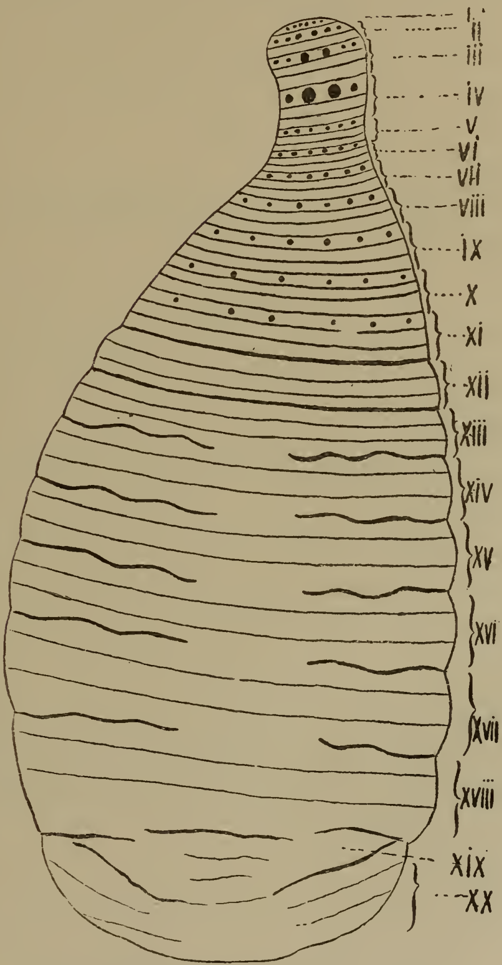

Fig. 13.—*Semilageneta Hilli*, gen. et sp.n.
Diagram showing the metameric arrangement in the annuli.

inasmuch as the sulcus behind this annulus certainly marks the line of division between somites xi. and xii. This important point of difference between *Glossiphonia* and *Semilageneta*, as regards the metameric significance of the papillæ, is rather astounding inasmuch as they are members of one family.

Another point of interest in connection with *Semilageneta* is the great reduction of somites which are generally visible as part of the body. Here we find fourteen, instead of seven, somites represented in the acetabular region.

No eyes are present.

The genital apertures are apparently united, the common pore lying on the posterior portion of the twenty-first annulus, that is the last annulus of the eighth somite.

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WEDNESDAY, JUNE 24TH, 1908.

The Ordinary Monthly Meeting of the Society was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, June 24th, 1908.

Mr. A. H. S. Lucas, M.A., B.Sc., President, in the Chair.

Messrs. Eustace William Ferguson, Boulevard, Strathfield, and Sydney George, Sydney University, were elected Ordinary Members of the Society.

The President read a draft of a letter of congratulation from the Society to Dr. Alfred Russel Wallace, in commemoration of the jubilee of the Darwin-Wallace enunciation of the Theory of Natural Selection in July, 1858.

The Donations and Exchanges received since the previous Monthly Meeting, amounting to 7 Vols, 60 Parts or Nos., 2 Bulletins, 3 Reports, and 6 Pamphlets, received from 50 Societies, &c., and one Individual, were laid upon the table.

NOTES AND EXHIBITS.

Mr. Fred. Turner exhibited botanical specimens, comprising *Rottboellia formosa* R.Br., collected near Collarenebri in north-western New South Wales. The seeds of this North Australian and North Queensland grass had no doubt been introduced into New South Wales by travelling stock. Several species peculiar to the northern part of Australia had, at various times, been collected on the camping-reserves and stock-routes in the north-west, or adjacent to them, and forwarded to him for identification, but he did not regard these plants as indigenous to New South Wales.—*Panicum glabrum* Gaud. (syn. *Paspalum ambiguum* DC.), collected by him first in 1904 and again in 1908, at Vaucluse, near Sydney. In the interval this Indian grass had spread very rapidly on the Vaucluse estate, and was now quite acclimatised.—*Lysurus australiensis* C. & M., a remarkable fungus, forwarded from Woolwich, Parramatta River.

Mr. Fletcher showed germinating seeds of the Fire-Tree, or Christmas-Tree of West Australia (*Nuytsia floribunda* R.Br.), one of the only two Australian terrestrial representatives of the N.O. *Loranthaceæ*, at interesting stages of development; and he intimated that, when the specimens were more advanced, he hoped to be able to show them again, for comparison with a series illustrating the germination and early growth-stages of the Eastern terrestrial member of the Order, *Atkinsonia ligustrina* F.v.M., which presented some noteworthy differences in regard to both the number and the behaviour of the cotyledons.

A CATALOGUE OF THE HEMIPTERA OF FIJI.

By G. W. Kirkaldy.

(Plate iv.)

The present paper is based on the collections made in Viti Levu, in 1905, by Mr. Albert Koebele, and in 1906, by Mr. Frederick Muir, when searching for parasites and predators to control the ravages of the "Sugar-cane Leaf-hopper" (*Perkinsiella saccharicida*) in the Hawaiian Islands.

In addition to these official materials, I have included an account of some Hemiptera kindly sent to me by Mr. Charles H. Knowles, Superintendent of the Department of Agriculture in Fiji. These are specially valuable, as being accompanied, in most cases, by indications of the food-plants. The leaf-hoppers have already been worked out,* the descriptions in this paper principally concerning the Heteroptera.

The previous total of Fijian Hemiptera was about 40. This has now been brought up to 202 (of which seven have not been specifically determined), but it is evident that the endemic forms are scarcely yet collected. Only three islands have been searched for Hemiptera, viz., Viti Levu, the largest island and the seat of the present capital; Ovalau, a small island, the former seat of government; and Taviuni, an island to the east of Vanua Levu. The whole Archipelago must be exceedingly rich in Hemiptera, and we know probably less than a tenth of the total of that fauna.

Fiji was associated, by Wallace, with other Pacific islands, in a "Polynesian Subregion," but its Hemipterous fauna seems decidedly continental, and to be included in the "Austro-Malayan

* 1906, Bull. Ent. Hawaiian Sugar Planters' Experiment Station, i. pp.269-479, Pls.xxi.-xxxii.; and 1907, *op. cit.* iii. pp.1-186, Pls.i.-xx.

Subregion" of the Australasian Region. However, till the present total is at least trebled, detailed discussion would be of very little value.

All the localities mentioned, except Ovalau and Taviuni, are in Viti Levu.

New Genera, etc., described in this Paper.

Nesostethus (subg. of Stalagmosthetus).
Insulicola.
Holophygdon.
Nesocypselas.
Nesocysta.
Phantasmatophanes.
Nesocrypha.
Anthropophagiotes.
Nesosylphas.
Nesodaphne.
Nesiope.

New Species, etc.

Calisius pacificus.
Ctenoneurus bergrothianus, C. fungicola.
Leptocoris insularis.
Graptostethus vitiensis.
Stalagmostethus ornatus.
Ninus stylatus, N. subsessilis.
Ontiscus vitiensis.
Bedunia nesiotes.
Insulicola pacificus, I. oceanicus.
Elasmolomus insularis.
Sinierus vitiensis.
Germalus pacificus, G. oceanicus (with var. *interrupta*).
Phatnoma pacifica.
Holophygdon melanesica.
Nesocypselas dicysta.
Nesocysta rugata.
Enicocephalus fungicola, E. corticicola.
Oncocephalus pacificus.
Phantasmatophanes muiri.
Gardena pacifica.
Ploiariodes calamine, P. euryale, P. stheno, P. medusa.
Luteva circe.

Microvelia pacifica.
Anthocoris pacificus.
Mesocrypha corticicola.
Eucerocoris thetis.
Tichorhinus vitiensis.
Anthropophagiotes thanatopharus.
Hyaloscytus elegantulus Reuter var. *filicicola.*
Notostira pacifica.
Nesosylphas pacifica.
Cyrtopeltis (?) *nicotianæ.*
Nesodaphne knowlesi.
Nesiope ornata.

Fam. CIMICIDÆ.

1. Platynopus melacanthus.

Pentatoma melacanthum Boisduval, 1835, Voy. Astrolabe, Ent. ii. 628, Pl. ii. f. 7.

Rewa (March and November; Muir). Also recorded from the Moluccas, Papua, New Caledonia, Lifu and Murua (Woodlark).

2. Canthecona cyanacantha Stal, 1870, Svensk. Vet. Handl. ix. No. 1, p. 42.

Rewa (March-April; Muir); Suva and Nadi (Knowles, No. 187). Two Oriental species of this genus are known to prey on caterpillars; thus the Fijian species may be of economic importance.

3. Catacanthus viridicatus Distant, Trans. Ent. Soc. London, 1881, 215.

Rewa (November; Muir); Suva (Knowles, No. 32). Also from the Tonga Isles.

Although the Fijian examples differ from Distant's description (which was drawn up from a Tongan one), I believe the former to belong to his species. Distant writes that the second segment of the antennæ is a little shorter than the third, and subequal to the fourth; the fifth broken off. In the Fijian specimens, the fourth segment is distinctly longer than the third, so that I suppose a part of Distant's fourth was broken off with the fifth.

The colouring of the Fijian examples, to the differences between which and the Tongan I attach little importance, is as follows :— Vertex, pronotum and scutellum dark metallic green, the pronotum with a bluish discal discoloration, scutellum with the posterior angle luteous. Antennæ dark bluish-black, a ferruginous spot on the first segment. The elevated lateral margins of the pronotum luteous. Clavus and corium (except the greenish embolium) reddish-bronzy, membrane bronzy. Tergites black partly with a bluish gleam, their pleurites luteous, bright metallic bluish-green at the incisures. The underside (including the first segment of the labium and the dorsal side of the second) luteous, abdominal spine tinged with red; a bright greenish-blue spot at the incisures of the sternopleurites, also two bluish-green spots on the pygophor; rest of labium blackish-brown. Coxæ and femora reddish-luteous; extreme apex of femora, tibiæ and fore tarsi blackish with a dark bluish-green gleam; other tarsi mostly yellow. Length 28-30 mill.

Rewa (November; Muir); Suva (Knowles, No.32).

4. Piezodorus rubrofasciatus (Fabricius) Stal, 1876, *l.c.* xiv., No.4, 100.

Rewa (April; Muir); also Ovalau. Also from "North Australia," New Caledonia, Tahiti, through the Malayan Archipelago to India, Cochin China, Philippines and Japan. Likewise throughout East Africa.

In the work of Stal cited above (p.100), there is a misleading error, which I think has been called attention to elsewhere by my friend Dr. Breddin. It is *P. pallescens* in which the second segment of the antennæ is shorter than the third; it is longer in *P. rubrofasciatus*.

The nymph in the last instar has the general colouring and appearance of the adult, but is broader in proportion. Apex of the second segment of the antennæ blackish. Tergites spotted with sanguineous. Labium extending well beyond the hind coxæ. Antennæ 7, 20, 15, 18. The anterior margin of the pronotum is only slightly roundedly emarginate, instead of somewhat deeply as in the adult; lateral margins narrowly laminate and minutely, roughly crenulate on the anterior half. First odoriferous orifices not paired. Sternites basally with a short, blunt tubercle.

5. HYPARETE VITIENSIS Distant, Trans.Ent.Soc.London,1901,585.
"Fiji."

6. VITELLUS INSULARIS Stal, 1876, *l.c.*
Rewa (Muir),

7. PEGALA BIGUTTULA Haglund, 1868, Stettin.Ent.Zeit.xxix.159.
Rewa (March; Muir).

8. GEOTOMUS PYGMAEUS (Dallas) Signoret, 1883, Ann. Soc. Ent. France (6) iii. 51, Pl.3, f.160.

Rewa (March; Muir). Also from India to Japan and through the Malayan Archipelago to New Caledonia; also immigrant into the Hawaiian Isles. This species has been found in the soil attached to plants introduced into the Hawaiian Isles, this doubtless accounting in part for its extensive distribution.

9. COLEOTICHUS NIGROVARIUS Walker, Schouteden, 1905, Ann. Mus. Hung. iii. 358, Pl.9, f.8.

Suva (Knowles, No.122); Ovalau (Walker).

10. C. SORDIDUS Walker, Schouteden, 1904, Gen. Ins., fasc.24, Pl.i., f.1.

"Fiji." Also Australia, New Caledonia and the Isle of Pines.

11. TECTOCORIS DIOPHTHALMA (Thunberg).

T. lineola Stal, 1873, *op. cit.* xi., No.2, p.11.

Rewa (March; Muir), a single example somewhat intermediate between Nos.11 and 12 of Plate 28 cited below; Suva, Lautoka, Nadi, Ba, Rewa, Caboni and Sigatoka (Knowles, No.31), therefore probably all over Viti Levu. The life-history has been partially worked out by Dodd, Trans. Ent. Soc. London, 1904, 483-5, Pl.28. Mr. Knowles informs me that he found a half-grown nymph with its setæ inserted in the body of a larva of a Zygoenid moth, *Levuana iridescens* Bethune-Baker, common in Fiji as a Coconut pest.

12. Lamprophara bifasciata (A. White) Schouteden 1904, *op. cit.* 31, Pl.2, f.1.

Rewa (March; Muir); Ovalau. Also Samoa.

I have not seen White's description, but suppose his species to be represented by Schouteden's figure. The examples collected by Mr. Muir belong to var. *quadrifera* (Walker), which lacks the pronotal band down the middle.

Nymph of last instar reddish-ochraceous. Vertex, hindmargin (broadly) of pronotum, the rounded posterior angle of the scutellum, lateral margins and the centre of the abdomen above, tibiæ, etc., metallic green, often with a blue tinge. Antennæ black, base of first segment ochreous. Tarsi more or less fuscous. Tegminal pads metallic green, with blue and bronzy reflexions in part. Subrotundate, convex above, concave below; vertex, pronotum, scutellum and tergites punctured. Head horizontal, lateral margins only slightly sinuate (not almost subangularly concave as in the adult). Labium extending to the middle of the sternites. Antennæ 4, 7, 7, 8½. There are two large, broad flaps on the fifth and sixth tergites, and two tiny lateral openings on the fourth.

13. Brachyplatys pacifica Dallas, 1851, List, 70.

Viti Levu (November; Muir, No.23), on *Saccharum officinarum*, also arboreal. Found also in the Tonga Group (Vavau and Tongatabu), and "Sula," Jilolo, Wallis Is. and the Marianas (or Ladrones) Is.

14. Calisius pacificus, sp.nov.

Allied to *C. interveniens* Bergroth, but is a little smaller, differently coloured, and with different antennal proportions. Head brownish-testaceous, the rest of the body ferruginous, except the following parts, which are blackish or dark fuscous, viz., eyes, apical half of the fourth segment of the antennæ, labium, tarsi, a suboblique band on the anterior half of the scutellum exteriorly, and the posterior third of the same; also specks on the pleurites. Labium extending to the base of the head. Fourth segment of the antennæ less than twice as long as the third. Length $2\frac{1}{2}$ mill.

Rewa (Muir).

15. Carventus sp.?

Viti Levu (January; Muir, No.68), on *Acacia* sp.; Rewa (March; Muir).

16. Mezira thoracoceras (Montrouzier).

Brachyrrhynchus thoracoceras Bergroth, 1886, Verh. zool.-bot. Ges. Wien, xxxvi. 59.

Rewa (March and December; Muir). Also from Papua, "North" and West Australia, New Caledonia, Murua, etc. On *Hibiscus tiliaceus* and under bark, according to Montrouzier.

The nymphs are not remarkable except that the third and fourth segments of the antennæ are not separated, and that all the segments are covered with apparent sensory organs.

17. Ctenoneurus bergrothianus, sp.nov.

Differs from the Maorian *C. hochstetteri* by its smaller size, much blunter eye-spine, the fourth segment of the antennæ very distinctly longer than any of the other three, and the scutellum scarcely extending posteriorly beyond the inner margin of the corium. Pitchy-black, eyes whitish-yellow; labium orange-brown. Coxæ, hind area of pronotum, the antennal and pedal articulations, reddish or reddish-pitchy. Apical margin of corium golden-yellow with a fuscous spot medially. Membrane sordid vitreous, with many thin, confused, dark veins. Length 6 mill.

Rewa (Muir), infested with a testaceous-coloured Acarid.

18. C. fungicola, sp.nov.

Ferruginous, darkening locally. Head, antennæ, pronotum, scutellum, clavus and corium pitchy; apical margin of corium golden-yellow. Eyes bright red. Membrane yellowish-hyaline, apical half of lateral margin and the apical margin continuously narrowly fuscous. Legs fusco-ferruginous. Tergites apparently yellowish-ferruginous, pleurites fusco-ferruginous with yellowish-ferruginous spots. Head extending apically to about half the length of the first segment of the antennæ, shortly bifid, the apices of each fork rounded. Spine behind eyes not prominent Antennæ 17, 10, 15, 15. Labium not quite reaching prosternum. Pronotum with the anterior margin roundly emarginate, antero-lateral angles acute. Genital segment and the projections lateral of it all rather prominent. Length $3\frac{1}{2}$ mill.

Viti Levu (March; Muir, No.150), under the bark of an old tree full of fungus.

The nymph in the last instar is very similar to the adult. Yellowish (dried), suffused dorsally with greyish. Eyes red. Lateral lobes extending very slightly beyond apex of head. Antennæ (of the single specimen before me) discordant; left 10, 7, 11, 14; right 10, 7, 17. The right antenna is trisegmentate; the left one appears to be quadrisegmentate, but there is no articulation or incision between the apparent third and fourth. As the latter is also the case in the nymphs (of the last instar at least) of *Mezira thoracoceras*, it is perhaps characteristic of Aradid nymphs.

Fam. LYGAEIDÆ.

19. Mictis profanus (Fabricius).

M. profana Stal, 1873, *op. cit.* xi. 44.

Rewa (March, April and November; Muir); Suva and island of Taviuni (Knowles, No.191). A widely spread species, inhabiting Ceram, Murua, Australia, Lifu, the Solomons and Samoa. The Fijian individuals, which scarcely differ from the more western, typical form, seem to be restricted to Fiji and Samoa, and constitute the var. *crux* Dallas.

20. Brachylybas variegatus (Le Guillou). (Plate iv., figs.4-6).

Gonocerus variegatus Le Guillou, 1841, Rev. Zool. 262.

Rewa (November, March and April; Muir); Ovalau. Also from Tonga.

This species is now figured dorsally and in profile, with a figure of one of the odoriferous orifices (Pl.iv., figs.4-6).

21. Theognis australis (Fabricius) Mayr, 1866, Novara Exp. Zool. ii. (2), p.101.

Rewa (March; Muir); Suva (Knowles, No.242).

22. Leptocorisa acuta (Thunberg) Stal, 1873, *op. cit.* xi., 86.

Rewa (February, March and November; Muir; and Knowles, No.140). Also from Australia and the entire Oriental Region.

The fourth segment of the antennæ is very distinctly longer than the first.

23. Noliphus insularis Stal, 1873, *op. cit.* xi., 87.

"Fiji."

24. Leptocoris insularis, sp.nov.

Head brownish-red, with a wide median blackish suffusion. Eyes and ocelli red. Labium, antennæ and legs (red coxæ excepted) black. Pronotum purplish-brown, the two impressed areas and the posterior half (more or less suffusedly) blackish. Tegmina purplish-brown, more or less darkened locally. Membrane metallic green, the basal margin narrowly peacock-blue. Sterna more or less reddish-brown; pleura greyish, lateral margins (and of the sternites) irregularly obscure red-brown, irregularly smudged with fuscous. Last sternite irregularly marked with red, black and orange-yellow. Antennæ with first segment extending well beyond apex of head, fourth segment distinctly longer than the second, which is a little longer than the third. Labium extending well behind the hind coxæ. Pronotum much as in *L. augur.*

♂. Last sternite roundly emarginate medially, postero-lateral angles rounded.

Length 18 mill.

Rewa (March; Muir).

25. Riptortus annulicornis (Boisduval), Stal, *l.c.*

Rewa (March; Muir). Also from Papua, Vanikoro and the Philippines.

26. R. sp.?

Rewa (March; Muir); Lautoka (Knowles, No.352), on leaves of "Mauritius-bean" (*Mucuna atropurpurea*).

This is almost certainly an introduced species, which I have not as yet been able to identify with certainty.

27. DYSDERCUS IMPICTIVENTRIS Stal, 1870 *op. cit.* ix., 120.

Rewa (April and November; Muir); Suva (Knowles, No.185).

♂. Like the female described by Stal, but the head above and at the sides is black with a faint red speck where the ocelli should be. Callose part of pronotum and the lateral margins orange-yellow, hind lobe cinereous-yellow. Scutellum immaculate orange-red. Labium extending to the apical margin of the second sternite.

A var. with immaculate orange-brown head was in cop. with a female like the above described male.

Length, ♂ 11; ♀ 13-15 mill.

28. D. INSULARIS Stal, *l.c.*

Rewa (April; Muir); Lautoka, "exceedingly common on land recently under cotton" (Knowles).

A var. occurs with the scutellum immaculate black. The labium extends to the middle of the fourth sternite (in Stal's sense).

Fam. MYODOCHIDÆ.

29. GRAPTOSTETHUS SERVUS (Fabricius) Stal, 1873 *op. cit.* xii., 117.

"Fiji." Also distributed over the Oriental and Ethiopian Regions and Mediterranean Subregion of the Palearctic.

30. G. VITIENSIS, sp.nov.

Allied to *G. servus* (Fabr.), but distinguished by the long labium, which extends well beyond the hind coxæ, and by the black head and bucculæ. Black, with sparse, very short, pale yellowish-grey pubescence; vertex without a red spot at base,* bucculæ black. Pronotum red with a large black trilithon-like mark. Beneath black, the prosterna and propleura yellowish (or reddish laterally) with a black transverse stripe which broadens at each end suddenly; ambulacra, posterior and lateral margins of the pleura, and the pleurites, yellowish, or reddish. The

* In one example, there is a very faint pale red speck at the basal margin, but there is not the slightest trace in the others, even when treated with alcohol, as directed by Stal.

pleura all have a large velvety black spot laterally. Tegmina red, partly suffused with black (as in *G. servus*); membrane black, apically margined with whitish. Head not notably declivous; second and fourth segments of antennæ subequal, each a little longer than third. Labium extending well beyond hind coxæ. Length $7\frac{1}{2}$ mill.

Rewa (March-April; Muir); Lautoka (Knowles, No.335).

31. STALAGMOSTETHUS MACTANS Stal, 1866, Berlin. Ent. Zeit. x.162.

"Fiji." Also Australia.

32. S. ORNATUS, sp.nov.

Head, pronotum and sterna (including ocelli and orifices) orange-red (paler beneath). Head between the ocelli at the base, eyes, apex of tylus, antennæ, labium, extreme angle of the latero-posterior part of pronotum, etc., black. Abdomen pale greenish. Tegmina very dark greenish with strongly elevated blackish-brown veins, membrane black. Fourth segment of antennæ longer than the second, which is longer than the first and widens gradually to the apex; the first extending just beyond apex of the head. Pronotum elongate, narrower apically than the head and eyes. Labium reaching to the middle of the hind coxæ. Femora unarmed. Length 9 mill.

Rewa (March; Muir).

This may form a new subgenus characterised by the colour, and by the following structural points: fourth segment of the labium longer than the third. A transverse keel near the anterior margin of the scutellum, a longitudinal one emitted from its middle. Pronotum with a keel, obsolete anteriorly. Tegminal veins very strong. It may be called *Nesostethus*.

33. PYRRHOBAPHUS LEUCURUS (Fabricius) Stal, 1868, Svensk. Vet. Handl. vii. No.2, p.73.

"Fiji." Also from Murua, Ceylon and the Philippines.

34. NYSIUS sp.?

Rewa (March-April; Muir).

35. NINUS STYLATUS, sp.nov.

It is difficult to separate this from Stal's meagre description of *N. insignis*, but the general colour is much darker ferruginous, and there is generally a basal (sometimes an apical also) dark fuscous transverse vitta on the pronotum. The fourth segment of the antennæ is fuscous. The eyes are very distinctly stylate and turn a little upwards. The antennæ are much more slender (as regards the last three segments), the second being slightly clavate apically. Length 4-4¼ mill.

Rewa (March-April; Muir, No.30); Ba (January; Muir); Navua (February; Muir); common on *Saccharum officinarum*.*

36. N.(?) SUBSESSILIS, sp.nov.

The colour and pattern are almost exactly like those of *N. stylatus*, except that there is no extero-lateral spot on the corium, and the apical margin of the corium is yellowish. The eyes, although exserted, are not stylated.

♂. Sternites brownish-yellow, with a dark fuscous lateral stripe.

♀. Sternites brownish-yellow.

Length 4 mill.

Rewa (February; Muir); Navua (February; Muir); Muir's Nos. 115 and 124, on native fern; Suva (March; Koebele).

37. ONTISCUS VITIENSIS, sp.nov. (Plate iv., fig.7).

Closely allied to *O. australis*, but the first two segments of the antennæ are concolorous with the head (*i.e.*, dark ferruginous), the others more dilute; there is a dark fuscous speck at the apex of the clavus and another on the apical margin of the corium. Membrane not fuscously veined. Legs yellowish. Head scarcely narrowed behind. Third segment of labium distinctly shorter than the first or second. Antennæ 12, 15, 11, 17, the fourth scarcely incrassate. Length, ♂♀ 5 mill.

Rewa (April and December; Muir); Ba (January; Muir).

* Dr. Bergroth informs me (*in litt.*) that he thinks, from my description, to him, that this belongs to the genus Breddin, the description of which, however, I have not seen.

38. Paromius seychellesus (Walker).

Plociomerus seychellesus Walker, 1872, Cat. Het. v.120.

Rewa (January-April; Muir); Ba (January; Muir). Also from Japan, Ceylon, Queensland and Samoa. It is perhaps only a form of *P. proximus* (Dallas), which I do not know in nature.

39. Bedunia nesiotes, sp.nov.

Head, third segment of antennæ and base of fourth, fuscous. Pronotum, apex of labium, pleura and sterna, black or blackish. Ocelli rubid. Collar pale ferruginous. Lateral margins of hind area of pronotum and the hind margin (irregularly), testaceous. Tegmina testaceous, clavus and intero-lateral margins of corium thickly and suffusedly punctured with fuscous; a large black spot right across the middle of the corium, also the hind angle of the corium black; membrane smoky, a central area obscurely ferruginous, apical margin paler. Sternites pale reddish-fuscous. First two segments of antennæ and the fore femora pale reddish-brown; middle and hind legs, labium, etc., yellowish-testaceous. Antennæ 22, 29, 24, 23. Length, ♂ $5\frac{3}{4}$ mill.

Navua (February; Muir).

Apparently allied structurally to *B. insularis*.

40. Orthoea limbata (Stal).

Pamera limbata Stal, *op. cit.* 149.

Rewa (February, March and November; Muir); Ba (January; Muir); Suva and Island of Taviuni (Knowles, No.188); Ovalau.

41. O. vincta (Say). (Plate iv., figs.1-3).

Pamera vincta Stal, *l.c.*

Orthoea periplanios Kirkaldy, 1907, Canad. Ent. xxxix. 426.

O. pacifica Kirkaldy, 1907, P. Haw. Exp. Stat. i. 151 (not Stal).

Rewa (April; Muir); Ovalau. Also from Australia and Tahiti; and throughout America, and the Oriental and Ethiopian Regions.

In the Hawaiian Isles, it is found on *Cynodon dactylon*, but I think it is insectivorous. The last nymphal instar is described in the P. Hawaiian Exp. Stat. i. 151, and is now figured, together with a brachypterous adult, and a tegmen of a macropterous individual.

42. O. PACIFICA (Stal).

Pamera pacifica Stal, *op. cit.* 149.

"Fiji."

43. O. NIGRICEPS (Stal).

Pamera nigriceps Stal, *op. cit.* 152.

Rewa (February, March and November; Muir); Suva, Lautoka and Nadi (Knowles, No. 189). Also from the Philippines, Tahiti and the Hawaiian Isles (introduced into the latter at least).

44. O. NIETNERI (Dohrn).

Pamera nietneri Stal, *op. cit.* 151.

Rewa (April; Muir). Also from the Philippines, Burma, Ceylon and Java.

The three females captured by Mr. Muir agree with Distant's description (1903, Faun. Ind. ii. 53), except that the fourth segment of the antennæ is bicolorous, the basal half pale, the apical half dark. This character is, however, mentioned by Stal.

INSULICOLA, gen. nov.

Elongate. Head longer than anterior lobe of pronotum, the central lobe extending well beyond the lateral lobe; exserted, but the hind area short. Ocelli fairly close to eyes. Labium reaching to, or beyond, middle of abdomen, first segment to base of head. Antennal tubercles reaching to base of tylus, first segment extending beyond apex of head, second nearly twice the first, and about one-half longer than the third, which is a little shorter than the fourth. Pronotum with an annuliform collar, lengthening a little in the middle, but nowhere a real collar (as in *Orthoea*, etc.); anterior lobe finely and sparsely punctured, much longer than the posterior, lateral margins rounded, gradually diverging, posterior margin (of anterior lobe) more closely and coarsely punctured, at least one-half wider than the anterior margin, very distinctly wider than head, which is distinctly wider than anterior margin. Hind lobe with the lateral margins fairly straight, but widely divergent, posterior margin more than twice as wide as anterior margin of pronotum; anterior half medially carinate. Scutellum longer than wide, depressed basally and at the sides, coarsely punctured on anterior margin of disk and on the sides. Clavus with three or four irregular rows of punctures. Corium with two rows internally and the external margin of the apical half, closely punctured, the rest smooth and polished. Membrane with strong, curved veins. Fore femora incrassate, with three or four longer spines and several shorter ones; tibiæ curved. First segment of hind tarsi nearly as long as the others together.

This has puzzled me considerably. Although there is not a proper collar, I would place it in the *Myodochini*. There is some affinity to *Dieuches* Stal, but the anterior lobe of the pronotum is entirely rounded. It is perhaps nearest to *Eucosmetus* Bergroth, but the head is much narrower and more elongate, and the pronotum is distinctly divergent laterally.

45. I. PACIFICUS, sp.nov.

Black; labium, antennæ, apex of tylus, etc., yellowish-testaceous, more or less sordid; "collar," posterior lobe of pronotum (both strongly punctured with blackish-brown), an elongate V on disk of scutellum, corium, etc., brownish-yellow. Clavus almost entirely dark fuscous. Corium with a large blackish spot at inner apical angle, the rest of the smooth part brown, punctures blackish-brown. Membrane dark fuliginous, veins pale and sordid, apex yellowish. Legs brownish-yellow, fore femora stained and spotted with dark brown, apex of fore tibiæ, etc., dark fuscous. Anterior lobe of pronotum twice as long as posterior lobe, medially. Fore femora strongly incrassate. Length, ♂ 10 mill.

Rewa (March; Muir).

46. I. OCEANICUS, sp.nov.

Very similar to the last, but smaller; and the anterior lobe of the pronotum barely one-half longer than the posterior lobe.

Fore femora much less strongly incrassate. Length, ♂ 7; ♀ 9 mill.
Rewa (March; Muir).

47. Elasmolomus insularis, sp.nov.

Apparently closely allied to the Philippine *E. v-album* (Stal), but the fusco-ferruginous of the head, scutellum, abdomen and legs is replaced by black. The anterior half of the pronotum is as in *E. v-album*, the posterior half is yellowish-testaceous, thickly and irregularly punctured with brownish-ferruginous. The explanate lateral margins are yellowish-testaceous, a fuscous spot near the apical margin and another at the base. The fore femora are black, except the extreme apex; apical half of middle and hind femora black, except the pale apex. Length 6 mill.
Rewa (December; Muir).

48. Sinierus vitiensis, sp.nov.

Head and anterior area of pronotum blackish or dark piceous. Antennæ brownish-yellow, second segment fuscate. Anterior margin (narrowly) of pronotum and the hind area brownish-yellow, thickly punctured with fuscous, and partly fuscously suffused. Scutellum dark fuscous, obscurely ferruginous medially. Tegmina dark fuscous, with some testaceous markings. Membrane irregularly dark smoky. Head beneath and sterna mostly piceous, sternites shining brownish. Labium and legs yellowish-testaceous, more or less fuscate. Head and pronotum gradually declivous. Pronotum, scutellum, sterna and tegmina thickly punctured. Labium reaching to middle coxæ. Antennæ 19, 25, 20, 24. Ocelli large, close to eyes. Length 3 mill.
Rewa (March; Muir).

There are also three species of *Pamerinæ*, belonging to as many genera. Distant has, however, recently proposed, in their neighbourhood, several Australasian genera, which are not identifiable with certainty, without illustrations or the inspection of types. I have therefore left these unidentified for the present.

49. Phaenacantha pacifica Horváth, 1904, Ann. Mus. Hung. ii. 136.
Rewa (April; Muir).

The fuscous vittæ on the hind area of the pronotum are not distinctly marked and not percurrent in the single example before me.

50. GERMALUS PACIFICUS, sp.nov.

Head pale orange (or pale chrome-yellow); the tylus and around the ocelli suffusedly black, or blue-grey (the extent variable). Eyes red. Antennæ yellowish-testaceous, more or less sordid. Pronotum pale yellow or yellowish-testaceous; a slightly oblique bluish-grey (or blackish-grey) transverse band on each side near the anterior margin, meeting medially (the pronotum anterior to this being chrome-yellow), at that place giving off a median line of the same colour almost to the base. There are also three black spots on the posterior margin, one near the lateral angles on each side and one in the middle. The pronotum is also varyingly punctured with dark brown. The Y-shaped keel on the scutellum is chrome-yellow and is punctured with black laterally, the rest of the scutellum bluish-grey or blackish-grey. Clavus chrome-yellow, with three broad, blackish-grey longitudinal lines. Tegmina hyaline, tinged with cinereous, punctured with dark brown close by the radial vein; apical half of median vein and apical margin of corium suffusedly dark fuscous. Membrane hyaline, a fuscous smudge from basal angle to apical margin (sometimes faint). Pleura black, lateral and hind margins more or less yellow. Ambulacra, legs and labium yellowish-testaceous; femora speckled with brown. Odoriferous orifices yellow. Tergites pale chrome-yellow, a sublateral black stripe on each side, meeting apically. Sternites orange or chrome-yellow, with a sublateral greyish-black or bluish-grey stripe, disk yellower and more sordid, basally black. Labium extending to middle coxæ. Length 5 mill.

♂. Sternites very hairy, the pilosity pale.

♀. Ovipositor-sheath black.

Rewa (February-April, November, December; Muir).

51. G. OCEANICUS, sp.nov.

Allied to the last, but the bluish part of the vertex is much less in extent and the transverse lævigate areas on pronotum anteriorly are concolorous, yellow, though bordered posteriorly with fuscous. Scutellum yellow, basally a little dark, punctured with fuscous. Clavus with two longitudinal dark lines, and tergites without black stripes. Beneath pale yellow; pleura strongly punctured with dark brown; sterna black; sternites basally rosy. Labium extending to hind coxæ.

♂. The hairiness on the sternites is white, not yellowish-testaceous, as in *G. pacificus*.

Length 5 mill.

Rewa (November; Muir); Ba (January; Muir).

Var. (b) INTERRUPTA, NOV.

The median line down the pronotum scarcely extends beyond the middle, but the lævigate area is suffused partly with greyish-black.

Rewa (April; Muir); Navua (February; Muir).

In the nymphs of the last instar, the head is very short and declivous; eyes scarcely pedicellate, slightly decumbent on the pronotum. Lateral margins of pronotum and tegminal pads laminate. There are two odoriferous orifices, on the 5th and 6th tergites. Yellowish-testaceous; disk of pronotum (except anteriorly), of nota (a thin yellow line down the middle) and of tegminal pads dark fuscous, extending obliquely on to apical half of the pads; a broad median band down the tergites reddish-piceous; glandular areas and most of the last segment, dark fuscous. A dark spot at the apico-lateral angle of each abdominal segment. Apical three-fourths of antennæ fuscous. Pleura marked with black.

52. G. SP.?

I have received from Mr. Knowles (No.229), from Lautoka, a nymph of a species of *Germalus*, which is evidently new. The adult would probably be identifiable from the nymphal description, but I prefer to wait for the arrival of the adult before naming it.

Fam. TINGIDÆ.

53. PHATNOMA PACIFICA, sp.nov.

Pale cinereous; tegmina and pronotum more or less lightly clouded in part with fuscous, but there is no definite pattern, and the extent and degree of infuscation are not the same in any two individuals. Sterna and abdomen also more or less fuscous. First two and basal half of first segment of antennæ brownish-testaceous, rest dark fuscous. The form is much like that of *P. marmorata* Champion, but the keels of the pronotum are very prominent, the median extending onto and far beyond the anterior lobe, and the second antero-lateral spine is more acute and directed more forwards. There is one long, median, porrect spine on the head anteriorly, followed by a long, submedian one on each side, these being basally contiguous, subporrect and apically divergent; then a long one on each side at the base, basally remote, semierect, apically divergent; laterally there is one long spine on each side between the eye and the antennal insertion, and one on each side anterior to the antennæ; nine in all on the head. The underside of the head is carinately foliaceous and reticulate, the bucculæ acutely prominently anteriorly. The cross-keels on the discoidal and subcostal areas are not very strong, though a little variable in this respect. In the costal area there are 4-7 cells of subequal size in each row, though these are irregular, and on the exterior margin, which is minutely multisinuate, there are much larger individual cells at intervals. The sternites are channelled to the base of the genital segment, the labium lying along this channel, right to the end. The last two or three sternites, except the last, are apically emarginate angularly. Tegmina and wings extend well beyond the apex of the abdomen.

♂. Last segment shaped much as in that of *P marmorata*, but much more emarginate broadly, the genital segment being much larger.

♀. Last sternite deeply emarginate, the lateral margins a little produced posteriorly, and the middle triangularly produced, so that the sternite is really bisinuate.

Length $3\frac{7}{8}$-$4\frac{1}{8}$ mill.

Viti Levu (March; Muir's No.102), on a native tree; Rewa (March; Muir).

This is nearest, perhaps, to *P. marmorata* Champion, from which it differs by the different form of the pronotum, the minutely multisinuate lateral margins of the tegmina and the different cell-form of the costal area, also by the genital segments. It differs from any species of *Phatnoma* by the middle keel of the pronotum extending beyond the apical margin, and by the very long labium.

HOLOPHYGDON, gen.nov.

Very distinct from any other genus by the form of the pronotum. Allied remotely to *Gargaphia* Stal. Head small, almost angularly convex above, spineless. First segment of antennæ longer than head. Bucculæ high, extending slightly beyond head, the space between them oval. Labium not reaching to base of mesosternum, and there are no sternal sulci, or at least only broad, somewhat impressed areas between the ambulacra. Pronotum entirely composed of a large subglobular cyst, largely reticulate, medianly keeled, not covering the head; the sides are thus not at all carinate, explanate or foliaceous, and the basal margin is perpendicular, not acutely produced. Discoidal area scarcely visible, tumid. Subcostal area largely reticulated irregularly, and there is no costal area differentiated. Tegmina extending far beyond abdomen.

54. H. MELANESICA, sp.nov. (Plate iv., figs.10-11).

Pale yellowish, legs, etc., paler. Apical four-fifths of last segment of antennæ, tarsi, apex of labium, etc., black. Tegmina hyaline (except discoidal area), veins pale yellow, sometimes apically fuscous. Length $3\frac{1}{4}$-$3\frac{1}{2}$ mill.

Viti Levu (November; Muir's No.34), on a native tree-climbing plant; Rewa (April and December; Muir).

NESOCYPSELAS, gen.nov.

Allied to *Derephysia* Spinola, but very different from anything known to me. Head minute, spineless; antennæ slender, second segment three or four times as long as first, third a trifle more than fourth, and about seven times as long as second. Labium short. Pronotum transverse, minute, tricarinate, scutellum visible from above; laterally, however, the pronotum is foliaceously dilated, extending posteriorly a little further than scutellum, laterally curving around inwards so as to form (as seen from above) a hollow curved tube on each side, the sides of which do not quite meet internally; these two tubes meet anteriorly, extending beyond the head; posteriorly they are remote, fully displaying scutellum. They are largely reticulate, but not carinate, the veins of the reticulation being minutely multispinose. Tegmina foliaceous, longitudinally depressed on subcostal area. Costal margin rectangularly dilated basally, apical margin obliquely, somewhat roundedly, truncate, extending far beyond apex of abdomen. Subcostal area biareolate, many of the veins minutely multispinose.

55. N. DICYSTA, sp.nov. (Plate iv., figs.8-9).

Head, pronotum and scutellum greyish; antennæ and legs pale yellow. Tegmina and foliaceous part of pronotum hyaline, veins partly concolorous, partly fuscous, spinules blackish. Tegmina with a small dark clouding close to base, and an outwardly curved stripe on apical half of tegmen exteriorly. Tarsi black. Length 3 mill.

Viti Levu (November; Muir's No.7); Ba (January; Muir); Rewa (March and November; Muir); Lautoka (Knowles, No.345); on leaves of *Artocarpus incisa*, the Breadfruit-tree.

NESOCYSTA, gen.nov.

Allied to the last, but the lateral lobes of the pronotum are remote anteriorly and, while hollow, are not swollen out, but appear as if somewhat crumpled; also, while in *Nesocypselas* the longitudinal opening of each is in the nota, in *Nesocysta* they open around the underside of the head. Labium extending just beyond middle coxæ. Second segment of antennæ about twice and one-half as long as first, third twice as long as fourth, which is nearly five times as long as second. Tegmina narrower than in the preceding, and narrowly rounded apically; veins of pronotum and tegmina not multispinose.

56. N. RUGATA, sp.nov.

Colouring as in *Nesocypselas dicysta*, but the fourth segment of the antennæ is somewhat fuscous. Tegmina hyaline, veins concolorous; apically, many are dark fuscous, especially the middle longitudinal line, which is a little suffused. Length $2\frac{1}{8}$ mill.

Rewa (March; Muir).

57. MONANTHIA NATALENSIS (Stal).

Physatocheila natalensis Stal, 1855, Öfver.Vet.Akad.Förhandl. xii. 38.

Rewa (March; Muir). This species appears to have little to do with typical *Monanthia*. The specimens before me differ from African specimens apparently only by the femora being basally and apically, and the tibiæ basally, dark reddish-fuscous.

Fam. NABIDÆ.

58. GORPIS CRIBRATICOLLIS Stal, 1859, Öfver.Vet.Akad.Förhandl. xvi. 377.

Rewa (March; Muir). Also from Australia and Ceylon.

59. REDUVIOLUS SP.?

Rewa (Muir).

Fam. GERRIDÆ.

60. MICROVELIA PACIFICA, sp.nov.

Winged ♂: black; vertex laterally with a strip of silvery pubescence. Antennæ brownish-pitchy. Head beneath discally, anterior margin of pronotum (except laterally) and the latero-posterior margins of the same, ferruginous. Labium yellowish-brown, apical segment black. Tegmina whitish, apical third more or less fumate; veins broadly greyish-fuscous. Fore legs testaceous; tibiæ, tarsi and apex of femora fuscate. Middle and hind legs dark fuscous, base of femora testaceous. The general form is that of *M. flavipes* or *M. paludicola*, but the antero-lateral margins of the pronotum are straighter. Labium extending beyond base of prosternum. Antennæ about 9, 6, 8, 16. Hind tibiæ with short hairs.

Apterous ♀ narrowly ovate, pleurites converging and almost meeting apically.

Length 2½ mill.

Rewa (April; Muir).

61. Limnogonus discolor Stal.

Gerris discolor Stal, 1859, Eugenies Resa, Ins. 265.

Rewa (March; Muir); also a nymph from the same locality (February; Muir).

62. Limnometra ciliata Mayr, 1865, Verh. zool. bot. Ges. Wien, xv.

"Viti Levu" (No.4656, Godeffroy Mus.).

L. ciliata was originally described from Java.

Fam. ENICOCEPHALIDÆ.

63. Enicocephalus fungicola, sp.nov.

Head, pronotum, scutellum and legs brownish-ochraceous, the latter unicolorous. Eyes black, ocelli red. Sides of hind lobe of head faintly, pronotum laterally strongly, fuscous. First and fourth segments of antennæ ochraceous, the others fuscous. Tegmina dark fuscous, laterally paler. Abdomen testaceous, more or less fuscous. Posterior lobe of head moderately transverse, subglobose, pilosity rather thick (as also all over, including eyes). Ocelli prominent though small. Antennæ with the basal segments rather shorter than the apical, first segment scarcely reaching apex of head; second a trifle longer than fourth, which is a trifle longer than third. Pronotum with the posterior lobe much wider than the anterior, which is much wider than the collar; scarcely emarginate behind. Discal cell of tegmina closed, venation on general plan of *E. telescopicus* (*cf.* Kirkaldy, 1901, Ent. Mo. Mag. (2) xii. 219, fig.2). Fore tarsi with long, uneven and somewhat connate claws. Length 5 mill.

Viti Levu (March; Muir's No.146), under the bark of an old tree, filled with fungus.

64. E. corticicola, sp.nov. (Text fig.1).

Very similar to the last, but larger. Head not laterally fuscous; base of fourth segment of antennæ fuscous. Pronotum, sterna and pleura dark fuscous, anterior margin and middle of collar, and hind margin and middle of posterior lobe, ochreous. Second segment of antennæ rather longer in proportion. Eyes smaller and less prominent. Anterior lobe of pronotum longer and wider in proportion. Length 6½ mill.

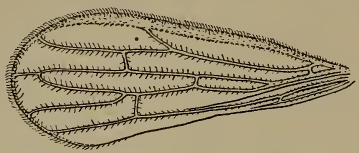

Fig. 1.—*Enicocephalus corticicola;* tegmen.

Viti Levu (Muir's No. 155), under the bark of an old fungus-filled tree.

It is possible that this and the preceding are the two sexes of one species, but no one has succeeded as yet in differentiating these forms sexually.

The nymph of the last instar (of one species or the other) is very similar to the adult, but the antennal segments are all stout, the fourth segment much the longest. Anterior and posterior lobes of the pronotum equally wide, much wider than the collar. Fore claws a little less connate.

Fam. **REDUVIIDÆ.**

65. Polytoxus sp.?

Rewa (February and November; Muir).

66. Oncocephalus pacificus, sp. nov.

Very closely allied to the Mascarene *O. angulatus* Reuter, but the eye (♂) occupies the whole height of the head, and the prosternal spines are more strongly uncinate. First segment of antennæ pale brownish-yellowish, a little infuscate beneath apically, second segment yellowish. Sterna and pleura yellowish-brown, irregularly striped and marked with fuscous. Sternites yellowish-brown, with a broad sublateral and a narrow submedian indeterminate dark fuscous stripe down each half. Pleurites brownish-yellow, a fuscous spot on apical margins of each, exteriorly. Fore femora less incrassate, with ten spines. Hind femora strongly adspersed with blackish-fuscous, darker and closer apically, base and trochanters pale. Prosternal spines prominent, subporrect, apically downwardly uncinate. Postero-lateral angles of pronotum also stronger. Length $14\frac{1}{2}$ mill.

Rewa (March; Muir).

67. PYGOLAMPIS FOEDA Stal, 1874, Svensk. Vet. Handl. xii. No.1, p.85.

"Fiji." Also from "North Australia," the Philippines and Ceylon. Probably not endemic.

68. POLIDIDUS ARMATISSIMUS Stal, Distant, 1904, Faun. Ind. Rh. ii. 386, f.246.

Rewa (December; Muir). Also from the Philippines, Japan and the Continental Orient.

69. TUNES SAUCIUS Stal, 1866, Berlin. Ent. Zeit. x. 165.

"Fiji."

70. ALLOEOCRANUM BIANNULIPES (Montrouzier and Signoret), Kirkaldy, 1902, Faun. Haw. iii. Pl. iv. f.17.

"Fiji." A very widely distributed form.

PHANTASMATOPHANES, gen.nov.

Allied to *Stenolemus* Signoret, but distinguished from all the other Ploiariinæ by the very long, thin pronotum, and the tufted antennæ and legs. Head pilose, but not spined; hind lobe of vertex narrowed behind eyes, laterally trituberculate on anterior margin; first segment of labium extending about as far as, or a trifle farther than, from its base to an eye; second segment short and swollen, third attenuated, extending to about fore coxæ. First segment of antennæ about as long as pronotum, a little shorter than the other segments together, elongately pilose all around and with four thick tufts about equidistantly; other segments filiform, pilose, but not tufted. Pronotum about as long as the abdomen and other nota together, about as wide anteriorly as the eyes, suddenly narrowed, and, for about three-fifths of its length, columnar and very narrow, then widening out subtriangularly close to the base which is elevated and angularly emarginate; the basal part is laterally carinate, the carinæ beginning and ending each with a tubercle, also there is a submedian tubercle on each side subanteriorly on this basal part. Scutum of metanotum with a small suberect spine. Tegmina extending beyond abdomen, ampliated interiorly near apex and suddenly concavely narrowed. Legs (except that the

Fig. 2.—*Phantasmatophanes muiri.*

middle and hind coxæ are not tufted) pilose and tufted. Fore femora a little longer than tibiæ, strongly spined all along, tarsi apparently bisegmentate; hind femora extending far beyond abdomen, tarsi shorter than fore tarsi.

71. P. MUIRI, sp.nov. (Text fig.2).

Brownish-testaceous, more or less shaded or marked with brownish. Pilosity whitish, tufts blackish-brown. Eyes black. Second segment of antennæ blackish-brown, annulated with white. First two segments of labium blackish-brown, third pale. Tegmina brownish, variegated with white, the brown deepening almost to black in a large subdiamond-shaped spot near the middle. Abdomen mostly blackish-brown. Length 11 mill.

Navua (February; Muir); Rewa (March; Muir).

72. GARDENA PACIFICA, sp.nov. (Text figs.3-3*a*).

Allied to *G. bicolor* Distant, but much smaller and differently coloured, the pronotum much shorter. Testaceous-brown, labium and first two segments of antennæ a little paler. Middle and hind legs immaculate pale yellowish, tarsi dark fuscous. Anterior

Figs.3-3*a*.—*Gardena pacifica;* tegmen and wing.

lobe of vertex not more elevated than posterior lobe; antennæ a little longer than body, first segment shorter than abdomen, longer than second, third very short, fourth not one-half length of second. Vertex shorter than pronotum, which is about one-third longer than mesonotum. First segment of labium very short, second reaching to eyes, third reaching to fore coxæ. Fore femora twice as long as their tibiæ, with five long spines, six rather shorter and a number of very short ones. Tegmina extending a trifle beyond middle of abdomen.

♀. Antennæ not pilose.

Length 19 mill.

Rewa (November; Muir).

The pronotum in this genus is usually described as fused with the mesonotum, and consisting of two lobes; I cannot see the expediency or correctness of this, and have termed the parts pronotum and mesonotum.

73. Ploiariodes calamine, sp.nov.

Ochraceous or ferruginous-yellow, a submedian stripe down each side of hind lobe of pronotum, these uniting apically and basally. Eyes and apical half of abdomen, etc., black. Two contiguous, opaque, white lines on pleural part of pronotum posteriorly; anterior lobe of head sometimes fuscous. Antennæ pallid ochraceous, middle part of first antennal segment fulvous or fuscous, a dark fuscous ring near apex; second segment more or less fulvous or fuscous, partly. Tegmina yellowish-testaceous with greyish-fuscous or yellow picturation. Fore femora and tibiæ testaceous, with two or three more or less well defined pale fuscous rings. Middle and hind femora testaceous, with a blackish ring near apex, and one or two narrow fuscous rings about middle. Hind lobe of head swollen, laterally rounded and narrowed behind the prominent eyes, impressed ovally longitudinally. First segment of antennæ longer than second. Hind lobe of pronotum about one-half longer than the anterior. Scutellum with two strong, erect spines. Length 6 mill.

Rewa (March-April; Muir's No.119).

This seems allied to *P. vagabundus* (Linn.).

74. P. euryale, sp.nov.

This is very closely allied to *P. rubromaculatus* Blackburn, but there are two well marked pale submedian lines, one on each side, which are subparallel, or a trifle divergent posteriorly, while these are not well defined, and are if anything convergent posteriorly in *P. rubromaculatus*. Also the eyes are more prominent in *P. euryale*, extending laterally distinctly beyond the apical margin of the hind lobe of the pronotum; while they are perhaps a little less prominent laterally than the apical margin of the hind lobe in the Hawaiian species. Length: ♂ 4; ♀ $4\frac{3}{4}$ mill.

Rewa (April, November and December; Muir).

The nymphs differ appreciably from those of the Hawaiian species, only by the larger eyes.

75. P. STHENO, sp.nov.

Distinguished by the tegminal picturation. Pale yellowish (head sometimes dark). Eyes, basal half of first segment of antennæ, first two segments of labium (and sometimes the apex of abdomen) black. Fore femora only feebly annulate with testaceous and yellowish. Tegminal veins suffusedly yellowish, large yellow spots in the cells; veins on basal third dark brown, subcostal and median continuing interruptedly so almost to apex; seven short, dark brown lines at apex. Posterior lobe of head rounded and convex; eyes large; first segment of antennæ longer than second. Pronotum feebly constricted, anterior lobe widely impressed longitudinally between two smooth, raised areas; posterior lobe a little more than one-half longer than anterior lobe. Scutellum with two erect spines. Length, ♂ $5\frac{3}{4}$ mill.

Rewa (April and December; Muir).

76. P. MEDUSA, sp.nov. (Plate iv., fig.12).

Also distinguished by the tegminal picturation. Dark fuscous, eyes black. Antennæ and legs colourless; first two segments of the former, and middle and hind femora, with two or three blackish rings; middle and hind tibiæ with two rings close to base. Fore coxæ colourless, apical third blackish; femora blackish, with two colourless rings; tibiæ colourless, with three black rings; tarsi dark. Abdomen partly dark. Basal half of tegmina colourless with a close fuscous pattern; stigma tinged with red or yellow; apical half mostly blackish-grey, with contortuplicate colourless lines marking out three or four large dark eye-spots; veins mostly a little browner than the ground-colour. Wings colourless, veins pale fuscous. Head as in *P. stheno*, second segment of labium more swollen. Length $4\frac{7}{8}$-5 mill.

Rewa (Muir).

77. LUTEVA CIRCE, sp.nov. (Text fig.4).

Somewhat allied to *L. concolor* Dohrn. Testaceous; clypeus, a narrow streak along propleura and other sparse markings on thorax, fuscous; abdomen mostly fuscous. First segment of antennæ and all the femora white and pale ferruginous in wide alternate rings, a blackish ring near apex of second (apex itself white) segment of antennæ, third and fourth (except the narrowly white apex and base) blackish. Fore tibiæ fuscous, basally colourless; tarsi colourless, with two fuscous rings; middle and hind tibiæ white, narrowly at base, then a fuscous ring. Tegmina testaceous (veins partly tinged with red), sparsely spotted with greyish-fuscous. Eyes black, very prominent, extending farther

Fig.4.—*Luteva circe;* tegmen.

laterally than mesonotum at base. Vertex suddenly, and a little emarginately, narrowed behind them. Second segment of labium reaching middle of eyes. First segment of antennæ about as long as abdomen, and about one-third longer than second, which is nearly twice the third. Pronotum about one-fourth longer than mesonotum, narrowed towards base, but widening again just before it, the two together a little more than twice as long as head. Venation characteristic. Tegmina extending to about three-fourths of length of abdomen.

♂. First two segments of antennæ with long snow-white hairs in continuous whorls, last two with silvery-white pubescence; last tergite medially truncate, laterally elongately produced acutely. Genital segment strongly constricted medially.

Length 13½ mill.

Rewa (April and November; Muir).

The nymph in the last instar is very similar to the adult, but has smaller eyes, which do not extend laterally further than the base of the mesonotum does.

Fam. ANTHOCORIDÆ.

78. Anthocoris pacificus, sp.nov.

Structurally allied to *A. sylvestris* (Linn.), but different in appearance. Piceous, shining, subglabrous; second segment of antennæ and last segment of labium testaceous, rest of antennæ more or less fuscous. Tegmina cinereo-testaceous basally; apically and the cuneus fuscate. Legs piceous; apex of fore and middle femora, fore and middle tibiæ and tarsi, hind tarsi, etc., testaceous. Head about as long as wide between the eyes, which are not nearly contiguous with pronotum. Ocelli near eyes. Antennæ distinctly longer than head and pronotum together, second segment distinctly longer than width of head, first segment extending about as far as apex of head, second segment twice and one-half as long as first, nearly one-half longer than third, which is a trifle shorter than fourth. Labium reaching fore coxæ, second segment a little longer than third. Pronotum much wider posteriorly than in front; lateral margins subsinuate; subsulcate down middle but not reaching the medially emarginate hind margin. Tegmina shortly pilose. Fore femora with four or more short bristles underneath. Length, ♀ $2\frac{3}{4}$-3 mill.

Viti Levu (November; Muir's No. 28), Rewa (December; Muir), common on *Saccharum officinarum*, doubtless preying on Aphidæ.

Fam. MIRIDÆ.

NESOCRYPHA, gen. nov.

Differs from *Isometopus* Fieber, by the scutellum not nearly reaching the membrane. Ovate, lightly punctured. Vertex transverse, narrower than pronotum anteriorly, narrower than an eye. Clypeus somewhat swollen. [Antennæ destroyed.] Labium extending about as far as hind coxæ(?). Pronotum transverse, wider behind than in front, anteriorly emarginate in middle, posteriorly biemarginate, lateral margins ampliate, roundly diverging. Mesonotum biemarginate posteriorly, but not bilobate. Scutellum longer than wide, posteriorly acute, not nearly reaching to apex of clavus. Tegmina and wings extending beyond apex of abdomen, the former clothed with short, rather stiff hair, and rounded laterally, embolium wide, apical margin truncate; clavus parallel-sided. Cuneus large, extending posteriorly as far as the membrane. Tegmina declivous at base of cuneus. Fore coxæ nearly as long as their femora. Hind femora strongly incrassate, tibiæ with about ten spinelets beneath, on apical half.

79. N. CORTICICOLA, sp.nov.

Yellowish-testaceous, or pale brownish-yellow, with yellowish-brown punctures. Pronotum and mesonotum slightly, in part, suffused with yellowish-ferruginous. Ocelli and clypeus, partly, red. Ten yellowish-ferruginous specks transversely on pronotum, and the following small fuscous spots on the tegmina on each side, one at base, one at apex of clavus and corium, one at base of embolium externally and one internally, one at apex of cuneus —ten in all; also one close to posterior angle of scutellum. Eyes blackish-grey. Legs testaceous, fore tibiæ biannulate with dark fuscous; hind femora irregularly annulate medially with dark fuscous. Length, ♀ 2¾ mill.

Viti Levu (December; Muir), under bark of native fig.

80. EUCEROCORIS THETIS, sp.nov.

♂. Shining yellowish, more or less suffused with sanguineous. Eyes black. Antennæ dark fuscous, first segment and base of second dark sanguineous, base of first yellowish. Labium yellowish-testaceous, apex black. Tegmina basally and laterally more or less fuscous, cuneus and membranal veins deep sanguineous. Legs not annulate, tarsi blackish. Apical half of abdomen polished black. Head nearly as wide as hind margin of pronotum, sulculate down the middle. Labium extending just beyond middle coxæ. First segment of antennæ naked, second and third elongately pilose, fourth shortly pilose, second segment twice as long as first, one-fifth longer than third, thrice as long as fourth. Legs not, unless shortly, pilose.

Var. more or less fuscously suffused.

Length 7-8½ mill.

Rewa (March-April; Muir's No.93).

81. HYALOSCYTUS ELEGANTULUS Reuter, 1904, Öfv. Finsk. Förh. xlvii. No.5, p.2, fig.1.

Var. FILICICOLA, nov.

Differs from the typical form by at least the basal half of the first segment of the antennæ being ochraceous, usually the first two segments being so. The colouring of the body is somewhat variable, being often suffused with red; the pronotum may be immaculate, or the postero-lateral angles may be more or less widely fuscous. In all the specimens before me, the head is more distinctly exserted than in Reuter's figure, but I presume that this extra part is usually withdrawn into the pronotum.

Viti Levu (November; Muir's No.5); Rewa (April; Muir); Navua (February; Muir); beaten from a bracken-like fern.

82. CYRTOPELTIS(?) NICOTIANÆ, sp.nov.

Yellowish-green; eyes, clypeus, middle third of first segment, base and apex of second segment of antennæ, apical segment of labium, etc., black. Labium, legs, etc., greenish-testaceous. Tegmina pale green, with rather sparse blackish hairs; a spot at middle of apical margin of corium, apical angle of cuneus, membranal veins, etc., brownish-black. Head nearly contiguous with pronotum, collar short. First segment of antennæ extending beyond apical margin of head. Length 3 mill.

Lautoka, on Tobacco-leaves (Knowles, No.350; November, 1907).

A closely allied American form, *Dicyphus minimus* Uhler, is known as a Tobacco pest.

83. TICHORHINUS VITIENSIS, sp.nov.

Ivory-white, tinged beneath with yellowish or brownish, furnished with whitish pubescence on tegmina, etc. Vertex partly suffused, rather obscurely, with reddish. First segment of antennæ, base of second, clypeus, anterior and lateral margins of pronotum (broadly), posterior angle of scutellum, basal half of corium, base and apex (broadly) of clavus, apical half of cuneus, membranal veins, etc., sanguineous. Third and fourth segments of antennæ whitish. Wings hyaline, veins white, apical half of femora pale yellowish-brown. The hairs on the head, antennæ, etc., dark. Antennæ standing out well in front of head, second segment one-half longer than third and fourth together. Length 4 mill.

Rewa (March; Muir).

ANTHROPOPHAGIOTES, gen.nov.

Belongs to the tribe Pilophorini. Head a little concave basally, thence convexly declivous, triangular. First segment of antennæ extending a little beyond apex of head; with the second incrassate, the latter flattened, third and fourth slender. Pronotum with a well marked collar; the suture and the rest of pronotum deeply impressed; pronotum also deeply impressed medially a little behind this, and rather feebly so about the middle, percurrently; lateral margins obtuse, concavely divergent posteriorwards; hind margin roundly emarginate. Posterior lobe of scutellum triangularly impressed. First cell of membrane very small, second elongate, posteriorly acute-angled, extending nearly to apex of tegmen. Very obscurely punctured, covered with very short, whitish pubescence. Legs normal.

84. A. THANATOPHARUS, sp.nov.

Dull black; third and fourth segments of antennæ pale fuscous. Labium, apex of tibiæ, the tarsi, etc. pale brownish-yellow. Membrane and wings smoky, veins fuscous. Antennæ with second segment nearly twice and one-half as long as first, second a little wider maximumly than first, nearly six times as long as wide, narrowing apically; [third and fourth segments shrivelled, bristly]. Labium extending beyond the third coxæ, first segment beyond base of head. Pronotum basally about one-third wider than apically. Length 4¼ mill.

Rewa (Muir).

85. CYRTORHINUS MUNDULUS (Breddin).

Periscopus mundulus Breddin, Deutsch. Ent. Zeit. 1896, 106; Van Deventer, 1906, Handb Suikerriet-Cultuur op Java, ii. 167.

Viti Levu (Muir's Nos.49 and 61, parasitised by No.35), common on *Saccharum officinarum.*

The ova are inserted in the midrib of *Saccharum officinarum*, the surface being whitened by the local decay. They are heavily parasitised.

The ultimate nymph is blood-red; antennæ and legs testaceous, more or less suffused with sanguineous.

NESOSYLPHAS, gen.nov.

Has much the appearance of a large, smooth *Disphinctus*, but is a true Capsine, allied to *Hyalopeplus* Stal, and *Malacopeplus* Kirkaldy. Head a little wider than an eye, transverse between eyes, sulcate medially, horizontal in front of eyes, which are a little emarginate basally, not touching pronotum, their intero-lateral margins diverging a little towards apical margin of vertex. Antennæ articulated contiguous to eyes at apex of vertex; first segment one-half longer than vertex, somewhat incrassate and curved; second about thrice as long as first; third about as long as first, thinner than second; fourth less than half third, very thin. Labium extending to hind coxæ. Head and eyes much wider than anterior margin of pronotum. Pronotum with a strong collar, which is about as long as width of second segment of antennæ towards apex of the latter; shortly behind this the pronotum is strongly constricted, the lateral margins behind this rounded and strongly diverging. This anterior lobe is about twice as long as the collar and very little wider;* posterior lobe about twice as long as collar and anterior lobe together; postero-lateral angles subacute and rather prominent, extending distinctly beyond base of tegmina laterally. Posterior lobe also roundedly raised. Head and anterior lobe of pronotum smooth and shining; posterior lobe minutely and very feebly rugose; scutellum smooth, dull, disk flat. Odoriferous orifices subauriculate. Tegmina not punctured, subhyaline, venation as in *Hyalopeplus*. Abdomen smooth and shining.

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* I use the terms "long" and "wide" with regard to the longitudinal axis of the insect.

86. N. pacifica, sp.nov.

Brownish-yellow or yellowish-brown. Eyes, apical third of second segment of antennæ, apical three-fourths of third, and all the fourth, a median spot on anterior margin of scutellum (the anterior part showing through the pronotum), postero-lateral angles of pronotum, black or blackish. First segment of antennæ and basal two-thirds of second dark ferruginous-red. A suffused spot near apical margin, in the middle, of corium, basal three-fourths of radial vein, commissure, membranal veins, etc., dark fuscous or blackish-grey; cuneus dark red. Femora speckled with dark brown. Tergites subsanguineous. Length $5\frac{1}{2}$ mill.

Rewa (February; Muir).

87. Notostira pacifica, sp.nov.

Apparently allied to *N. doddi* (Distant), but the second segment of the antennæ is much longer than the hind tibiæ. Head with a sanguineous stripe down middle; pronotum trivittate with sanguineous, the middle vitta being divided by a pale line, vitta and line being continued to posterior angle of scutellum. Tegmina lined with sanguineous. (These sanguineous lines fade to greenish-fuscous or pale fuscous). Colour otherwise apparently as in *N. doddi*. Second segment of antennæ thrice as long as first and one-seventh longer than third. Labium reaching to middle coxæ. First segment of hind tarsi longer than third. Length 4-5 mill.

Viti Levu (March; Muir); Ba (January; Muir); Rewa (Muir).

Nesodaphne, gen.nov.

Superficially like *Phytocoris*, but the antennæ are nude, or nearly so. Differs from all the Capsini known to me by the tufts of hair on the pronotum and scutellum. Elongate; head elongate, subdeclivous, marginate behind, eyes widely diverging towards apex. First segment of antennæ extending well in front of apex of head, rather longer than third, about three-fourths of second; fourth very short. Eyes extending far beyond anterior margin of pronotum laterally; posterior margin of pronotum more than twice as wide as anterior margin; punctured and covered with long tufts of hair. Scutellum with two or three tufts. Labium extending to base of middle coxæ. Tegmina explanate laterally.

88. N. KNOWLESI, sp.nov.

Head, sterna, etc., testaceous. Antennæ dark fuscous; basal half and apex of first; base, a middle ring, and apex of second; apices of third and fourth; whitish-testaceous. Pronotum pale purplish-brown, two subanterior spots, collar, and posterior margin (very narrowly) pale. Scutellum, clavus and interior third of corium, dark purplish-brown; posterior angle of scutellum greenish-yellow. Rest of corium dark fuliginous, spotted with hyaline. Sternites yellowish-green. Legs multiannulate with fuscous. Length 5 mill.

Lautoka (Knowles, No.349), on *Artocarpus incisa* and Tobacco-leaves.

I hope to ampliate this diagnosis later and figure the interesting Mirid.

Fam. CICADIDÆ.

89. CYCLOCHILA AUSTRALASIÆ (Donovan), Goding & Froggatt, 1904, Proc. Linn. Soc. N. S. Wales, xxix. 569.

Recorded by me (1907, Bull. Ent. Haw. Sugar Plant. Assoc. iii. 17), but Mr. Froggatt tells me that he thinks that the individuals were accidental visitors, or introduced into Fiji, as this species has a very limited range in Australia.

90. MACROTRISTRIA ANGULARIS (Germar).

Cicada angularis Goding & Froggatt, 1904, *op. cit.* 580.

The same remarks apply to this as to the former.

91. CICADA KURUDUADUA Distant, Trans. Ent. Soc. London, 1881, 645; Waterhouse, 1882, Aid Ident. Ins. i. Pl. C.

"Fiji."

92. C. KNOWLESI Distant, 1907, Ann. Mag. Nat. Hist.(7) xx. 413.

"Fiji."

93. COSMOPSALTRIA VITIENSIS (Distant).

Sawda(?) *vitiensis* Distant, 1906, Entom. xxxix. 12.

"Fiji."

94. DICEROPYGA DISTANS (Walker), Distant, 1906, Cat. Hom. i. 64.
Rewa (Muir); Ovalau (Walker).

95. D. STUARTI (Distant).
Cosmopsaltria stuarti Distant, Proc. Zool. Soc. London, 1882, 125, Pl.vii. f.2; Kirkaldy, 1907, *op. cit.* iii. 17.
Rewa (March; Muir).

96. CICADETTA TYMPANISTRIA Kirkaldy, 1907, *op. cit.* 18, Pl.i. figs. 1-3.
Rewa (Muir).

Fam. **CERCOPIDÆ.**

97. NESAPHRESTES DREPTIAS Kirkaldy, 1907, *op. cit.* 21.
Rewa (Muir), on a native tree in the bush.

98. N. PTYSMATOPHILUS Kirkaldy, *l.c.*
Rewa (Muir).

99. NESAPHROGENEIA VITIENSIS Kirkaldy, 1907, *op. cit.* 20 and 22.
Rewa (Muir).

Fam **TETTIGONIIDÆ.**

100. EURINOSCOPUS HAMADRYAS Kirkaldy, 1907, *op. cit.* iii. 39.
Rewa (Muir).

101. HYBRASIL BRANI Kirkaldy, 1907, *l.c.* Pl.ii. f.18.
Rewa (Muir).

102. DRYADOMORPHA LOTOPHAGORUM Kirkaldy, 1907, *l.c.*
Rewa (Muir).

103. XESTOCEPHALUS PALLIDICEPS Kirkaldy, 1907, *op. cit.* 51 (with vars. CONTORTUPLICATA and DECEMNOTATA).
Rewa (Muir).

104. X. PURPURASCENS Kirkaldy, *op. cit.* 52.
Rewa (Muir).

105 X. VITIENSIS Kirkaldy, *op. cit.* 51.
Rewa (Muir).

106. NEPHOTETTIX PLEBEIUS Kirkaldy, 1906, *op. cit.* i. 331; 1907, *op. cit.* iii. 54, Pl.ii. figs. 3-4.
Rewa (Muir).

107. Deltocephalus histrionicus Kirkaldy, 1907, *op. cit.* iii. 57.
Viti Levu, arboreal (Muir).

108. Conosanus hospes Kirkaldy.
Phrynomorphus hospes (Kirkaldy) Kirkaldy, 1907, *op. cit.* iii. 60, Pl.i. figs,13-17 (nymph on f.13).
Lowlands of Fiji. Also Eastern Australia and the Hawaiian Isles, on *Cynodon dactylon*, etc. The metamorphoses have been partially described and figured (*l.c.*).

109. Allygus lotophagorum Kirkaldy, 1907, *op. cit.* iii. 62.
Rewa and Ba (Muir).

110. Limotettix filicicola Kirkaldy, 1907, *op. cit.* iii. 63.
Rewa (Muir), on Tree-ferns.

111. Nesosteles hebe Kirkaldy, 1906, *op. cit.* i. 343, Pl.xxxii. fig.8.
Rewa and Navua (Muir); Suva, on leaves of *Saccharum officinarum* (Knowles, No.157). Also Queensland and the Hawaiian Isles.

112. Cicadula vitiensis Kirkaldy, 1906, *op. cit.* i.; 1907, iii. p.68.
Rewa (Muir).

113. C. hyadas Kirkaldy, 1907, *op. cit.* iii. *l.c.*
Rewa (Muir).

114. C. euryphaessa Kirkaldy, 1907, *op. cit.* 68.
Rewa and Navua (Muir), on *Saccharum officinarum*, and on a native tree.

115. Erythroneura doris Kirkaldy, 1907, *op. cit.* 69.
Rewa (Muir).

116. E. lalage Kirkaldy, 1907, *op. cit.* 70.
Rewa (Muir).

117. E. leucothoe Kirkaldy, 1907, *l.c.*
Navua (Muir).

118. E. rewana Kirkaldy, 1907, *op. cit.* 71.
Rewa (Muir).

119. Tharra kalypso Kirkaldy, 1907, *op. cit.* 76.
Rewa (Muir).

120. T. ogygia Kirkaldy, 1907, *l.c.*
Rewa (Muir).

121. T. kassiphone Kirkaldy, 1907, *op. cit.* 75 and 77.
Rewa (Muir).

122. T. nausikaa Kirkaldy, 1907, *l.c.*
Rewa and Navua (Muir).

123. T. sp.(?) Kirkaldy, 1907, *op. cit.* 78, Pl.ii. figs.14-15 (nymph).
Rewa (Muir).

124. Muirella oxyomma Kirkaldy, 1907, *op. cit.* iii. 74 and 79, Pl.ii. figs.21-22.
Rewa and Navua (Muir). Nymphs figured, Pl.i. figs.10-11.

125. Tettigonia albida Walker, Kirkaldy, 1906, *op. cit.* 1.
Rewa (Muir). All over the tropics of the Old World.

Fam. MEMBRACIDÆ.

Membracidæ have not yet been recorded from Fiji.

Fam. POEKILLOPTERIDÆ.

126. Vanua vitiensis Kirkaldy, 1906, i. 416, Pl.xxvii. figs.7-9 (nymphs on Pl.27, figs.6-7); 1907, iii. 97.
Rewa (Muir & Koebele).

127. Plestia marginata (Montrouzier) Melichar, 1898, Ann. Mus. Wien, xiii. 294, Pl.xii. fig.17; and Pl. xiv. fig.1.
Rewa (Muir & Koebele). Also from "Australia" and Lifu.

128. Euricania tristicula (Stal) Melichar, *op. cit.* 259 and 265, Pl.xi. fig.7; and Pl.xiii. fig.14.
Rewa (Koebele & Muir); Ovalau (Melichar).

Fam. ISSIDÆ.

129. Tylana intrusa Melichar.
Ovalau (Melichar).

130. T. ORIENTALIS Melichar.
Ovalau (Melichar).

131. O. PICEUS (Walker) Melichar.
Viti Levu. Also from Papua and Aru.

Fam. FULGORIDÆ.

132. OLIARUS TASMANI Kirkaldy, 1907, *op. cit.* iii. 108.
Rewa (Muir).

133. O. LUBRA Kirkaldy, var. VITIENSIS Kirkaldy, 1907, *op. cit.* 109, Pl. viii. figs. 7-9.
Rewa, Ba and Navua (Muir), on *Artocarpus incisa.* The type-form is from Australia.

134. O. SACCHARICOLA Kirkaldy, 1907, *l.c.*
Rewa (Muir), on *Saccharum officinarum.*

135. URVILLEA MELANESICA Kirkaldy, 1907, *l.c.*
Rewa (Muir).

136. NESOCHARIS KALYPSO Kirkaldy, 1907, *op. cit.* iii. text f.1.
Rewa (Muir).

137. MYNDUS (?) VITIENSIS Kirkaldy, 1907, *op. cit.* iii.
Navua (Muir).

138. LEIRIOESSA VITIENSIS Kirkaldy, 1907, *op. cit.* 112.
Viti Levu (Muir), on a native tree in the bush.

139. DYSTHEATIAS BEECHEYI (and var. FUSCATA) Kirkaldy, 1907, *op. cit.* 113.
Rewa (Muir).

140. QUIROSIA VITIENSIS Kirkaldy, 1907, *op. cit.* 115.
Rewa (Muir).

141. NESOCHLAMYS VITIENSIS Kirkaldy, 1907, *op. cit.* 115.
Rewa and Navua (Muir).

142. PHENELIA BICUNEATA Kirkaldy, 1907, *op. cit.* 117.
Rewa (Muir).

143. P. TRISTIS Kirkaldy, *l.c.*
Rewa (Muir).

144. CALLINESIA PULCHRA Kirkaldy, *op. cit.* 118, Pl.ix. fig.17.
Rewa (Muir).

145. C. ORNATA Kirkaldy, *l.c.*
Rewa (Muir).

146. C. PUSILLA Kirkaldy, *op. cit.* 118, 119.
Rewa (Muir).

147. C. VENUSTA Kirkaldy, *op. cit.* 118, 119.
Rewa (Muir).

148. CALLICHLAMYS MUIRI Kirkaldy, *op. cit.* 120, Pl.ix. figs.20-1.
Rewa (Muir).

149. C. UNDULATA Kirkaldy, *l.c.*
Rewa (Muir).

Fam. **ASIRACIDÆ.**

150. UGYOPS VITIENSIS Kirkaldy, *op. cit.* 127.
Viti Levu, arboreal (Muir).

151. MELANESIA PACIFICA (and var. STRIGATA) Kirkaldy, *op. cit.* 129, Pl.xvii. figs.13, 14.
Rewa and Navua, arboreal (Muir).

152. PEREGRINUS MAIDIS (Ashmead) Kirkaldy, 1907, *op. cit.* 132, Pl.xii. figs. 7-8; and Pl.x. fig.14.
Rewa (Koebele & Muir); Lautoka (Knowles, No.347), on *Zea mays* and grass; widely disseminated.

153. DICRANOTROPIS ANDERIDA Kirkaldy, *op. cit.* 133.
Rewa, Ba and Navua, on grass. Also from Australia.

154. D. KOEBELEI Kirkaldy, 1906, *op. cit.* i. 408; and 1907, iii. 133-134, Pl.vii. figs.9-10; Pl.xvii. figs.8-9.
Rewa (Koebele & Muir).

155. PERKINSIELLA PSEUDOMAIDIS Kirkaldy, 1906, i. 408; 1907, iii. 136, Pl.xii. figs.1-3.
Viti Levu (Muir), on *Saccharum officinarum*. Also from Australia.

156. P. VITIENSIS Kirkaldy, 1906, i. 405-406; 1907, iii. 137, Pl.xii. figs.9-10.

Levuka (Koebele).

157. STENOCRANUS PACIFICUS Kirkaldy, 1907, *op. cit.* 139, Pl.xv. figs.4-5.

Rewa, Navua and Ba (Muir), on *Saccharum officinarum* and grass.

158. SARDIA PLUTO (Kirkaldy).

Hadeodelphax pluto Kirkaldy, 1906, i. 410; 1907, iii. 140, Pl.xvii. fig.12 (with var. *pallidior*).

Rewa, Navua and Ba (Muir & Koebele). Also from Australia and Ceylon.

159. MEGAMELUS PROSERPINA Kirkaldy, 1907, *op. cit.* 147, Pl.x. figs.5-7; xii. figs.19-21.

Suva (Muir).

160. DELPHAX DRYOPE Kirkaldy, 1907, *op. cit.* 152, Pl.xvi. figs. 12-13.

Rewa (Muir). Also Queensland.

161. D. MATANITU Kirkaldy, 1907, *op. cit.* 155, Pl.xvi. figs 4-5; Pl.xviii. fig.15.

162. D. DISONYMOS Kirkaldy, 1907, *op. cit.* 156, Pl.xviii fig.4.

Rewa and Suva (Muir).

163. D. OCHRIAS Kirkaldy, 1907, *op. cit.* 157.

Rewa (Muir). Also Australia.

164. D. PUELLA (Van Duzee) Kirkaldy, 1907, *op. cit.* 160, Pl.xv. figs.1-3.

Suva (Muir). Also Australia and North America.

165. D. EUPOMPE Kirkaldy, 1907, *op. cit.* 162, Pl.x. figs.3-4; xii. figs.16-18.

Fam. **DERBIDÆ.**

166. NISIA ATROVENOSA (Lethierry) Kirkaldy, 1907, *op. cit.* 165.

Rewa, Navua and Ba (Muir & Koebele). Also Australia, the Orient, the Ethiopian Region, etc.

167. SUVA KOEBELEI Kirkaldy, 1906, i. 428; 1907, iii. 165, Pl.ix. figs.14-16.
Suva (Koebele).

168. PHACIOCEPHALUS MILTODIAS Kirkaldy, 1907, *op. cit.* 167-8, Pl.xix. fig.20.
Rewa, arboreal (Muir).

169. P. MINYRIAS Kirkaldy, *op. cit.* 167, 168.
Rewa (Muir).

170. P. NESODREPTIAS Kirkaldy, *op. cit.* 167.
Rewa (Muir).

171. P. NESOGONIAS Kirkaldy, *l.c.*
Rewa (Muir).

172. P. PULLATUS Kirkaldy, *op. cit.* 167, 168.
Rewa, arboreal (Muir).

173. P. VITIENSIS Kirkaldy, 1906, i. 428; 1907, iii. Pl.xix.figs.12-14.
Suva, arboreal (Koebele)

174. RHOTANA HALOSYDNE Kirkaldy, *op. cit.* iii. 169.
Rewa (Muir).

175. LEVU VITIENSIS Kirkaldy, 1906, i. 434.
Suva and Rewa (Muir & Koebele).

176. NIPHADODITE INSULICOLA Kirkaldy, 1907, iii. 170.
Viti Levu, arboreal (Muir).

177. PYRRHONEURA SACCHARICIDA Kirkaldy, 1906, i. 434; 1907, iii. 170, fig., and Pl.xx. figs.6-7.
Rarawai and Rewa, on *Saccharum officinarum*, and native trees in the bush (Koebele & Muir); Lautoka, on leaves of *Artocarpus incisa*, and one on leaves of Coconut almost under the Breadfruit (Knowles, No.353).

178. P. CITHARISTA Kirkaldy, 1907, *op. cit.* 171, Pl.xx. figs.1-2.
Viti Levu, arboreal (Muir).

179. P. VITIENSIS Kirkaldy, *l.c.*
Rewa (Muir).

180. NESOCORE FIDICINA Kirkaldy, 1907, *op. cit.* 172.
Rewa (Muir).

The nymph occurs under the bark of old trees, and is figured on Pl.xviii., figs.9-10.

181. NESONIPHAS INSIGNISSIMA Kirkaldy, 1907, *op. cit.* 175, Pl.xix. figs.10, 11.
Rewa (Muir), on *Zingiber Zerumbet.*

182. LYRICEN IMTHURNI Kirkaldy, 1907, iii. 164 and 172, Pl.xix. figs.1-3; xx. figs.3-5.
Rewa (Muir).

183. MUIRIA STRIDULA Kirkaldy, 1907, *op. cit.* 175 and 177, Pl. xix. figs.4-5; xx. figs.10-13.
Rewa (Muir), on a palm.

184. SIKAIANA NESIOPE Kirkaldy, 1907, *op. cit.* 178, Pl.xviii.fig.13.
Rewa (Muir).

185. NESOPHANTASMA VITIENSIS Kirkaldy.
Phantasmatocera vitiensis Kirkaldy, 1906, i. 431, Pl.xxviii. figs.1-3.
Viti Levu (Koebele).

186. SWEZEYIA LYRICEN Kirkaldy, 1906, i. 430; 1907, iii. Pl.xix. figs.15-19.

Fam. CHERMIDÆ.

187. TRIOZA VITIENSIS Kirkaldy, 1907, P. Hawaiian Ent. Soc. i.
Rewa (Muir); Lautoka, on leaves of *Artocarpus incisa* (Knowles, No.348)

188. T. VANUÆ Kirkaldy, 1907, *op. cit.*
Rewa (Muir).

NESIOPE, gen.nov.

The form of the tegmen and the venation seem characteristic. Vertex flat, wide, slightly declivous, lateral margins of vertex very slightly diverging towards apex. Eyes large. Pronotum and dorsulum short, mesonotum rather large. Tegmina elongate.

189. N. ORNATA, sp.nov. (Text fig.5).

Testaceous, eyes and ocelli red. Apices of antennal segments dark fuscous. A central pale line down dorsulum and mesonotum, very narrowly bordered with black, sides of mesonotum broadly ferruginous, with two pale, curved, very narrow lines. Tegmina hyaline, with brownish spots as shown in the figure.

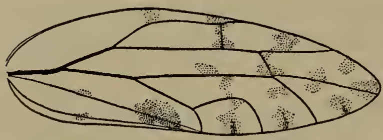

Fig.5.—*Nesiope ornata;* tegmen.

Length 4 mill.

"Fiji" (my collection).

Although my material is very poor, I have briefly diagnosed this pretty little species, which I think can be thus identified. Mr. Muir has also captured two specimens, but in very bad condition (Rewa).

Fam. APHIDÆ.

I am not aware of any Fijian Aphid-records.

Fam. ALEYRODIDÆ.

190. ALEYRODICUS HOLMESII (Maskell).

Aleurodes holmesii Maskell, 1896, Trans. N. Zeal. Inst. xxviii. 435, Pl.xxxi. pt.2.

"Fiji," on *Psidium*.

191. ALEYRODES BERGII (Signoret) Kirkaldy, 1907, Bull. Agr Hawaii Ent. ii. 48 (bibl.).

Rewa; Ovalau, Levuka; also Java and Mauritius. On *Saccharum officinarum*.

192. A. CALOPHYLLI Kotinsky, 1907, Bull. Agr. Hawaii Ent. ii. 98, Pl.i. fig.5.

Ovalau, Levuka, on *Calophyllum inophyllum*.

193. A COMATA (Maskell) Kirkaldy, 1907, *op. cit.* 150 (bibl.).

"Fiji."

194. A. FIJIENSIS Kotinsky, 1907, *op. cit.* 100, Pl.i. fig.6.

Rewa (Muir).

195. A. LEAKII (Peal) Kirkaldy, *op. cit.* 59 (bibl.).
Suva (Muir). Also India, on *Indigofera tinctoria* and *I. arreca.*

196. A. SACCHARI (Maskell) Kirkaldy, *op. cit.* 69 (bibl.)
"Fiji," on *Saccharum officinarum* and grass.

Fam. COCCIDÆ.

(For full references and food-plants, *cf.* Fernald, 1903, Bull. Massachusetts Exp. Sta. 88.)

197. ICERYA PURCHASI (Maskell) Fernald, 25.

198. ANTECEROCOCCUS BRYOIDES (Maskell) Fernald, 58.

199. TRECHOCORYS CALCEOLARIÆ (Maskell).
Pseudococcus calceolariæ Fernald, 98.

200. COCCUS LONGULUS (Douglas) Fernald, 171.

201. AULACASPIS ROSÆ (Bouché) Fernald, 236.

202. ASPIDIOTUS VITIENSIS (Maskell) Fernald, 281.

203. CHRYSOMPHALUS AURANTII (Maskell) Fernald, 287.

204. C. DICTYOSPERMI var. PINNULIFERA (Maskell) Fernald 290.

205. LEPIDOSAPHES BECKII (Newman) Fernald, 305.

EXPLANATION OF PLATE IV.

Fig. 1.—*Orthoea vincta;* nymph.
Fig. 2.— ,, ,, brachypterous adult.
Fig. 3.— ,, ,, tegmen of macropterous adult.
Fig. 4.—*Brachylybas variegatus.*
Fig. 5.— ,, ,, the same in profile.
Fig. 6.— ,, ,, odoriferous orifice.
Fig. 7.—*Ontiscus vitiensis.*
Fig. 8.—*Nesocypselas dicysta.*
Fig. 9.— ,, ,, the same in profile.
Fig. 10.—*Holophygdon melanesica.*
Fig. 11.— ,, ,, the same in profile.
Fig. 12.—*Ploiariodes medusa;* tegmen.

REVISION OF THE GENUS *SEIROTRANA*, TOGETHER WITH DESCRIPTIONS OF NEW SPECIES OF OTHER AUSTRALIAN COLEOPTERA.

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

Seirotrana Pascoe.

Journ. of Ent. ii. 1866, p.483.

TENEBRIONIDÆ.

In 1866 Pascoe formed the genus *Seirotrana* for the reception of *Adelium catenulatum* Boisd., describing its distinguishing characters in fifteen words, " Characteres ut in *Adelio;* sed elytra prothoraci arcte applicata. Antennæ articulo tertio duobus sequentibus breviore."

It is a pity that Pascoe did not add Blessig's excellent characters for differentiating this genus from *Adelium*, since the latter's third class of Adelia, consisting of *A. parallelum*, *A. elongatum* and *A. catenulatum* are specially described as having " the abdominal process* quite margined, *abruptly truncate*"; and he adds, " they are of elongated form, the intervals on the elytra are alternately shallow and elevated." Another character, which though not common to all the species, is true of thirteen out of the twenty species herein specified, is the crenulated sides of the prothorax.

A better character for differentiating *Seirotrana* from *Adelium* and from *Coripera* is the form of the epipleura, which in *Coripera* is nearly vertical, in *Adelium* rounded or much more acutely joined to the elytra, in *Seirotrana* it is narrower and intermediate,

* I have already spoken of this in my revision of Adelium as the " intercoxal process."

in its application to the elytra between the two former genera, the epipleural fold being subobsolete.*

The interrupted costæ on the elytra cannot be taken as a distinctive character, since it occurs in many species of *Adelium*; while in five species of *Seirotrana*, namely, *S. mastersi*, *S. strigipennis*, *S. crenicollis*, *S. denticollis*, and *S. uniformis* it is replaced by a quite different sculpture.

I have seen the types of all the described species, except of *S. catenulata* Boisd., *S. elongata* Erichs., *S. parallela* Germ., *S. congesta* Pasc., *S. integricollis* Haag-Rut., and *S. geniculata* Haag-Rut., but I have little doubt of my identification of the above.

S. catenulata Boisd., is the commonest species in New South Wales, and is found in all our collections. I have taken it plentifully near Sydney, Newcastle, and in the Illawarra district. Its chief variation seems to lie, as with other crenulated-sided forms, in the greater or less dentation or crenulation; and I am inclined to think, from my observation of the less crenulate forms, (*e.g.*, *S. vicina* Carter, *S. proxima* Pasc., that the female has the more strongly marked incisions on the sides of the prothorax.

S. elongata Erichs., *S. integricollis* Haag-Rut., and *S. paralella* Germ., are allied forms that may be confounded; but are, I think, readily distinguished by the following characters—that is if my identification be correct.

S. integricollis Haag-Rut.—(1) Colour shining dark bronze. (2) Marginal border of pronotum thick. (3) Anterior angles moderately advanced. (4) Elytral costæ fairly distinct. (5) Wider form.

S. elongata Erichs.—(1) Colour black-bronze. (2) Marginal border fine. (3) Anterior angles less advanced. (4) Elytral costæ subobsolete. (5) Form intermediate.

S. parallela Germ.—(1) Colour black-bronze. (2) Marginal border fine. (3) Anterior angles prominent. (4) Elytral costæ elevated. (5) Narrower form.

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* See Pascoe's note, Ann. Mag. Nat. Hist. 1869, pp. 43, 44.

My specimens of *S. integricollis* come, one from Wee Waa, New South Wales, and two from Gayndah given me by Mr. Masters (the latter is the locality given by Haag-Rutenberg).

My two specimens of *S. elongata* were taken by myself near Launceston, Tas. Erichson's species is Tasmanian.

I have a number of specimens of *S. parallela* from Adelaide (Germar's locality); also from Bullarook, Grampians and Apollo Bay, Vic., a district also noted by Blessig for this species.

S. geniculata Haag-Rut.—Two specimens, taken by myself on the hills near Wollongong, but it is known from other parts of New South Wales, a specimen in the Macleay Museum being labelled "Blue Mountains." Though described as black, fresh specimens are really a dark bronze colour, subject to some variation; one of my specimens is distinctly bronze.

S. femoralis Macl.—The type from Gayndah in the Australian Museum is unique. It is very distinct from *S. geniculata* Haag-Rut., in its small size and light colour.

S. proxima Pasc.—Of the two specimens in the British Museum the type has the sides of the prothorax more dentate than the other specimen. I have specimens from Monaro, N.S.W., and from Victoria.

S. congesta Pasc.(*Adelium congestum* Pasc.) = *S. parallela* Germ. —From the description I had little doubt that this *was* a Seirotrana. By some chance I neglected to note the type in the British Museum, but in answer to my enquiries Mr. C. J. Gahan has courteously examined the type for me and writes, "*A. congestum* Pasc., is clearly identical with *A. parallelum* Germ."

S. repanda Pasc.(*Adelium repandum* Pasc.) = *S. dispar* Blackb. —I have closely compared the type of *S. dispar*, kindly lent me by Mr. C. French, with cotypes of *A. repandum* from Gayndah, given me by Mr. Masters, who sent the type to Pascoe, and find them identical. I must express my doubt as to the correctness of the locality given by Mr. Blackburn for this species (viz., Victoria). The species has a wide range from Inverell, N.S.W., to Gayndah; but from a large collection of Seirotrana I have seen nothing like it from Victoria. The type of *S. dispar* has no locality-label, and it is just possible that Mr. French may have mistaken the locality.

It is strange that Pascoe should have described species of his own genus in the same papers as those in which he described both *A. congestum* and *A. repandum*, without noticing the very distinctions by which he separates that genus from *Adelium*. Thus under *A. repandum* he notes "in the closeness of its prothorax to the elytra, and also in habit, slightly approaching the genus *Coripera*." Mr. Blackburn may well be excused from not suspecting that Pascoe would not recognise his own genus.

S. major Blackb.—Two specimens in the Macleay Museum bear this name, from Tamworth. I have also one specimen from Cape Hawke district which corresponds to these, and to the description (except in colour). The description gives "ænea," while in the note following, Mr. Blackburn says "of a bright (almost nitid) brassy colour." The three specimens mentioned above are shiny bronze, but scarcely "brassy," and are certainly darker than *S. mastersi* Macl. It is probable that the type was unusually bright. Mr. Blackburn has been misled by Pascoe's description of *S. mastersi* in supposing that *S. major* can be differentiated from that species by its crenulate prothorax alone. (See notes on *S. mastersi* Pasc., *infra*).

A strong character in the species I take to be *S. major* is the remarkably coarse and close puncturation of the pro- and metasternum; while the fore femora are covered with smaller punctures, and the epipleuræ are coarsely but more distantly punctured. From the specimens before me the most apparent distinctions between *S. major* and *S. mastersi* are as follows :—

S. major Blackb.—Colour shining dark coppery bronze (varying to lighter). Prothorax: disc strigose, coarsely punctate, *without* larger punctures; anterior angles more acute. Sternum densely and coarsely punctate.

S. mastersi Pasc.—Colour brilliant coppery-bronze. Prothorax: disc finely punctate, *with* larger scattered punctures; anterior angles less acute. Sternum finely punctate.

S. mastersi Pasc.—The description of this species is misleading from faults both of omission as of commission. I have three specimens from Queensland which I have compared with the type, and which correspond to the Macleay Museum specimens.

The very brief description (Ann. Mag. Nat. Hist. 1870) gives the margin of prothorax as entire, "marginibus integris," and in the note following "the margins with a raised linear border." This border is certainly not interrupted, but is distinctly wavy, and in some cases sufficiently so to be called "toothed." There is no material difference in this respect between *S. major* and *S. mastersi*; in both species the crenulation is faint in the anterior portion, but more distinct near the base. The most noticeable omission by Pascoe is the failure to note the small shining pustules placed (as in *S. major* Blackb.) on the elytral interstices between the rows of punctures. These are smaller and less obvious than in *S. major*, but are sufficiently distinct. Thus it will appear that the only evident characters by which we can distinguish these two species are those tabulated above. These differences are, however, very considerable, and especially in the widely different puncturation of their respective pro- and metasterna, *S. mastersi* having a much finer and less pronounced sculpture. The puncturation of their epipleuræ is also very different. In *S. mastersi* the punctures are confined to the lower part, *i.e.*, nearest the abdomen, leaving a smooth surface nearest the elytra; in *S. major* the punctures are irregularly scattered over the whole epipleuræ, with an irregular line of them immediately next the elytral borders, while the border is itself more strongly marked and reflexed at the humeral angles in *S. mastersi* than in *S. major*.

S. strigipennis Bates.—I have a cotype from the British Museum labelled "Adelaide R."

S. punctifera Macl.—Two cotypes from Gayndah, obtained through the courtesy of Mr. Etheridge and of Mr. Rainbow of the Australian Museum.

S. nasodermoides Pasc.—Two cotypes from Wide Bay, also from the Australian Museum.

The total number of species thus known to me is twenty, and these can be readily divided into two groups.

i. Those having the sides of prothorax crenulate or dentate, and with the disc of pronotum more or less vermiculate-punctate without larger punctures.

ii. Those having the sides of prothorax entire, and the disc of pronotum with larger punctures irregularly placed among smaller.

To this arrangement *S. mastersi* Pasc., is a solitary exception, since by its crenulate-sided prothorax it belongs to group i.; while in its having larger punctures on its pronotum it should be in group ii. Its close affinity to *S. major*, noticed above, makes it more naturally belong to group i.

The following tabulation will be of assistance in determining the species.

Group i. Sides of prothorax crenulate or dentate.

A_1. Disc of pronotum more or less vermiculate-punctate, without larger punctures (except in *S. mastersi* Pasc.).

B_1. Elytra with alternate intervals catenulate.

C_1. Size large, more than 15 mm. long.

1. D_1. Pronotum strigose without larger punctures...*major* Blackb.

2. D_2. Pronotum punctulate with larger punctures ...*mastersi* Pasc.

C_2. Size smaller, less than 15 mm.

3. E_1. Colour black, legs concolorous................*catenulata* Boisd.

E_2. Femora yellow at apex.

4. F_1. colour black, or deep bronze............*geniculata* Haag-Rut.

5. F_2. Colour bright copper, size much smaller....*femoralis* Macl.

G. Colour dark bronze, subnitid.

6. H_1. Form more convex...........................*proxima* Pasc.

H_2. Form depressed.

7. I_1. Suture at apex flat...........................*vicina*, n.sp.

8. I_2. Suture at apex nodulose.............. *vertebralis*, n.sp.

B_2. Elytra with alternate intervals scarcely interrupted......

9. *monticola* Blackb.

B_3. Elytra with all intervals subcostate and crenulate........

10. *strigipennis* Bates.

A_2. Disc of pronotum nodulose.

J. Colour brown.

11. K_1. Edge of prothorax crenulate...........................*crenicollis* Pasc.

12. K_2. Edge of prothorax strongly dentate...............*denticollis*, n.sp.

13. A_3. Disc of pronotum longitudinally grooved.........*nosodermoides* Pasc.

Group ii. Sides of prothorax entire.
A. Disc of pronotum with large punctures irregularly placed.
B_1. Colour olive-bronze, shining.
C_1. Size large, form convex.
14. D_1. Elytra without elevated costæ.................. *punctifera* Macl.
C_2. Size much smaller.
D_2. Elytra with interrupted costæ faintly elevated.
E_1. Form broad and flat.
15. Sides of prothorax moderately rounded........ *repandum* Pasc.
dispar Blackb.
E_2. Form more elongate and parallel.
16. G_1. Border of pronotum thick.......... *integricollis* Haag-Rut.
B_2. Colour bronze-black.
17. G_2. Border of pronotum fine..................... *elongata* Erichs.
D_3. Elytra with interrupted costæ strongly elevated.. ..
18 *parallela* Germ.
congesta Pasc.
B_3. Colour black.
19. H_1. Elytral costæ elevated only at apex............... *simplex* Blackb.
20 H_2. Elytra uniformly striate-punctate................ *uniformis*, n.sp.

The following are the descriptions of the new species in the above table :—

SEIROTRANA VERTEBRALIS, n.sp.

Oval-depressed, bronze, subnitid, tarsi red, legs, antennæ and palpi reddish-brown.

Head rugosely punctate on front, more finely punctate on epistomal ridge, the latter only slightly raised above frontal surface. Antennæ short and stout; third joint much shorter than fourth and fifth combined, apical joint ellipsoidal and little longer than preceding, joints gradually thickening from base to apex. *Prothorax* slightly convex, without foliate margins, half as broad again as long (3 × 4·5 mm.), edge with border raised and slightly crenulated. Anterior angles obtuse and slightly produced forward. Sides very gradually rounded, sinuous near base. Hind angles rectangular. Front and base sinuate, the latter having scutellar region advanced, border in both narrower than at sides. Disc densely but finely subvermiculate-punctate, the slight vermiculation consisting of raised shining lines more or less longitudinal; sculpture coarser towards the sides. *Elytra* oval, about twice and one-half as long as and a little wider than prothorax; shoulders slightly obtuse, scutellum widely transverse and elliptic, very finely punctate. Each elytron lineate-punctate with ten lines of regular punctures; alternate intervals, viz., third, fifth, seventh and ninth with raised shining elongate nodules which become shorter towards apex. The sutural lines themselves nodulose towards apex only. Epipleuræ coarsely punctate. Abdomen pitchy-brown and very finely punctate. Intercoxal process raised and truncate. Front tibiæ moderately bowed, other tibiæ straight. *Dimensions*—15 x 5 mm.

Hab.—Blackheath, Blue Mountains (H. J. Carter).

A very distinct species. In general shape somewhat like *S. parallela* Germ., but differing in the absence of large punctures on pronotum, its crenulate sides and more oval form. The nodulose suture is a strong distinctive character, while the basal portion of the elytra is free from any sign of nodulation.

Seirotrana vicina, n.sp. (Text fig.1).

Elongate-ovate, depressed, dark bronze, subnitid; tarsi, palpi and antennæ brown.

Fig. 1.

Head and prothorax coarsely vermiculately punctate. Antennæ short (but thinner than in *S. vertebralis*), third joint little longer than fourth. *Prothorax* differs from that of *S. vertebralis* in the following particulars—sides notched, deeply in the female, less deeply in male, anterior angles strongly produced forward, sides more widely rounded and angulately incurved at base (where the dentation ends). Disc more coarsely punctate, the longitudinal lines more prominent, and having two larger depressions on basal half. *Elytra* more parallel than in *S. vertebralis*, with shoulders sharply margined, the raised intervals wider, less elevated, shining, and more evenly divided into elongate nodules. Suture flat throughout, and the seriate punctures are much larger than in the preceding species. Abdomen dark bronze. *Dimensions*—10·5 × 4·7 mm.

Hab.—Grose Valley, Blue Mountains (taken by the author).

While having a similar general facies to *S. vertebralis* mihi, the form is shorter, squarer, and more parallel, the colour much darker, especially on the abdomen, while the widely different shape of the prothorax, its dentate edge, and coarser sculpture distinguish it. The female specimen is lighter in colour, with more dilated tarsi, and more dentate edge of prothorax than the male.

SEIROTRANA DENTICOLLIS, n.sp. (Text fig.2).

Reddish-brown, opaque, flat, elongate and parallel, legs and antennæ lighter.

Head rugosely punctate, epistoma with a triangular split in the middle, front with a raised line of shining nodules forming a horse-shoe impression, having its arms pointing forward. Eyes large and nearly round when viewed from above. *Prothorax* longer than broad, strongly emarginate in front and base. Anterior angles roundly acute and a little recurved, narrower at base than in front and scarcely coarctate. Sides and front with broad red margin, this much narrower at base. Sides strongly dentate, widest part forming largest tooth at middle; gradually narrowing towards base; posterior angles rectangular. Disc thickly covered with raised shining nodules, and two wide depressions near posterior angles. *Elytra* wider than prothorax at base, and more than twice as long. Shoulders round and subrectangular. Sides parallel to apical third, then strongly vertically undulate. Disc with four rows of elongate shining nodules, alternating with five irregularly duplicated rows of minute and more depressed nodules. Surface undulate, especially towards apex. Epipleuræ wide and thickly granulated. Body beneath thinly clothed with brown decumbent hair. Femora with broad yellow ring near apex. *Dimensions*—11 × 4·2 mm.

Fig.2.

Hab.—Perth, W.A.

I have received a single specimen of the above from Mr. W. L. Du Boulay. While closely allied to *S. crenicollis* Pasc., and therefore totally unlike all other known species, it differs from that species in (1) the strongly dentate edges of prothorax; (2) the curiously undulate surface of the elytra; and (3) the much less regular pustulation of the elytral disc. My specimen is distinctly smaller than each of three specimens of *S. crenicollis* before me, whose average is 13 × 5 mm.

Seirotrana uniformis, n.sp.

Elongate-ovate, convex, black, nitid, antennæ, palpi and tarsi piceous.

Head coarsely punctate; antennæ stout, four apical joints continuously increasing in size, apical joint much the largest and oval. *Prothorax* convex, a little wider than long, front and base subtruncate; anterior angles very moderately advanced and nearly rectangular; base somewhat bilateral from the advance of the central portion of the elytra; posterior angles rectangular. Sides evenly and moderately rounded, sinuous towards posterior angles; recurved border at sides thick, narrower at apex, obsolete at base. Disc finely punctate, with larger punctures irregularly scattered on surface, but more frequent near base. Larger fovea at middle of sides near border. Central canal obsolete or scarcely indicated near base. *Scutellum* widely transverse, apparently smooth. *Elytra* elongate, subparallel, about twice and one-half as long and same width as prothorax, to which it is closely applied. Punctate-striate, with eleven striæ on each elytron; punctures in striæ large, regular and close. Intervals smooth and convex, especially towards sides and apex. Epipleuræ coarsely punctate. Abdomen longitudinally strigose, black and shining. All tibiæ bowed. *Dimensions*—14 × 5 mm.

Hab.—Quirindi, N.S.W. (Mr. J. K. Hay).

Two specimens of the above, labelled Quirindi, N.S.W., were amongst some Coleoptera received from the late Dr. C. D. Clark. While in general shape and colour it approaches *S. simplex*

Blackb., its elytral sculpture is widely different, the intervals being uniform and convex, with a slight tendency to waviness; while the punctures are much larger and closer than in that species. This is the only Seirotrana known to me, except *S. strigipennis* Bates, having no indication of nodulose elytra. The above diagnosis sufficiently differentiates it from *S. strigipennis.*

HYOCIS BICOLOR (n.sp. *Trachyscelinarum*).

Head, prothorax, and underside dark ferruginous, elytra pale yellow with black markings, antennæ and legs pale rufous.

Head and prothorax closely punctate; antennæ shorter than in *H. Bakewellii* Pasc., with the last joint a lighter colour than the rest. *Prothorax* transverse, very similar to that of *H. Bakewellii* but less sinuate at the sides near base, and with posterior angles rectangular; disc closely clothed with whitish hair; median line distinct. *Scutellum* triangular. *Elytra* adorned at the middle of the disc with a large O-shaped black mark (this marking sometimes a little incomplete), obscure and irregular black markings near base: striate-punctate, the punctures closer and smaller than in *H. Bakewellii*, each puncture bearing a short yellow hair. Intervals convex. Fore tibiæ strongly dilated and bowed, other tibiæ straight. Under surface punctate and thinly pilose. *Dimensions* —2·5-3 mm. long

Hab.—Botany Bay, near Sydney, N.S.W.

I have five specimens of this very distinct insect, taken by myself on the sandhills at La Perouse, Botany Bay. I have compared it carefully with Macleay's species, *H. pallida* and *H. pubescens*; also with identified specimens of *H. Bakewellii* Pasc., *H. subparallela* Champ., and *H. occidentalis* Blackb. Mr. Blackburn has also kindly compared it with his other two species, *H. nigra* and *H. variegata.* From all of the above it is readily differentiated by colour alone; while the widely dilated fore tibiæ further distinguish it from any other Hyocis known to me.

ADELODEMUS EXCISICOLLIS, n.sp.

Oblong-oval, opaque brown, covered above and below with a thick squamose derm.

Head: labrum emarginate, punctate, with apex concave and fringed with brown hair; epistomal ridge clearly separated from front by a transverse depression, front subbilobed and depressed, with a longitudinal raised line in middle; eyes narrower than in *A. squalidus* Macl.; antennæ short and stout (not reaching beyond apical half of prothorax when set back); first joint thick, second very small and bead-like, third joint longest but not so long as fourth and fifth combined, joints 4-10 equal, eleventh longer than tenth and ovoid. *Prothorax* (4 x 5·5 mm.) widest behind middle, as wide at base as at apex, slightly convex on disc, with broad recurved foliate margins, deeply excised near hind angles (quasi-bilobed), anterior margin bisinuate, produced in middle in two raised humps (one on each side of the wide central channel), anterior angles prominent and acute; sides subangulately widened to beyond half-way, then suddenly excised rectangularly to nearly the full width of the lateral foliation, the posterior lobe forming a wide subrectangular posterior angle, this also recurved; base bisinuate and divided by the wide sutural channel. Disc and head alike covered with rugose punctures, more or less obscured by the squamose clothing. *Elytra* broader than prothorax at base, but the maximum width of each approximately equal; oval, convex, shoulders narrowly rounded, apex more acuminate and with steeper declivity than *A. squamosus*. Striate-punctate, both striæ and punctures somewhat obscured by derm, the intervals strongly pustulose and punctate, especially towards sides. Sternum foveate-punctate. Legs and abdomen squamose, femora hairy. Tarsi and tibiæ very much as in *A. squamosus*. *Dimensions*—15 x 6 mm.

Hab.—Victoria (received from Mr. C. French, F.L.S., Government Entomologist of Victoria); Gippsland (one specimen taken by Mr. H. M. Giles).

This interesting addition to the Australian Tenebrionidæ is a close ally of *A. squamosus* Macl., in its general structure, oral organs, antennæ, legs and tarsi. It is easily distinguished by its remarkable prothorax, the anterior lobe of the lateral foliation being shaped like an elephant's ear. The wide and pronounced median line of the pronotum, on each side of which the antero-median lobe forms two rounded humps, is also remarkable. The derm which clothes the whole insect is readily removable, showing an opaque black surface beneath.

Ceropria bifasciata, n.sp.

Ovate, convex, nitid. Head and prothorax blue-black, with violet reflections; elytra the same colour, with yellow fasciæ as below; antennæ and legs brown; abdomen and under side of legs red.

Head: front and epistoma finely punctate, head narrower and more narrowly rounded than in *C. peregrina* Pasc. *Prothorax* more than twice as broad as long, truncate in front, sinuate behind, with two pronounced foveæ near basal border; anterior angles obsolete, posterior angles obtuse, wider at base than at apex; sides gently rounded. Disc minutely punctate. *Elytra* convex, striate-punctate with rows of closely placed punctures, these finer than in *C. peregrina.* Intervals flat, except near sides, the border sharply defined. Scutellar region, suture and ground colour metallic black with violet reflections, with two fasciæ yellow interrupted at suture, first at base wide and regular extending from border to near suture, second on apical third part of disc narrower, extending from border to half-way across each elytron, where it is curved towards apex. *Dimensions*—9 x 4·5 mm.

Hab.—Cairns, N.Q.

In form very like *C. peregrina* Pasc., its sculpture more resembling that of *C. valga* Pasc., from both of which it is easily distinguished by its yellow fasciæ.

Platydema metallicum, n.sp.

Oval, moderately convex, dark blue (sometimes violet), shining, body beneath, antennæ, legs, and palpi rufo-castaneous.

Head finely punctate, with transverse impression clearly separating front from episterna, without any erect horn to distinguish the sexes. *Prothorax* transverse, moderately convex, twice as broad as long, slightly narrower at apex than at base; anterior and posterior angles acute, sides very little rounded; base strongly bisinuate and closely fitting elytra, with median lobe slightly produced backwards; distinctly and closely punctate. *Scutellum* bronzy and triangular. *Elytra* a little wider and more convex than prothorax, elongate-elliptic, with greatest width behind middle; about once and one-half as long as wide; disc strongly striate-punctate, with intervals rather flat and very minutely punctate. Metasternum smooth and shining, abdomen with the four apical segments longitudinally strigose at their junctions; intercoxal process acutely rounded. *Dimensions*—Length 4 mm.; width 2(vix)mm.

Hab.—Sydney (found commonly in old fences by the author).

I cannot find that the above common insect has yet been described. It differs from all its Australian congeners, except *P. novicum* Motsch., in its metallic blue colour; whilst *P. novicum* is described as being twice the size of *P. metallicum*, and having its head and pronotum black. With nine specimens before me, I am unable to distinguish any sexual differences.

HETEROCHEIRA NITIDA, n.sp.

Black, very shiny, body beneath piceous-red, legs, antennæ and palpi rufo-castaneous.

Head and *prothorax* almost smooth and very nitid, the latter much wider at base than at apex. *Elytra* striate-punctate, the striæ very distinct on disc, less clear towards the sides; punctures in striæ regular and well defined. Pro- and metasternum smooth and shining, abdominal segments faintly longitudinally strigose; legs smooth and shining. *Dimensions*—6 × 2·8 mm.

Hab.—Cairns, N.Q. (sent by Mr. Anderson; also taken by Mr. H. Hacker).

I have three specimens, probably correctly identified by Mr. Blackburn, of *H. australis* Boisd., which are superficially like the above; on closer examination, the following comparison of characters will readily differentiate *H. nitida* :—

H. australis.—Colour brown, moderately nitid. Sides of prothorax subparallel till near front angle. Pronotum finely but evidently punctured. Elytral intervals punctate. Punctures in striæ indistinct. Pro- and metasternum strongly punctate. Abdomen rugose. Legs and abdomen concolorous, piceous. Under surface of legs punctate. Dimensions—8 x 3 mm.

H. nitida.—Colour black, very nitid. Sides of prothorax rounded and narrowed anteriorly. Pronotum scarcely punctate. Intervals smooth. Punctures in striæ strongly marked. Pro- and metasternum smooth. Abdomen faintly strigose. Legs a much lighter colour than the abdomen. Under surface of legs smooth. Dimensions—6 x 2·8 mm.

The wide difference of locality is also to be noted, West Australia being stated in Masters' Catalogue as the habitat of *H. australis* Boisd. (My own specimens have no locality-label).

PTEROHELÆUS NITIDULOIDES, n.sp.

Broadly ovate, depressed, reddish-brown; legs, flanks, and suture near scutellum red.

Head with narrow, square, truncate clypeus, divided from the front by a raised tuberculate impression; behind this the front hollowed in centre and strongly punctate. Antennæ short (at rest extending to one-half length of prothorax) with the apical joints strongly clavate, apical joint globular and hairy. *Prothorax* very transverse, almost semicircular anteriorly, subtruncate posteriorly, with narrowly reflected border becoming obsolete near hind angles; anterior and posterior angles obtuse, much wider at base than at apex, sides gradually and evenly rounded, but suddenly incurved near base. Disc without central canal, and covered with short, decumbent, reddish pile, beneath which are obscure rugose punctures. Scutellum widely elliptic. *Elytra* narrower than prothorax, sides nearly parallel; bluntly rounded at apex, with very narrow border obsolete at apex. Disc covered (but far more sparsely than pronotum) with fine recumbent red hair; finely costate, with about six faintly perceptible costæ becoming obsolete near sides. Intervals finely rugulosely punctate. Epipleuræ narrow. Abdomen densely punctate and pubescent. *Dimensions*—4·5-6 × 2·5-3 mm.

Hab.—Medlow, Blue Mountains, N.S.W. (taken by the author).

I captured a considerable nnmber of this small Pterohelæus in September, 1907, on the underside of a dead tree, in the crevices of which they were so well concealed by their colouring as to be difficult to detect. Its nearest ally in colour and facies is *P. thymeloides* Pasc., from South Australia, which is, however, a much larger and more convex insect (among other differences). The only other Pterohelæus known to me of such minute dimensions is *P. opatroides* Macl., which is black in colour, longer and narrower than the above, with a widely different sculpture. The strongly clubbed antennæ in conjunction with its small size should enable this species to be easily identified.

Chartopteryx imperialis, n.sp. (Subfamily *Cyphaleinæ*).

Elliptical-elongate, glabrous, subnitid, chocolate-brown above, darker beneath, tibiæ and basal joints of antennæ red.

Head: labrum emarginate, hairy, truncate in front, widely rounded on sides; epistoma prominent, raised and punctate, sinuate in front, meeting the square antennal orbit at right angles. Eyes very large, coarsely faceted and separated by about one-half width of one eye. Front more finely punctate than epistoma. Antennæ long, extending beyond base of prothorax, first joint stout, second thinner and very short, third as long as fourth and fifth combined. Joints 4-7 of equal length; 8, 9, 10 shorter and thicker; 11 about as long as 9 and 10 together. Joints 1-7 red and smooth, 8-11 brown and hairy. *Prothorax* almost flat, 6 × 10·5 mm., the length (excluding front angles) being measured at middle, the width at base. Width at apex 6 mm. Truncate in front, except for prominent and wide front angles, these acute, slightly reflexed, and extending the full length of the eyes. Sides very gently rounded, and slightly produced backwards at posterior angles, the latter acute. Base strongly bisinuate. The whole pronotum margined by a raised shining border, thickest near anterior angles, thinnest at base. Disc slightly raised in middle, depressed towards sides, glabrous, but under a lens seen to be closely and finely punctate. At posterior angles are small subfoveate depressions. *Scutellum* large, forming an equilateral triangle with sides a little curved; minutely punctate. *Elytra* 25 x 16 mm. Oval and very convex. At base the same width as prothorax, soon widening in a regular curve to the greatest width behind middle, near apex rather suddenly and sinuately incurved, each elytron separately rounded at apex. This subapical sinuation emphasised by the raised shining border being discontinuous, the border from the shoulder backwards ending abruptly at three-quarters the length, a second more prominently raised border beginning *inside this*, and continued to apex. Disc very convex, with the greatest height in front of middle, gradually curved to apex. Glabrous, closely, finely, punctate, except sutural region and two smooth longitudinal lines on each elytron. *Abdomen* and whole underside smooth and very minutely punctate, the punctures becoming more evident (but requiring a strong lens to be seen) towards apex. *Legs*: femora and tibiæ smooth, the latter straight, very little thickened at apex, with small spine on inside.* Posterior tarsi with basal joint not as long as the rest combined. *Dimensions*—34-35 x 16 mm.

Hab.—Kuranda, N.Q. (Messrs. C. Dodd and H. Brown).

I have two specimens, the female from Mr. Dodd, the male from Mr. P. Shaw, who received it from Mr. H. Brown. I have seen one other specimen in the collection of Mr. C. French. It is by far the largest species of the group, but I have little doubt in placing it in this genus. The male has the prothorax slightly more widely rounded, the fore tarsi more transverse, the elytra more convex, and the abdomen thicker.

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* Pascoe in his tabulation of Cyphaleinæ (Ann. Mag. Nat. Hist. April 1869, p. 288) gives "basal joint of posterior tarsi as long as the rest together;" but in *C. childreni* Westw., and *C. victoriensis* Blackb., the proportions are much as in the above species.

MELAPS, n.gen. (Subfamily *Apocryphinæ* ?).

Head triangular, inserted in prothorax as far as the eyes, antennal ridge small. Eyes prominent, round, entire. Antennæ scarcely covered at point of insertion; long, filiform and scarcely thickened towards apex; scape cylindrical, second joint obconic, third about twice as long as the scape, 4-10 about the same length and thickness, eleventh lineate-ovate, but not perceptibly thicker than preceding. Mentum subquadrate, membranous, maxillæ short, maxillary palpi very long with last joint securiform. *Prothorax* very convex and spherical; base and apex truncate, more than one-third as broad again as long, regularly rounded at sides; not margined. Base angles obtuse but marked, base closely fitting elytra. *Elytra* short, ovate, epipleuræ narrow and vertical, with the flanks of elytra raised above them. Shoulders close to but not meeting base angles of elytra, declivous; apterous, *Legs* stout, femora thickened, tibiæ slightly bowed at base and expanded at apex. Anterior tarsi with claw-joint longest, posterior tarsi with first joint as long as second and third combined; tarsi pubescent. Anterior coxæ globular, moderately separated; middle and posterior coxæ more widely separated, without trochantin. Metasternum shorter than mesosternum. *Abdomen* with penultimate segment narrower than the rest.

MELAPS CISTELOIDES, n.sp. (Text fig.3).

Very convex, ovate, black, shining.

Head subtriangular, finely but distinctly punctate, and sparingly pilose, hairs castaneous. Mentum, palpi, tibiæ and tarsi reddish. Palpi very long. Antennæ with joints 1-10 reddish, 11-13 black; not perceptibly thickened towards apex, joints long and narrow as above. Much longer than head and thorax combined. *Pronotum* very convex and spherical, base and apex truncate; width is to length as 25 : 18; greatest width at middle. Anterior angles obsolete, or so declivous as to be obscured by the convexity. Sides regularly rounded, posterior angles obtuse. Disc finely but distinctly punctate, punctures regular and distant; two round depressions symetrically placed on each side of the middle, with no trace of medial canal. *Scutellum* transversely elliptical. *Elytra* convex, oval, glabrous, closely joining pronotum at base, but shoulders declivous and not meeting hind angles of pronotum. Sides gradually widening in a curve to half-way, then narrowing to a sharp point at apex; punctured similarly to pronotum, but the punctures coarser, producing short castaneous hairs. Body beneath and legs a piceous-red, shining. Femora swollen; tibiæ slightly expanded at apex and armed with a small spur; tarsi scantily and shortly pubescent. *Dimensions*—8 × 3·1 mm.

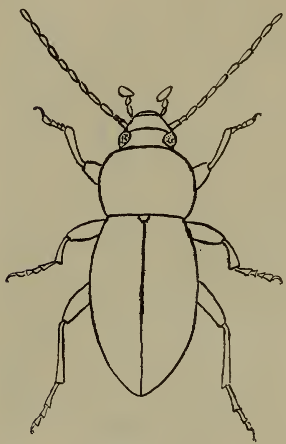
Fig.3.

Hab.—Mount Kosciusko (under logs; two specimens collected by the author).

This insect is entirely different from any Australian Tenebrionid I have yet met with. It is remarkable for the entire absence of striæ or costæ, combined with its convex form, and cistelid-like facies of legs and underside. It is most like *Melytra ovata* Pasc., in some respects, but differs widely from this insect in the shape of the prothorax and the structure of its antennæ. I have placed it provisionally in this section of the Tenebrionidæ with some diffidence.

Hymæa laticollis.

Elongate, subcylindrical; shining fulvous-brown, darker on front and pronotum, oral regions, epistoma and antennæ reddish. *Head* placed vertically, coarsely punctured, less triangular, proportionately shorter and with eyes less prominent than in *H. succinifera* Pasc.; antennæ more slender and lineate, with the three apical joints more bead-like, *i.e.*, less flattened and more globose. *Prothorax* ovate-cylindrical (sometimes cylindrical when viewed from above, distinctly and angulately widened in the middle when viewed from the side), wider than head, apical portion elevated and forming a hood-shaped lobe, separated from the posterior portion by a semicircular depression with extremities near the anterior angles. Truncate in front and behind, with anterior lobe slightly produced so that the anterior margin appears excised near the angles. Posterior angles obtuse and minutely toothed. Disc more densely but less deeply punctured than *H. succinifera*, and without any superimposed tubercles; scutellum large, transverse, semi-elliptic and fulvous. *Elytra* distinctly longer than head and thorax together, not wider than prothorax, elongate-ovate, glabrous, basal half subparallel, very slightly widened before apex, shoulders rounded but distinct, sides with narrow horizontal yellow border. Epipleuræ narrow and oblique. Seriate-punctate, punctures in series large and close, the lines of punctures less regular than in *H. succinifera*, giving the raised nitid interstices a wavy appearance. On each elytron are amber-like tubercles less raised than in *H. succinifera* and placed as follows: two longitudinally oval spots on basal half (inner one nearer base), one smaller spot near apical declivity, a fourth much larger than this, on the shoulder. Undersurface, especially abdomen, coarsely punctate. Colour brown-black; legs dark amber-colour, five femora armed on inner ridge with blunt tooth; tarsi pilose. *Dimensions.*—5 × 1·5 mm.

Hab.—Sea Lake, Victoria.

This description has been made from a unique specimen sent by Mr. G. C. Goudie, who now possesses the type. It is a doubtful congener of *H. succinifera* Pasc., as the characters of the genus *Hymæa* (Ann. Mag. Nat. Hist. Jan. 1869) would have to be modified to include this insect, especially as to the shape of the head and its insertion in the thorax, shape of prothorax and body. The sculpture of the elytra, the structure of the antennæ, the oral organs and the abdomen are closely similar, so that, provisionally at least, it may be referred to this genus. The most striking difference lies in its hood-shaped prothorax, and in its vertically placed head, almost resembling in this respect the genus *Bostrichus.*

Byallius kosciuskoanus, n.sp.

Elongate-oval, moderately convex; black, subnitid, antennæ piceous-red; antennæ, labrum, and tarsi clothed with golden pile. *Head* closely, coarsely punctate, labrum and rounded sides of mentum prominent, the former separated from the clypeus by a brown membrane. Clypeus truncate, without epistomal ridge, with front angles rectangular. Antennal orbits prominently raised and parabolically rounded in front of eyes. Antennæ with third joint at least as long as fourth and fifth combined; joints 4-7 obconic, 9 and 10 oval, 8 intermediate in shape between 7 and 9, 11 much longer than 10, oval; apical joints flatter, less nitid, and lighter in colour than basal. *Prothorax* very convex, wider than long (5 x 7 mm.), with greatest width near base, wider at base than at apex; sinuate in front, anterior angles prominent, acute and a little reflexed. Sides scarcely foliaceous, little rounded, with the thickened edge more upturned towards front than towards base, edge much thinner at base and apex; posterior angles widely obtuse, scarcely distinct and deflected. Disc finely punctured, sometimes with a transverse line near base forming a basal lobe. *Scutellum* widely transverse and triangular, punctured as on pronotum. *Elytra* ovate and strongly convex, wider than prothorax at base, about once and one-half longer than wide, gradually widening posteriorly, greatest width at apical third. Reticulately rugose, with three rows of wavy sub-costate lines on each elytron; the whole distinctly but finely punctured, and margined by a thin subcrenulate border. Legs, abdomen, and sternum coarsely punctate. *Dimensions* 18-21 x $7\frac{3}{4}$-11 mm.

Hab.—Lower slopes of Mount Kosciusko, near Jindabyne, N.S.W. (taken by the author).

This insect differs from the only other member of the genus (*B. reticulatus* Pasc.) in the following particulars. Prothorax shorter, in proportion to length, much more convex, and with sides much less strongly rounded and recurved. (N.B.—The figure of *B. reticulatus*, Ann. Mag. Nat. Hist. 1869, pl.x. fig.6, exaggerates the recurved sides). The elytra are less coarsely rugose, but the punctures above and below are larger and more distinct. The abdominal punctures especially differ; in *B. reticulatus* they are largely confluent and longitudinally rugose; in *B. kosciuskoanus* they are uniformly round and separate. My specimen of *B. reticulatus* Pasc., is from Fernhill, Victoria; and was compared with the type in the British Museum by myself. Two other specimens from Buffalo Mountains, Vic., differ from the Fernhill specimen in having a less widely reflected margin to prothorax, and more distinctly raised costæ on the elytra. Four specimens of *B. kosciuskoanus* are before me, of which I consider there are two of each sex. If this be correct, the apparent males are smaller, narrower, more convex than the females, with the penultimate joint of the front tarsi less transverse.

Cardiothorax rotundicollis, n.sp.

Flat, elongate-ovate. Black, moderately nitid.

Head and front with typical markings. Antennæ short and stout, with apical joints less markedly thicker than the basal joints, as in most of its allies, and clothed with reddish hairs. *Prothorax* almost flat and widely foliate at sides, and with a markedly wide raised border extending all round except at base, and middle part of apex. Much narrower at base than apex, widest at middle; base slightly curved, with the concavity towards the elytra and basal edge depressed. The front very sinuate, with middle of disc advanced and anterior angles well produced forward to meet the rounded sides at an obtuse angle. Sides widely and regularly rounded, rather abruptly contracting at base posterior angles obtuse and subobsolete. Central channel deeply, impressed throughout, except on apical border. On each side of this two deeply lineate impressions abruptly ending forward but produced at right angles to meet central channel behind. Foliate sides divided from disc by curved impression. *Elytra* ovate, deeply and regularly striate. Intervals sharply raised, about as wide as prothorax at widest. Shoulders prominent and rounded, with strongly raised border in that region, apex narrowly rounded. *Abdomen* black, shining, epipleuræ smooth, tibiæ straight and slender, legs unarmed. *Dimensions*—14 × 4·5 mm.

Hab.—Atherton, N.Q.

A single specimen, which I take to be ♀. The marked characters of the antennæ and prothorax of this species distinguish it from all others of the genus. It is in general outline like a small *C. Walckenærii*, from which it widely differs in all other characters. I am indebted to Mr. Sloane for this specimen which he captured himself near Atherton.*

CORIPERA BISTRIATA, n.sp. (Text fig.4).

Elongate-oval; dark bronze shining; tarsi, basal joints of palpi, knees, thoracic and elytral bands castaneous; antennæ fuscous.

Fig.4.

Head elongate, labrum salient and square, epicranium separated from clypeus by transverse ridge. Coarsely punctate. Eyes large, oval, coarsely faceted. Antennæ with the four penultimate joints triangular, apical joint spheroidal, these five joints opaque; joints 1-8 shining; 3 scarcely larger than 4, joints 1 and 2 short and beadlike. *Prothorax* irregularly and strongly rugose, transversely striolate on the sides, about as long as broad. Bisinuate and emarginate at apex, anterior angles bluntly acute; sides with undulating outline, slightly widest at middle. Hind angles sharp and subrectangular; this angle, though not dentate, emphasised by the depressed groove at base near angles. Base strongly sinuate and produced a little backwards at middle; base and apex intersected by the otherwise obsolete medial channel. Entire pronotum edged by a shining reflexed border. Sides, for the width of front and hind angles, with a light castaneous band. *Scutellum*

* A second specimen subsequently received from Cooktown, sent by Mr. Anderson of Cairns.—*Postscript*, 21st July, 1908.

small and transverse. *Elytra* a little wider than prothorax at base, humeral angles bluntly rectangular; sides parallel till near apex, then sharply narrowed to a point. A narrow, light, castaneous band running from shoulder to apex, widening at apex. A single narrow stria on each side of and close to suture, not reaching base. On each elytron about twenty-five ocellate foveæ; these not arranged in series, but scattered irregularly over the whole surface; foveæ, as well as the spaces between them, irregularly and finely punctate. The sides have a crenulate appearance, especially towards apex, due to raised "lumps" on the surface, which are continued to a modified extent on the epipleuræ. Near the scutellar region the sculpture presents an irregular strigose appearance. Underside dark bronze and smooth, except apical segment of abdomen, which is finely punctate. *Dimensions*—13 x 4·4 mm.

Hab.—Zeehan, Tas. (one specimen, kindly given to me by Mr. A. M. Lea).

A quite distinct member of this genus, easily recognised by its single stria on each elytron, and its irregular ocellate pattern, in combination with the light-coloured band.

BRYCOPIA CRENATICOLLIS, n.sp. (Text fig.5).

Shortly ovate, convex; nitid, bronze, glabrous; antennæ, tibiæ, underside of femora castaneous; tarsi and palpi pale castaneous; abdomen dark metallic-bronze.

Head short, wide, densely punctate; eyes round and prominent. Antennæ stout, reaching (when set back) beyond base of pronotum; joints increasing in width from base to apex and closely articulate; joint 3 very little longer than 4, joint 11 much the largest and ovate. *Prothorax* convex, coarsely and regularly punctate, punctures closer than in *B. globulosa* Carter, and not tending to confluence as in *B. pilosella* Pasc.; truncate at base and apex, with apex slightly advanced in the middle, sides moderately rounded anteriorly, abruptly narrowed posteriorly, and minutely crenate at edge; anterior angles sharply obtuse, posterior angles obsolete. *Scutellum* small, transverse and depressed below the plane of elytra. *Elytra* moderately convex, much wider than prothorax at base, shoulders squarely rounded, sides not bulging towards middle in either sex, and with rather blunt apex; striate-punctate, with ten striæ on each elytron, the last two on the sides; striæ fine, with punctures close and regular. Intervals flat, very minutely punctate, and wider near suture than at sides. Beneath densely punctate, punctures especially coarse on epipleuræ and prosternum, much finer on abdomen. Intermediate tibiæ slightly curved, the other tibiæ straight. *Dimensions*—♂, 4·5 × 2·2 mm.; ♀, 5·8 × 2·5 mm.

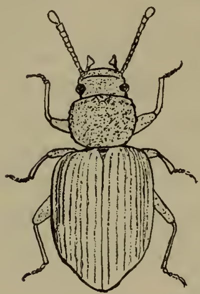

Fig.5.

Hab.—Grose Valley near Blackheath (four specimens found in rotten wood by the author).

This insect is easily distinguished from its allies by its short, rounded, and minutely but distinctly crenate sides of prothorax. It is nearest to *B. globulosa* mihi, which besides being more convex, has a much wider prothorax (in *B. globulosa* as wide as the elytra) with the punctures thereon less close and deep. The eyes are not so large as in *B. pilosella*, but are prominent, quite round when viewed from above, while the ocular cavity beneath is densely punctured. One specimen presented to the Macleay Museum, the three types in the author's collection.

BUPRESTIDÆ.

Cyria cincta, n.sp.

Elongate, depressed, black, shining, with a broad lateral vitta flavous on elytra and prothorax. Beneath shining black, with base and sides of abdominal segments and legs sparsely covered with long white hairs.

Head coarsely and unevenly punctate, with scattered whitish hairs, deeply channelled between the eyes. Antennæ fine (much finer than in *C. vittigera* Hope) and pilose. Third joint longer than fourth, successive joints becoming thinner and shorter. *Prothorax*: width at base, 8 mm., at apex 6 mm.; length 6 mm. Apex strongly bisinuate and notched in the middle, the thick elevated border strongly raised in this region, being hollowed at the junction of the middle canal. Sides scarcely rounded, the yellow vitta not extending to apex. Base bilobed and acutely directed backwards at centre, posterior angles acute. Disc rather distantly punctate, punctures coarser and more crowded near apical angles, much finer near base at centre. Central channel marked by finely cut line throughout, widening at base and apex. *Elytra* 22 × 9 mm. Shoulders widely rounded, sides slightly incurved at middle, finely punctate-striate, the striæ fine and shallow, interstices flat; punctures in striæ small and circular, largest in the third and fourth striæ beyond base, becoming smaller by degrees towards apex, *there* very minute. Lateral vitta not extending to apex, occupying the width of three intervals (broader on shoulders), leaving, however, a narrow black border outside the vitta. Each elytron strongly bispinose at apex, inner spine formed by the termination of the sutural edges, these acutely divided at apex. Beneath, first abdominal segment with large scattered punctures; on each succeeding segment the punctures smaller and fewer. *Dimensions* —30 × 8 mm.

Hab.—Kuranda, N.Q. (taken by Mr. C. Dodd).

This fine insect, from the collection of Mr. C. French, adds a very distinct member to this small genus. It is readily distinguished by colour and its bispinose elytra, in which it most nearly approaches *C. vittigera* Hope; while in form and sculpture it is nearer *C. australis* Boisd. Type returned to Mr. C. French.

CYRIA AUSTRALIS Boisd. (*C. gagates* Hope).

Notwithstanding Saunders' note* I am convinced that the above species is quite distinct from *C. imperialis* Don. While it is probable that "melanism" may occur in the case of *C. imperialis*

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* Trans. Ent. Soc. Lond. 1868, p.3.

—Boisduval specially mentions one case ('Faune de l'Océanie' p.61)—such cases are extremely rare; and some remaining mark, usually the thoracic vitta, remains to mark the species. *C. australis*, however, is a common form, with a definite habitat (South Queensland), constant in colour and form. I have examined a considerable number of both species, and note the following distinguishing characteristics :—

C. australis Boisd.—*Antennæ* finer, third joint longer than fourth. *Head*: frontal punctures fewer and more irregular. *Prothorax* without lateral yellow band; disc with four (or more) large foveate depressions; median part of disc lightly and distantly punctate, punctures small. *Elytra* of wider form, with a tendency to swollen middle; more convex; punctures in striæ small; basal part of elytra transversely strigose, especially towards sides; apex acutely angulate; sutural part longest. *Prosternum* distantly punctate. *Metasternum* faintly punctate.

C. imperialis Don.—*Antennæ* stouter, third joint about equal to fourth. *Head*: frontal punctures dense and regular. *Prothorax* with yellow band; disc in general with no regularly placed large foveæ; median part of disc much more coarsely and densely punctate, punctures large. *Elytra* of narrower and more tapering form; less convex; punctures in striæ larger; basal part without any transverse strigosity; apex rounded. *Prosternum* strongly and coarsely punctate. *Metasternum* coarsely punctate.

A specimen of *C. imperialis* from Tasmania is less coarsely and less densely punctate than specimens from the mainland, but even this presents markedly different sculpture from that of any specimens of *C. australis* that I have examined.

Stigmodera caudata, n.sp.

Oblong, feebly enlarged at the posterior third. Head, antennæ, pronotum, prosternum, and ovate patch on elytral apex brilliant shining blue. Elytra otherwise yellow with margins red. Beneath, except prosternum and legs, brilliant metallic blue-green.

Head deeply punctate, widely channelled between eyes, colour darker on clypeus than on front. *Prothorax*: length 4 mm.; width at base 7 mm., at apex 4 mm. Anterior margin produced, anterior angles acute, sides widely rounded, posterior angle acute; base strongly sinuate, median lobe produced backwards and foveate near scutellum; junction of middle and lateral lobes marked by a triangular notch on basal border. Disc very convex, central region humped, thence strongly declivous anteriorly, less steeply declivous towards sides and base. Finely and regularly punctate; without central canal. *Scutellum* blue, cordate and depressed in centre. *Elytra* 17 × 8·5 mm., widest at posterior third, wider at base than prothorax, sides slightly sinuate, apex strongly bidentate, inner tooth spinose (formed by elongation of suture), slightly longer than exterior tooth and apparently elevated. (This appearance due to convexity of disc near apex). Suture divergent at apex. Disc striate-punctate, punctures in striæ large and close, intervals convex. Yellow, except for oval apical patch blue, and red margin, the former (blue patch) narrowed near apex, then suddenly widened to include the exterior tooth. Exterior four intervals near apex sanguineous, the red margin narrowing to a single interval on sides, but not quite continued to base. Beneath: sternum deeply and regularly punctate, first segment of abdomen moderately punctate, last segment closely but more finely punctate; other segments minutely punctate. *Dimensions*—21-22 × 8-8·5 mm.

Hab.—Cairns district, N.Q. (Mr. Henry Hacker).

I am indebted to Mr. Hacker for a pair of this as of the following fine species. I have been unable to find anything like either amongst the numerous species hitherto described, nor are they known in the British Museum, whose fine collection, recently enriched by the addition of Mr. Kerremans' collection, I have lately examined. The apparent elevation of the apical portion, due to the pre-apical convexity, combined with its colour, and strongly bidentate elytra will sufficiently differentiate it.

STIGMODERA UNIMACULATA, n.sp.

Oblong-oval, moderately widened at the posterior third. Head and pronotum blue-green; antennæ, legs, and underside bright metallic-green; elytra yellow, with a large triangular macula near, or on apex, blue-black; apical region sanguineous at sides, basal margin narrowly violaceous.

Head densely punctate, not furrowed between eyes. *Prothorax* 4 mm. long; 6 mm. wide at base, 3·5 mm. wide at apex. Anterior margins produced with angles acute, anterior margin wide and raised. Sides sinuately widened, widest behind middle, with depression near widest point (in one specimen foveate), then slightly incurved, posterior angles subrectangular; base sinuate and lobed, middle lobe moderately produced backward. Central canal strongly marked throughout. Disc moderately convex, deeply and closely punctate. *Scutellum* dark blue, cordate, slightly elevated and smooth. *Elytra* 13 mm. × 7 mm., widest behind middle; same width as prothorax at base, then sinuately widening, and rather widely rounded at apex, without dentation; suture divergent at apex. Disc striate-punctate, punctures in striæ not in general clearly marked, but evident on basal half, becoming smaller and inconspicuous towards apex, where the striæ themselves become vague or obsolete. Intervals very slightly raised. The black macula in one specimen extends to the apex; in the other it does not reach apex; with exterior four to five intervals stained red, this colour not extending beyond posterior third. Beneath, closely and regularly punctate, the punctures becoming gradually finer towards apex of abdomen. Tibiæ and tarsi clothed with short yellow hair. *Dimensions*—18-19 × 7-8 mm.

Hab.—Cairns district, N.Q. (Mr. Henry Hacker).

In general appearance like the preceding species, but on closer view widely different and easily separated from it by its shorter and proportionately wider form, its widely different sculpture, and its undentate elytral apex. The colour and shape of the apical maculæ differ, that in *S. unimaculata* having anterior edge straight (or bisinuate with concavities facing forward); in *S. caudata* it is oval, with anterior edge convex towards the tront.

Stigmodera flavo-purpurea, n.sp.

Oval, depressed, shining, rather widely enlarged towards the apical third. Head, antennæ, prothorax, legs and undersurface a bright metallic-green. Elytra bronze-purple variegated with yellow pattern as in *S. flavo-picta* Boisd., or (regarding the yellow as the groundcolour) the purple pattern is as follows—a wide sutural and basal margin, the latter extended to form a curved longitudinal vitta from the shoulder, meeting the side again before the basal half; a postmedian fascia widened at middle, and the apex widely covered, with the front margin of apical blotch bisinuate.

Head and *prothorax* strongly and closely punctate, the former canaliculate, the latter without any sign of a median line except a shallow fovea near base; widest at base, with sides rounded. *Scutellum* metallic green, cordate and depressed in middle. *Elytra* regularly striate-punctate, intervals rather strongly convex and finely punctate. Apex narrowly and ovally (longitudinally) excised and undentate. *Sternum* coarsely, *abdomen* very finely punctate, the whole rather thickly clothed with whitish decumbent hair. *Dimensions*—10-12 mm. long; 3·6-4·6 mm. wide.

Hab.—Medlow, Blue Mountains, and Jindabyne, N. S. W. (taken by the author).

This widely spread insect has, so far as I can discover, escaped notice. There is no specimen in the British Museum or in the Kerremans Collection. The pattern is almost an exact replica of *S. flavo-picta* Boisd., as figured by Saunders (Trans. Ent. Soc. Lond. 1868, Part 1, Pl.iii. fig.29), but it differs markedly from that species (which I have from Adelaide, Tasmania, and from New South Wales) in the following respects. In shape, flatter and wider, with more sinuately widened sides to the elytra. In colour, the prothorax and abdomen are of a much brighter metallic green, while the elytral colouring is even more emphatically distinct, the darker part being of a coppery-purple. (It is blue in *S. flavo-picta*). The sculpture and clothing of the abdomen of these two species differ in a marked degree. It is altogether a handsomer and more striking species.

S. DIMIDIATA, n.sp.

Oblong-oval, subparallel; very slightly widened at the posterior third. Head, prothorax, and greater part of elytra shining peacock-blue-green; elytra adorned with yellow as follows—one elongate spot on lateral edge near shoulders; an interrupted median fascia, extending from sides, terminating at second interval from suture and widest near middle, with its hind margin nearly straight, its thickened portion extending triangularly forward; and a subapical curved fascia interrupted at first elytral interval, meeting on the sides a narrow yellow border which begins at this point and is continued nearly to apex.

Head coarsely punctate, strongly canaliculate, antennæ with basal joints blue, the rest metallic brown. *Prothorax* moderately convex, widest at base, sides lightly rounded and a little explanate at base; coarsely punctate, punctures becoming confluent and rugose towards the sides; median line scarcely indicated in front and by a smooth space and small fovea at base. *Scutellum* triangular and minutely punctate. *Elytra* striate-punctate, with intervals rather flat except on sides and towards apex, and closely rugulosely punctate. Apex excised in a small semicircle, undentate. *Sternum* and *abdomen* a brilliant metallic green, the former sparsely and finely clothed with short whitish hairs, the latter smooth; the whole underneath strongly punctate. Femora metallic green, tibiæ blue, tarsi brown, clothed with golden hair. *Dimensions*—9-12 mm. long; 3-4 mm. wide.

Hab.—Blue Mountains (taken by the author).

This species, commonly found in the Kanimbla Valley, near Blackheath, in November, has not yet, I think, been described. In colour it is not far removed from *S. subgrata* Blackb., (*S. campestris* Kerr.), but it is without the yellow border to the pronotum of that species, while the groundcolour is of a far more brilliant iridescent blue-green, which varies in different specimens. In general the blue is more prominent on the elytra, with the greener tint on the pronotum, but it is impossible to give the limits of these colours. It is besides more elongate and parallel than *S. subgrata*, with the apex of the elytra clearly excised.

ON THE NEW GENUS *AUSTROGYNACANTHA* [NEUROPTERA: *Odonata*] WITH DESCRIPTION OF SPECIES.

By R. J. Tillyard, M.A., F.E.S.

(Plate v.)

In his unpublished MSS.* de Selys has described a new species *Gynacantha heterogena* from a unique female in his collection. This interesting species has ever since remained known to odonatologists by this unique example only. Two years ago M. René Martin sent me the description and locality—Rockhampton, Queensland—and I was hopeful that I might be fortunate enough to discover the male. While examining and naming the fairly extensive collection of Odonata in the Macleay Museum, Sydney University—most of which are Queensland insects taken by Sir William Macleay's collectors—I found two males of a species which evidently coïncided with *G. heterogena*. One of these was presented to me in exchange by Mr. Masters, the Curator of the Museum; and as it is from Rockhampton, the same locality as the unique female of de Selys, I have founded my description on it and made it the type-male. This year, during my visit to Cooktown, I searched carefully for it and for other species of *Gynacantha*, but the continuous heavy rains

* The species is not recorded in the Zoological Record, which I have carefully searched through twice from 1866 to present date. It is not recorded in Kirby's 'Catalogue of the Odonata,' but it is given by M. René Martin, without description, in his 'Odonates du Continent Australien 1902.' I have therefore concluded that the description was known to M. Martin but not to the world, and is probably one of de Selys' numerous unpublished MSS. species.

made it impossible to obtain any *Aeschnidæ* worth mentioning. A week after I left, however, my friend Mr. Olive found this species by no means uncommon there, and he has since then forwarded me six males and six females. These, in spite of considerable damage in transit by post, afford me sufficient material for the present paper. Doubtless de Selys felt, when describing the female, that its smaller size and very different markings and colouration might warrant the formation of a new genus to contain it; at least the name *heterogena* irresistibly suggests the impression it made upon his mind. But it was not de Selys' way to propose a new genus for a unique female, which possessed all the more essential characters of the genus *Gynacantha* as defined by Rambur. Later on Förster,* in instituting the new genus *Karschia* for the reception of his species *Gynacantha cornuta* and *G. angulata*, *of which the females alone were known*, seems to have set a precedent which it would not be wise to follow. It is at least evident that the characteristics of his genus are incomplete, and must necessarily suffer alterations and additions when the males of his species are discovered. It is also evident that when he speculates as to the probable number of cells in the anal triangle of the hindwing of the *unknown* male, he is not dealing with facts at all, and such speculations should be rigidly kept out of his generic definition. With the male of *G. heterogena* before me, I can go so far as to say that no odonatologist could possibly have predicted the extraordinary form of its anal angle, either by examination of the corresponding cells of the female, or by drawing on his imagination. Even with the added knowledge of the group that this remarkable insect has given me, I am not at all prepared to say what the males of *Karschia cornuta* and *angulata* will be like. They might possess either a two-, three-, or four-celled anal triangle, and it may be either sharply angulated, as in the true species of *Gynacantha*, or of the peculiar rounded form found in

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* Odonaten aus Neu-Guinea, von F. Förster in Bretten, ii.; Természetrajzi Füzetek, xxiii. Köt. 1900 ("Bemerkungen zur Gattung *Gynacantha* Ramb.").

G. heterogena. Though the two species of *Karschia* are of smaller size than the true species of *Gynacantha*, yet *G. heterogena* again is smaller still. And though *Karschia* exhibits several important differences from the true species of *Gynacantha*, yet *G. heterogena* (female) again exhibits important differences from *Karschia.* Hence I will not attempt to rope in the females of *Karschia* with *heterogena*, whilst, on the other hand, it is impossible to ignore the striking characters of the male of *heterogena* and attempt to place it, by female characters only, under the genus *Karschia.*

I propose to found a new genus *Austrogynacantha* for the reception of the beautiful and remarkable species *Gynacantha heterogena.*

AUSTROGYNACANTHA, n.g.

Type *Gynacantha heterogena.*

Characters as in *Gynacantha* Rambur, viz., "Face narrow, eyes large, touching for a long space, slightly sinuous behind, occiput very small. Second segment of abdomen in male having a pronounced tubercle. Appendages of male simple, slender; last segment in female jutting out and prolonged below, furnished with long spines [two or three only in the species which I know]; membranule nearly nil,"* but with the following important exceptions and differences, shown best by a comparative enumeration.

GYNACANTHA (s.str.)[*G. Rosenberghi*† Selys].—(1) Large insects, expanse of wings in ♂ 90 mm. at least. (2) *Abdomen of both sexes sharply constricted at segment* 3. (3) Spurs of segment 2 in ♂ very conspicuous, *rounded.* (4) Hindwings very broad. (5) *Anal margin of hindwing of ♂ strongly angulated;* the outer side of the anal triangle composed of a very strong and thick vein, much stouter than the continuation of the postcostal margin; anal angle *conspicuously angulated.* (6) *Anal triangle of hind-*

* Rambur, Neuroptères, p.209, 1842.

† I have chosen this species as being one that is both well known to me and very typical of the genus.

wing of ♂ rather short, broad, three-celled. (7) Triangles of fore- and hind-wings of equal length, 6-7 celled, and practically similar. (8) Nodal sector, just below the pterostigma, takes an abrupt and conspicuous bend, and then runs straight to the margin of the wing. (9) Arculus at least 2 mm. from the inner angle of the triangle; *at least one* hypertrigonal cross-vein interposing.

AUSTROGYNACANTHA [*G. heterogena*]. — (1) Size moderate, expanse of wings in ♂ about 80 mm. (2) *Abdomen of both sexes not constricted at segment 3.* (3) Spurs of segment 2 smaller, not very conspicuous, *angulated.* (4) Hindwings only moderately broad. (5) *Anal margin of hindwing of ♂ scarcely angulated at all;* the outer side of the anal triangle scarcely, if at all, thicker than the rest of the postcostal margin, and *curving insensibly round to join it at the anal "angle."* (6) *Anal triangle long and narrow, four-celled.* (7) Triangle of hindwing somewhat shorter and broader than that of the forewing, both four-celled. (8) Nodal sector takes only a slight and gentle curve. (9) Arculus scarcely 1 mm. from inner angle of triangle; *no* hypertrigonal cross-vein interposing.

The following may be indicated as less important, or subordinate, differences:—

GYNACANTHA (s.str.).—(10) Space between the fork of the subnodal sector and the supporting sector beneath it 5 or more cells broad. (11) 4-6 hypertrigonals in hindwing. (12) Between the short sector and the auxiliary sector lying below it, at its broadest point, 4-5 cells. (13) Superior appendages of ♂ very long (about 7 mm.), slender, narrow, and leaf-like. (14) Appendages of ♀ very long and exceedingly fragile. (15) Pterostigma 3·5-4 mm.

AUSTROGYNACANTHA.—(10) Space between the fork of the subnodal sector and the supporting sector beneath it 3 cells broad. (11) 2-3 hypertrigonals in hindwing. (12) Between the short sector and the auxiliary sector lying below it, at its broadest point, 3-4 cells. (13) Superior appendages of ♂ strong and fairly thick, not so long (5 mm.), narrow, sublanceolate. (14) Appendages of ♀ not so long, similar in form, and fragile. (15) Pterostigma 3 mm.

Of these differences, I consider Nos. 2, 5, and 6 of primary importance, and sufficient in themselves to place *Austrogynacantha* absolutely apart from *Gynacantha* (s.str.). The form of the abdomen may be seen in the Plate (fig.1); the remarkable formation of the anal triangle of the male, giving it practically a *rounded* hindwing, in fig.7; while that of *G. Rosenberghi* is shown in fig.6. The difference in the curvature of the nodal sector may be studied in figs.8 and 9.

The differences 10-12 may be directly attributed to the difference in size between the insects; while differences in the appendages and pterostigma cannot be pressed, for we find an amazing amount of variation in these respects in the *Aeschnidæ*. For instance, the species of the genus *Austroaeschna* show remarkable variety in the size and shape of the appendages of both sexes; while actually in the *individual* specimens of *A. unicornis* Selys, the pterostigma shows a considerable variation in length.

It is now necessary to indicate the differences between *Karschia* Förster, and *Austrogynacantha* Tillyard. This can only be done by a comparison of the females, the males of *Karschia* being still unknown. Furthermore, the position of *Karschia* in any classification of the *Aeschnidæ*, as well as its exact relation to *Gynacantha* (s.str.) cannot be accurately determined until the males are forthcoming.

Karschia Förster (*K. cornuta*♀ Foërster).—(1) Upper edge of front interrupted in the middle, more or less projecting in an angle. (2) Eyes strongly arched above, not depressed. (3) Spikes of the terminal fork of the tongue-shaped abdominal appendage on seg. 10 only half as long as the tongue. (4) Between nodal and principal sectors, near end of wing, only 5 rows of cells at the most. (5) 3-4 hypertrigonals in hindwing.

Austrogynacantha Tillyard (*G. heterogena* ♀).—(1) Upper edge of front *not* interrupted in the middle, straight or very slightly curved as in *Gynacantha* (s.str.). (2) Eyes weakly arched above, as in *Gynacantha* (s.str.). (3) Spikes of the terminal fork of the tongue-shaped abdominal appendage on seg. 10 almost as ong as the tongue (Plate v. figs. 4, 5). (4) 6-7 rows of very small cells. (5) 2-3 hypertrigonals in hindwing.

Karschia and *Austrogynacantha* apparently agree in the shape of the abdomen at segment 3, and also in the curvature of the nodal sector under the pterostigma.

Austrogynacantha and *Gynacantha* (s.str.) agree in the shape of the front and eyes, and practically also in the form of the membranule, which, though small in both, can scarcely merit the summary dismissal implied in the "presque nil" of Rambur (Plate v. figs. 6, 7).

The following key will now serve to distinguish the new genus and to show its correct position in a classification of the Australian genera of the subfamily *Aeschninæ*.

	Hindwing of ♂ *without* an anal triangle (*i.e.*, postcostal margin *quite rounded*)........................	*1.*
	Hindwing of ♂ *with* an anal triangle (*i.e.*, postcostal margin *more or less angulated*)..........................	*2.*
1	Inferior appendage of ♂ truncated....................	*Anax.*
	,, ,, ,, triangular	*Hemianax.*
2	Subcostal vein prolonged beyond nodus............	*Telephlebia.*
	,, ,, *not* prolonged beyond nodus........	*3.*
3	Basilar space reticulated..................................	*Caliaeschna.*
	,, ,, free..	*4.*
4	Subnodal sector *not* bifurcated..........................	(absent from Australia)
	,, ,, bifurcated...............................	*5.*
5	One row of cellules under fork........................	*Austroaeschna.*
	3-7 rows ,, ,, ,, ...	*6.*
6	Seg. 10 of ♀ rounded below, carrying small spines	*Aeschna.*
	,, ,, prolonged below into a tongue armed with two distinct prongs	7.
7	Anal triangle of ♂ *fairly broad, 3-celled;* postcostal margin *strongly angulated*................	*Gynacantha.*
	Anal triangle of ♂ *very narrow and long, 4-celled;* postcostal margin scarcely angulated at all...	*Austrogynacantha.*

AUSTROGYNACANTHA HETEROGENA.

Gynacantha heterogena Selys MSS. (♀).

♂. Total length 59-60 mm.; abdomen 46 mm.; fore and hindwings 37-38 mm. W i n g s: *costa* brown, *subcosta* and *nodus* pale brown, rest of neuration dark brown to black; *pterostigma* 3 mm., dark brown; *membranule*, fore very small, white; hind 1·5 mm., very narrow, white. *Nodal Indicator*

15-18	10-13
11-14	10-13

Head: *eyes* dark brown, very contiguous; *occipital triangle* very small, yellow; *vertex* very small, forming a yellow crescent-shaped tubercle. *Front* hairy, dull yellowish-brown above, upper edge marked with an indistinct dark brown ray gradually merging into the ground-colour; *face* olive-green, yellowish on sides; *clypeus* hairy, greenish-yellow; *labrum* dull greenish-yellow, an indistinct narrow brown line in suture next clypeus; *labium* and *genæ* dull yellowish, mouth edged with dark brown. Thorax: *prothorax* very small, brown. *Meso-* and *metathorax* rather short and thick, dark chocolate-brown above, dorsal ridge yellow, elevated near its centre into a sharp spine; on either side a beautiful slanting lemon-yellow antehumeral ray, rather short, and tapering to a point outwards in front. Sides of thorax greenish-yellow, more or less shaded with brownish-olive. Wing-joins and notum pale brown, profusely spotted with yellow. *Legs* very dark brown, underside of pro-femora pale yellowish, tibiæ distinctly ciliated. Abdomen: 1 wide, 2 slightly narrowing, 3 *not* constricted, 3-10 almost cylindrical, if anything 7-9 slightly wider than the rest, 2-7 with supplementary transverse carinæ. Colour: 1-2 dark brown, rest black, marked with pale lemon-yellow (greenish-yellow in mature specimens) as follows:—1, base yellow, a short dorsal mark and two small anal spots, sides also yellow—2, a distinct longitudinal dorsal ray, constricted in the middle by the supplementary carina, which divides the segment slantingly; a pair of indistinct central spots, very small, bordering the carina above and inclined to the dorsal ray, a pair of small anal spots; sides yellow, sutures with transverse brown rays, a brown line along the central carina; spurs very small, angulated, lemon-yellow; genital appendages not prominent—3, a fine dorsal line slightly thickened basally and broken by the carina; a pair of small central spots just below the carina and very close together; a pair of larger anal spots, wide apart; sides yellowish, except sutures and carina, which are brown—4-7, a fine dorsal line, a pair of small round central spots close together, a pair of longitudinal spots wider apart, very little yellow on sides—8, a touch of yellow at base, a pair of spots one-third from base, a pair of large anal spots, wider apart—9, a pair of very small spots at base; a pair of anal spots wide apart—10, a pair of anal spots. Appendages: *superior* long and slender, 5 mm., narrow sublanceolate, black; projecting slightly below inwards just before half-way so as to form a very obtuse ledge, carrying a series of longish hairs on inner margin. *Inferior* nearly straight, slightly upcurved, hollow above, narrow subtriangular, 2 mm. (Plate v. figs. 2 and 3—the hairs are not quite as dense as shown).

♀. Very similar to ♂ but somewhat larger. Total length 60-65 mm.; abdomen 48-50 mm.; fore- and hindwings 39-41 mm.; pterostigma paler. Abdomen slightly thicker than in ♂, marked as in ♂, but the longitudinal dorsal ray more conspicuous, wider on first half of seg. 2, and on 3-7 slightly enlarged basally into a small triangular area; 9 somewhat larger than 8, 4 mm. long; 10 very short and narrow. Ovipositor with a very long and narrow spike, dark brown, reaching to below the end of 10 (*not* shown in the Plate); anal end of 9 carrying below two small 2-jointed filaments; 10 projecting below into a conspicuous tongue furnished with two prongs or forks curving downwards, their length being about equal to the distance which the tongue itself projects beyond the base of the rounded end of 10; this rounded end forming a pale downy tubercle placed above the tongue. Appendages very fragile [nearly always missing], 3 mm., dark brown, slender, leaf-like, narrow lanceolate, with hairs on inner margin. (Plate v. figs. 4, 5).

Hab.—Northern and Central Queensland: Rockhampton; Cooktown (February).

Types: The male is in my collection, the female in Coll. de Selys.

EXPLANATION OF PLATE V.

Fig. 1.—*Austrogynacantha heterogena* ♂, nat. size.
Fig. 2. ,, ,, ,, appendages seen from above.
Fig. 3. ,, ,, ,, ,, seen sideways.
Fig. 4. ,, ,, ♀, ,, seen from above.
Fig. 5. ,, ,, ,, ,, seen sideways.
Fig. 6.—*Gynacantha Rosenberghi* Selys ♂; anal triangle of hindwing.
Fig. 7.—*Austrogynacantha heterogena* ♂; venation of basal portion of hindwing.
Fig. 8.—*Gynacantha Rosenberghi* Selys; portion of forewing, showing curvature of nodal sector.
Fig. 9.—*Austrogynacantha heterogena*; portion of forewing, showing curvature of nodal sector.

WEDNESDAY, JULY 29TH, 1908.

The Ordinary Monthly Meeting of the Society was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, July 29th, 1908.

Mr. J. H. Maiden, F.L.S., Vice-President, in the Chair.

Mr. George I. Playfair, Auburn, was elected an Ordinary Member of the Society.

The attention of Members was called to a circular received from the Hon. Secretaries of the Anderson Stuart Testimonial Fund.

A letter from the Royal Society of South Australia was read, urging "the necessity for legislation to preserve the fauna of New South Wales. This, it is thought, may be possibly best effected by providing for the complete protection of the fauna in all the forests of the State, in any legislation which may be introduced on the Report of the Royal Commission on Forestry" now exercising its functions.

A letter from the Advisory Committee *re* Fisheries and Game Acts in Victoria, Melbourne, inviting the Society's co-operation in approaching the Federal Government with a view to the prevention of the export of the plumes or skins of Egrets, Lyrebirds, Birds of Paradise, &c., as one means of checking the destruction of native birds, was also read. The recent introduction, to the British Parliament, of the Prohibition of Plumage Importation Bill, by Lord Avebury, suggests that the present time is a suitable one for taking actio n in Australia

At the next Meeting of the Society, on 26th August, it is proposed to afford the Members the opportunity of considering the two propositions outlined above, as part of the general question of the welfare of the flora and fauna, and the best means of safe-guarding it. Members are requested therefore to extend invitations to be present to others who are interested in the question. Country Members who are unable to attend are requested to forward statements of their views and experiences. The last Presidential Address (Proceedings, 1908, pp.28-37) may advantageously be kept in mind.

At the present time there are two Acts in force in this State having for their object the protection of certain species of birds and mammals—the "Birds' Protection Act, 1901," and the "Native Animals' Protection Act, 1903."* What has been the outcome of the introduction of this legislation? Evidence bearing upon this and cognate matters is especially asked for.

The Donations and Exchanges received since the previous Monthly Meeting, amounting to 22 Vols, 64 Parts or Nos., 17 Bulletins, 8 Reports, and 15 Pamphlets, received from 56 Societies, &c., and one Individual, were laid upon the table.

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* Copies of these documents are procurable at the Government Printing Office.

NOTES AND EXHIBITS.

Mr. Froggatt showed a specimen of a beautiful neuropterous insect, with curiously modified hind wings, *Chasmoptera huttii*, from West Australia. The species was described and figured by Westwood in 1847 (Trans. Ent. Soc. London, v., Journ. Proc. p.xxvii., pl. viii. fig. 1), two specimens at that time having reached England. Mr. Du Boulay had recently been successful in rediscovering this interesting form.

Mr. Palmer exhibited a fine series of examples of aboriginal chipping work from the north-west coast of Australia, illustrating the aptitude of the Blacks in utilising material which civilisation had brought within reach—glass-bottles, insulators, &c.—for fashioning spear-heads; specimens of the curious bird-like flowers of *Crotalaria Cunninghamii* R.Br., from West Australia; and, from Lawson, Blue Mts., a remarkable coccid gall (*Brachyscelis duplex* Schrader) and some heteromerous coleoptera.

Mr. Musson sent, for exhibition, two examples of *Loranthus linophyllus* Fenzl, *in situ* upon unusual hosts, namely *Melaleuca linariifolia* Sm., and a cultivated Plum (var. Loutherboro') from the neighbourhood of Richmond, collected by Mr. R. Farlow.

Mr. W. S. Dun exhibited a series of specimens of Graptolites, collected by Mr. J. E. Carne, from Parish Inverary, County Argyle, on the Shoalhaven River about 12 miles from Tallong. These fossils prove a great extension of the Ordovician system in this State. The beds are of the same age as those developed in N.E. Gippsland of Upper Ordovician age; and in the Delegate and Berridale (Cooma) districts. The following genera and species are represented :—*Climacograptus affinis*, *Diplograptus foliaceus* and *D.* sp., *Dicranograptus*, *Dicellograptus affinis* and *D.* sp.

Mr. A. A. Hamilton exhibited (1) a specimen of *Pterostylis grandiflora* R.Br. [N.O. Orchideæ], from the Federal Pass, Katoomba (April, 1908), with a terete foliaceous bract about 1 in. long, springing from the base of the upper stem-leaf, a character not mentioned in descriptions; the examination of specimens in the National Herbarium, Botanic Gardens, disclosed an example from Kurrajong Heights with a similar bract, and one from Cook's River with the bract partially developed—(2) Specimens of *Baeckea crenulata* R.Br. [N.O. Myrtaceæ] from Mt. King George (J. Gregson; January, 1908), Woodford (J. H. Maiden; January, 1899), and Leura (A. A. Hamilton; December, 1907), showing that this plant, hitherto recorded from the coastal districts, has a wide range on the Blue Mountains.—(3) A specimen of *Paspalum brevifolium* Flügge, from Cook's River (A. A. Hamilton; February, 1908) described in the 'Flora Australiensis' as with "Spikes or panicle branches 2 or rarely 3"; whereas it was the rule rather than the exception for plants in the patch, from which the specimens exhibited were taken, to have 3-6 spikes.

THE ACIDITY OF MILK

By H. G. Chapman, M.D., B.S., Demonstrator of Physiology in the University of Sydney.

(From the Physiological Laboratory of the University of Sydney).

The reaction of milk is commonly stated in text-books to be alkaline or neutral. This statement is made with regard to the behaviour of litmus indicator towards cow's milk and for milk examined in Europe and America. In the more recent accounts,* however, authors note the amphoteric nature of the reaction By this term attention is drawn to the fact that milk behaves as an alkaline fluid towards indicators sensitive to basic substances and as an acid fluid towards those sensitive to acid substances. Red litmus paper is turned blue, and blue litmus paper red.

This amphoteric reaction depends upon the dissolved constituents of the milk. It is principally related to the amounts of dihydrogen and monohydrogen phosphate present in solution.

When acids or alkalies are added to a solution of phosphates an acid or alkaline reaction does not develop at once, and free acid and free alkali are not present in the liquid until a certain quantity of acid or alkali has been added. If, for example, hydrochloric acid is added to a solution of mixed phosphates, there is no free hydrochloric acid present at first, but the acid

* Raudnitz, Ergeb. f. Physiol. 1903, Abt.1, S.300.

reacts with monohydrogen phosphate to form dihydrogen phosphate. This change may be represented—

$$Na_2HPO_4 + HCl = NaH_2PO_4 + NaCl.$$

Similarly, when soda is added to a solution of mixed phosphates the reverse change occurs and dihydrogen phosphate is converted into monohydrogen phosphate. Thus—

$$NaH_2PO_4 + NaOH = Na_2HPO_4 + H_2O.$$

In these cases no free acid or alkali will be present until all the phosphate has been converted into the acid or basic phosphate as the case may be.

When this change is considered from the standpoint of the concentrations of hydroxyl and hydrogen ions* certain important applications become evident.

In distilled water ionisation occurs to a slight extent and H and OH ions are both present in relatively equivalent concentrations. If to this distilled water we add sufficient acid to make a solution of $\frac{N}{5000}$ then we have a great increase in the concentration of H ions and a relative diminution of the concentration of OH ions. In other words, we have a weak acid but a definitely acid solution. Similarly the addition of alkali to make a $\frac{N}{5000}$ solution will lead to an increase in the concentration of OH ions and a relative diminution in the concentration of H ions.

But if to a solution of mixed phosphates of similar concentration to the phosphates in milk, acid is added, then the amount of acid must be $\frac{N}{5}$ before the acid properties develop. Here the addition of acid causes no rapid change in the relative concentrations of H and OH ions, but instead there is the change in the phosphatic type shown above. If, on the other hand, to the phosphatic solution base is added, then sufficient alkali must be added to raise the alkaline content to $\frac{N}{20}$ before the concentration of OH ions becomes markedly increased and the concentration of H ions relatively diminished. In distilled water the addition therefore of a small quantity of acid or alkali is sufficient to

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* Compare Moore, and also Whitley, Biochem. Journ. Vol.i. 1906.

produce an excess of H or OH ions as the case may be. To pass from an excess of H ions to an excess of OH ions, only the addition of a small amount of alkali is required. But, on the other hand, in the solution of phosphates the points at which an excess of H or OH ions occurs are widely separated and much more acid or alkali must be added to pass from one side to the other.

The phosphates thus possess a regulating influence on the concentration of H and OH ions. In such a solution the concentrations of the two opposed ions may be regarded as mutually equivalent. The addition of acid or alkali will not alter these concentrations until much acid or alkali is present. The fluid will thus exhibit the characters of a neutral fluid, should small amounts of acid or alkali be added to it. Important applications of this regulating mechanism have been noted in the case of blood-serum, lymph, and urine as well as with milk.

During 1906 a large number of samples of milk obtained in New South Wales have been examined. In the case of milk bought in Sydney the reaction to litmus paper has been acid. This has been the case with every sample obtained, even with those that have been brought from the dairy to the laboratory in the morning. On first notice this acidity was ascribed to lactic acid. On neutralisation of this acidity with $\frac{N}{10}$ NaOH the behaviour was no longer that of fresh milk.* A little investigation showed that the acidity was not due to lactic acid present in the milk. Attention was then paid to milk immediately after removal from the cow, and my friend, Mr. J. M. Petrie, D.Sc., made a number of determinations at Singleton, for which I am greatly indebted to him.

To determine the capacity of milk to combine with alkali the milk has been titrated with $\frac{N}{10}$ NaOH, using phenolphthalein as

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* See Moseley & Chapman, Proc. Linn. Soc. New South Wales, Vol. xxxi. p.568, 1906.

indicator. It has been found that, when 1 c.c. of a 0·1 % alcoholic solution of phenolphthalein has been present in 100 c.c. liquid, it has been easy to determine the first appearance of the pink colour. The figures obtained have been found to vary with the method of titration adopted. After much experiment the following method has been adopted, and this has been used for all titrations.

25 c.c. milk have been added to a beaker which has contained 100 c.c. distilled water (free from CO_2) and 1 c.c. phenolphthalein solution. $\frac{N}{10}$ soda has then been run in until the first pink colour has been observed.

When the method is varied, different results have been obtained. Thus with the same milk the following results have been found:

25 c.c. milk plus 1 c.c. phenolphthalein,	at 17° C,	required	4·2 c.c. $\frac{N}{10}$ NaOH.
25 c.c. milk plus 1 c.c. phenolphthalein, plus 50 c.c. water	,,	,,	3·4 c.c. ,,
25 c.c. milk plus 1 c.c. phenolphthalein, plus 100 c.c. water	,,	,,	3·35 c.c. ,,
25 c.c. milk plus 1 c.c. phenolphthalein, plus 100 c.c. water	at 70° C,	,,	3·8 c.c. ,,

It has been invariably found that heating the milk increased the amount of alkali to be added, and that dilution diminished the amount up to a certain figure, and then further dilution produced only a slight effect.* It is customary to designate the number of cubic centimetres of decinormal soda used to neutralise 100 c.c. milk as so many degrees of acidity. The figures obtained for 25 c.c. milk have been multiplied by 4 to obtain this figure.

Upon determining the degree of acidity of milk within one minute after its removal from the mammary gland of the cow, it has been found to vary from 12° to 19° acidity in 14 cows. The figure for the mixed milk of the 14 cows at the end of milking

*Compare Söldner, Landw. Vers.-Stat., Bd.35, S.354, 1888; and Siegfeld, Hildesheim. Molkereiztg., 1900.

was 15·5°. All these samples turned blue litmus paper red and red litmus paper blue. Fluid litmus solution was turned red. The samples were all without effect upon Congo red paper, which detects free acid. The cows were tested on December 18th at a farm on the Hunter River, 150 miles north of Sydney, at about 4.45 a.m. The detailed figures are given in Table i.

Table i.

No.	Temperature.	Acidity in degrees.	Red litmus paper.	Blue litmus paper.	Congo red paper.
1	32°C	14	blue	red	neutral
2*	26°C	15	,,	,,	,,
2†	36°C	13·5	,,	,,	,,
2‡	30°C	13	,,	,,	,,
2§	30°C	14	,,	,,	,,
3	36°C	15	,,	,,	,,
4	30°C	15	,,	,,	,,
5	31°C	17	,,	,,	,,
6	34°C	19	,,	,,	,,
7*	27°C	15·5	,,	,,	,,
8*	27°C	15	,,	,,	,,
9*	27°C	16·5	,,	,,	,,
10*	29·5°C	16	,,	,,	,,
11*	29·5°C	16	,,	,,	,,
12*	29·5°C	16	,,	,,	,,
13†*	28°C	12	,,	,,	,,
13§*	28°C	14	,,	,,	,,
14*	28°C	17	,,	,,	,,
Mixed milks*	29°C	14·5	,,	,,	,,

A determination has been made of the rate at which the acidity alters in a sample of milk. This milk was drawn into an open vessel kept covered from dust though air freely entered. The results are recorded in Table ii.

* Cooled quickly.
† First drawn milk.
‡ Last drawn milk.
§ Average sample from milking pail.

TABLE ii.

Time.	Age of Milk.	Temperature of Milk.	Acidity.	Blue litmus paper.	Red litmus paper.	Remarks.
4.45 a.m.	1 min.	32°C	14°	faint red	faint blue	
5.45	1 hour	28°C	13°	,,	,,	
6·45	2 hours	26°C	13°	,,	,,	
7.45	3 ,,	27°C	13°	,,	,,	
8.45	4 ,,	28°C	12·5°	,,	,,	
9.45	5 ,,	30°C	12°	red	,,	
10.45	6 ,,	32°C	12°	,,	,,	
noon.	7½ ,,	34°C	11°	,,	,,	
12.45p m.	8 ,,	34°C	12°	,,	,,	
1.45	9 ,,	36°C	13°	,,	,,	
2.45	10 ,,	35°C	13°	,,	,,	
3.45	11 ,,	35°C	18°	,,	,,	
4.45	12 ,,	35°C	21°	very red	,,	
5.45	13 ,,	34°C	28°	very red	unchanged	smell suspicious, not acid to taste
6.45	14 ,,	33°C	29·5°	,,	,,	sour to taste
6.45 a.m.	26 ,,	—	90°	,,	,,	thick and sour
9.45 a.m.	29 ,,	—	90°	,,	,,	thick and sour

These figures show that the acidity slightly diminishes until the eighth hour and then increases slowly until the eleventh hour, after which the rate of increase is greater.

The figures for a large number of milks which had been mixed together have been determined at the delivery depôt of a milk factory. The longest interval between milking and titration was under three hours. These results are recorded in Table iii.

TABLE iii.

No.	Acidity.	No.	Acidity.
1	12°	11	13·5°
2	12°	12	12°
3	12·5°	13	14·2°
4	12·5°	14	14·5°
5	13°	15	14°
6	13°	16	13·5°
7	14°	17	14°
8	15°	18	13·5°
9	13°	19	12·5°
10	13°	20	13·5°

These figures show the acidity to vary from 12° to 15°.

The number of milks that have been estimated in Sydney has been large, and only a consecutive number are recorded in Table iv.

TABLE iv.

Milk.	Acidity.	Milk.	Acidity.
1	14°	9	16°
2	20°	10	13°
3	18°	11	14·5°
4	19·2°	12	16·4°
5	15°	13	15·2°
6	15°	14	14·8°
7	18·8°	15	13·6°
8	17°		

These figures cannot be compared with those in the other Tables, since it is not known how old the samples were. In some cases in which the source was known the acidity was higher (18° to 20°) than in country milk (12° to 15°).

It is interesting to note that the acidity of milk bought in Sydney does not alter for some hours even when kept at a temperature of 37° C. Thus, one sample giving an acidity of 16° at 9.30 a.m., showed no alteration at 12.40 p m.; and at 5.40 p.m., after 5 hours in the water bath at 37° C, gave the same figure upon titration. In some cases the acidity commenced to rise towards the end of 6 hours' incubation.

As mentioned previously, the acidity of the milk was at first ascribed to lactic acid. This view became untenable when it was found that $CaCO_3$ even after hours failed to greatly reduce the acidity. In a sample of milk of acidity 17·6°, after some hours contact with $CaCO_3$ at 70° C the acidity was 16°. In this sample the lactate was directly estimated and was found to be equivalent to only 0·25 c.c. $\frac{N}{10}$ NaOH for each 100 c.c. milk.

Samples of milk of known acidity have been filtered through Chamberland filters under a pressure of 4 atmospheres. The filtrate is perfectly clear with a faint yellow tinge when viewed in quantity by reflected light. The acidity of the filtrate is low, being 5° or less. Filtration through porcelain removes not only the fat and caseinogen but also the greater part of the phosphate which is present in suspension, not in solution.

In 100 c.c. milk there has been found 0·236 gm. P_2O_5, while in 100 c.c.* of the filtrate through porcelain has been found 0·082 gm. P_2O_5. Since caseinogen contains phosphorus, a determination of the phosphate not combined with caseinogen has been made. 20 c.c. milk were heated to 70°C and mixed with 20 c.c. 2 % acetic acid, likewise heated to 70°C. After a few minutes' standing the precipitate was filtered off. Of the filtrate 32 c.c. were collected and considered to correspond to $\frac{32}{40}$ths of the 20 c.c. milk. The phosphate was estimated by calcining with excess of pure soda, by precipitation with ammonium molybdate and by weighing the phosphate in the latter precipitate as magnesium pyro-phosphate. The weight of P_2O_5 uncombined with caseinogen in the milk has been found to be 0·175 gm. A little more than one-half of the uncombined phosphate was thus removed by filtration through porcelain.

In the sample of milk under consideration the acidity was 12° and the total phosphate equivalent to 0·236 gm. P_2O_5% of which 0·175 gm. P_2O_5% was uncombined with caseinogen, while after filtration the acidity fell to 4° and the phosphate to 0·082 gm. P_2O_5%.

From these figures it is evident that the increased acidity of the whole milk is due not only to the presence of phosphates but also to the caseinogen which possesses similar powers of changes from dicaseinate to monocaseinate and *vice versâ*.

In conclusion I beg to record my thanks to Professor Anderson Stuart, in whose laboratory this investigation was carried out.

* 100 c.c. filtrate corresponds more nearly to 112 c.c. milk than to 100 c.c. milk.

ON THE GENUS *NANNODYTHEMIS*, WITH DESCRIPTIONS OF NEW SPECIES.

[NEUROPTERA: *Odonata.*]

By R. J. TILLYARD, M.A., F.E.S.

(Plate vi.)

The genus *Nannodythemis* was proposed in 1868 by Brauer* to receive an aberrant species of the *Libellulinæ* from Australia, which became the type under the name of *N. australis*. It is a short stumpy-looking insect with brilliant red abdomen; and as it sits about on the reed-stems, with its wings depressed and abdomen curved, it irresistibly suggests some kind of wasp. Brauer's specimens were from Moreton Bay, Queensland, and I have found it to be fairly common in coastal swamps in New South Wales, especially at Byron Bay.

While on a visit to Western Australia, in January, 1907, I found in a swamp at Wilgarrup, near Bridgetown, an insect very similar to the above species. I took it to be *N. australis*; but, later on, when I had the two series side by side in my collection, I could see considerable differences, not only of size, but of venation and colouration; and I made a note suggesting that the Western Australian form was a new species. However, as I possessed no description of Brauer's species and had not seen the types, I published the western species as *N. australis* Brauer,† only remarking on the greater size of the western form. Later on I wrote to Dr. Ris, the expert on *Libellulinæ*, and to M. René Martin, mentioning these circumstances, and I was glad to find that they too had recognised, in de Selys' collection, two distinct

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* Brauer, Verh. zool-bot. Gesell. Wien, xviii. pp.369, 726(1868).

† See "The Dragonflies of Western Australia," these Proceedings, 1907, Vol.xxxii., p.723.

forms of *Nannodythemis*. I also obtained the information that Brauer's species was, as I had expected from its locality, most certainly the smaller form.

I now had materials for a short paper on the genus; but there was a further surprise in store for me. After making careful descriptions of the two species, I paid a visit to Wentworth Falls, hoping to get a better series of *N. australis* than I had at the time. There I took, in February of this year, two distinct species of this genus, one of which was certainly *N. australis*, but the other quite distinct from it and from the western form. Of the new form I was unfortunately only able to take four males and two females, but these, with my long series of the other two species, are sufficient to determine accurately the existence of three distinct but closely allied species of the genus.

Brauer distinguished his genus *Nannodythemis* from *Nannophya* Rambur* chiefly by the fact that the triangle of the hindwing is normal (*i.e.*, three-sided) in *Nannophya* while in *Nannodythemis* it is abnormal (*i.e.*, quadrilateral). Now in the two new species before me, which are evidently so closely allied to Brauer's *N. australis* that there can be no doubt as to their being congeneric, we find the following remarkable fact:—in the western form, the triangle of the hindwing in both sexes is normal; in the form from Wentworth Falls the males have normal triangles, while the two females I possess have an abnormal triangle in the hindwings. The former should then be placed in *Nannophya*, together with the male of the latter; while the female of the latter is a true *Nannodythemis*! The solution of this difficulty is an obvious one. Brauer, in creating the genus *Nannodythemis*, chose in defining it a variable character, which, far from being of true generic value, is not even of specific value. I can even find in my series of *N. australis* several individual specimens which possess a normal or nearly normal triangle in the hindwings, either on one side only or on both; while in my series of the western form careful examination reveals the

* Rambur, Ins. Névr. p.27(1842).

beginnings of a fourth side in one or two specimens. This extreme variability of the hindwing triangle causes it to lose absolutely its generic value, and the only course open to us is to suppress *Nannodythemis* Brauer, in favour of the older genus *Nannophya* Rambur. If the name *Nannodythemis* is to be retained at all, it must be used only as indicating a geographical subgroup of the principal genus *Nannophya*, to include the three Australian species which are so closely allied. And in this sense only I will retain the name in this paper, as I prefer that Dr. Ris should deal more fully with the two names in his great work on the "Libellulines" which will shortly be published..*

I propose to name the Western Australian form *N. occidentalis*, and to give to the third species (that from Wentworth Falls) the name of *N. Dalei* in memory of de Selys' great friend, the well-known British entomologist Mr. Dale; this name having already been applied by de Selys to this species on the label in his cabinet. In order to understand fully the differences between these three closely allied species, I will include a careful description of *N. australis* Br., taken from my own series.

1. N. AUSTRALIS Brauer. (Plate vi. fig.1).

♂. Total length 20-21 mm.; abdomen 13-13·5 mm.; forewing 14-14·5, hindwing 13·5-14 mm. Wings well rounded, neuration black, bases very slightly or not at all saffroned in mature specimens; in some less mature specimens there is saffroning up to arculus of forewing and from base to behind nodus of hindwing. *Pterostigma* 1 mm., dark brown between the black nervures, outer portion just whitish. Sectors of *arculus* arising together at or near its base. *Triangle* of forewings abnormal, the two portions of the upper side being practically equal; *triangle* of

* I have to thank Dr. Ris for showing me the generic difference; I myself did not possess the published definitions of the two genera until recently. Hence while I must put on record the two new species for inclusion in Dr. Ris' great work, I feel I should leave the full discussion of the generic differences to him who first discovered them.

hindwings also abnormal, the proximal portion of the upper side twice as long as the distal portion.* One cross-nervure in submedian space of forewing; *two* in that of hindwing. *Membranule* almost nil. *Nodal Indicator* $\left\Vert\begin{array}{cc}5 & 4\\ 4 & 4\end{array}\right|$ three to five single cells following triangle of forewings (generally five). Head: *eyes* dark brown, paler beneath; *vertex* very small, tubercled, dull greyish or blackish, *antennæ* 1 mm., black; *front* well rounded, slightly indented behind medially, shining olive-grey, with stiff black hairs; *clypeus* olive-grey, hairy; *labrum* and *labium* ochreous, *mouth* edged with black. Thorax: *prothorax* dull blackish. *Meso-* and *metathorax* downy, black, carrying above, in the less mature specimens, a pair of narrow nearly straight antehumeral bands, bright lemon-yellow, about 2 mm. long, and slightly indented or hooked inwards anally; sides of thorax with a broader straight lateral yellow band followed by a less regular and slightly narrower black band below, then an irregular sublateral yellow band, then a wavy black line in the suture; rest of sides and underside yellowish; *notum* black, scuta and scutella yellow. *Legs* black with stiff spines, coxæ touched with yellow. In the more mature insect all these markings are obliterated by a covering of dull dark greyish pruinescence. Abdomen: 1-2 slightly enlarged, 3-5 very narrow cylindrical, 6 widening, 7-9 strongly dilated, flat underneath, 10 narrower. Colour: in the less mature insect, 1-6 black marked with orange-yellow as follows—1, an anal transverse band or two elongated anal spots; 2, orange, with a large dorsal area of black of variable shape, but generally much enlarged in the middle and stalked basally; 3, a pair of large basal spots, a pair of central spots, and a pair of very small anal spots, having an irregular black dorsal area, stalked basally, but very variable in shape; 4, a pair of basal spots and a pair of elongated central spots, or sometimes one long patch on each side; 5, an elongated spot on each side; 6, a larger suboval patch on each side. In the more mature insect 1-3 are covered with dull grey pruinescence, the sutures, dorsal ridge,

* I possess one or two specimens with the triangles practically normal.

and transverse carinæ shining black; 4-5 nearly black, the orange markings more or less obliterated; 6 with the large spots red; 7-10 brilliant red, each segment sometimes with a more or less regular transverse anal black band, and sometimes unmarked except for a black point at the tip of the segment, low down on each side. A p p e n d a g e s : *superior* 0·8 mm., narrow, wavy, sublanceolate, carrying a few fine hairs; just touching near tips; pointed, red. *Inferior* 0·6 mm., subtriangular, tip slightly upcurved, orange-red.

♀. Total length 19-21 mm; abdomen 12·5-13·5 mm.; forewing 15-16 mm.; hindwing 14·5-15·5 mm. Wings as in ♂ but with a considerable amount of saffroning, extending in forewings nearly to arculus, and in hindwings covering a larger area nearly to arculus, lighter along costa, and another light patch along nodus. H e a d : *eyes* paler than in male, bright ochreous underneath; *front*, *clypeus* and *labrum* yellower than in male. T h o r a x as in the less mature male. A b d o m e n wider and more cylindrical than in male; colour black, marked with orange as follows—1, a transverse anal band; 2, sides orange crossed by a thick black line on the transverse carina; 3, a large orange patch on each side; 4-6, an elongated oval spot or patch on each side; 7, a very large oval spot on each side; 8, a smaller subtriangular spot on each side; 9, a pair of small basal lateral spots; 10, black, suture orange. Underside black with large semielliptical yellowish spots on either side of each segment, 2-6 downy beneath. A p p e n d a g e s separate, 0·4 mm., subconical, pointed, hairy, orange with black tips.

Hab.—Queensland: Moreton Bay—New South Wales: Byron Bay, National Park, Wentworth Falls, and probably on all coastal swamps and mountain bogs. It appears at the end of September, when it may be found sitting in characteristic attitude on the reed- and grass-stems, with wings very much depressed and abdomen somewhat curved inwards. It continues on the wing until February. Its flight is irregular, close to the surface of the water, or in and out among the reed-stems. The females are less active and are found in the thicker parts of the reed-beds.

2. N Dalei, n.sp. (Plate vi. fig.2).

♂. Total length 23-25 mm.; abdomen 15-16 mm.; forewing 17·5-18·5 mm., hindwing 16·7-17·7 mm. Wings: neuration black, bases touched with saffron for 1 mm. in forewings and 1·5 mm. in hindwings. *Pterostigma* 1·3-1·6 mm., black, touched with white at inner end and with a small triangular area of white at its outer end. *Only one* cross-nervule in submedian space of all wings. *Triangle* of forewings abnormal, the proximal portion of the upper side about twice as long as the distal portion; *triangle* of hindwings normal. 2-3 single cells following triangle of forewings (generally 2). *Nodal Indicator* ‖ 5 5-6 / 4 5-6. *Membranule* almost nil. Head: *eyes* brown, occipital triangle black above, yellow underneath, hairy; *vertex* and *antennæ* black; *front* well rounded, deeply cleft medially, yellow covered with thick black hairs, *a large black patch in front*; *clypeus* yellow, sometimes touched with black; *labrum* yellow with a small black patch in the middle; *labium* yellow, mouth edged with black. Thorax: *prothorax* black, with a small dorsal double spot, yellow. *Meso-* and *metathorax* jet black with fine hairs, a touch of yellow along the dorsal ridge; on each side an antehumeral lemon-yellow band, narrow, slightly indented or hooked inwards anally; sides bright yellow, with irregular black lines in sutures, underside yellow; *notum* black, scuta, scutella, and some small spots on wing-bases orange-yellow. In the more mature insect these markings are all much duller and darker, but I have seen no signs of pruinescence even on specimens taken as late as February. Abdomen broader and less pinched than in *N. australis*; 1-3 slightly enlarged, 4-5 very slightly narrower, 6 widening, 7-9 dilated, but not so much, proportionately, as in *N. australis*, 10 narrower. Colour: 1-4 orange-red marked with black as follows—1, a transverse black band; 2, dorsal area more or less widely black; 3, an irregular longitudinal dorsal black band or line, enlarged anally, the transverse carina more or less black; 4, a longitudinal dorsal black band, enlarged at both ends, very variable; 5-6 very variable, bright red, a dorsal line or band of black, thick or thin, enlarged anally; 7-10 brilliant red; 7-8 sometimes touched with black dorsally; a touch of black in sutures. Appendages: *superior* 1 mm., separate, narrow, wavy, sublanceolate, carrying fine hairs, just touching near tips; red or orange-red touched with black at tips. *Inferior* 0·8 mm., subtriangular, tip slightly upcurved; orange.

♀. Total length 22 mm.; abdomen 14 mm.; forewing 17·5 mm.; hindwing 16·7 mm. Wings as in male, *except triangle of hindwings, which is abnormal.* Head as in male, *but lacking the black marks on front and labrum.* Thorax as in male. Abdomen shorter and thicker than in male, nearly cylindrical; colour orange or dull orange-brown, with an irregular longitudinal dorsal black band, and transverse basal and anal black bands on each segment; on each side a broad sublateral band of black reaching from middle of 3 to end of 8 and connected with the dorsal band by the transverse bands of each segment; underside yellowish, ventral carina blackish, 1-8 very hairy beneath.

Hab.—N.S.W.: Blue Mts., Blackheath, Katoomba, and Wentworth Falls, also National Park—Victoria: Mt. Macedon. Rare. October-February.

It inhabits mountain bogs and swamps; its flight and habits are very similar to the preceding species.

3. N. OCCIDENTALIS, n.sp. (Plate vi. fig.3).

♂. Total length 24-27·5 mm.; abdomen 15·5-18 mm.; forewing 18-19·5 mm.; hindwing 17-18·5 mm. Wings: *neuration* black, bases strongly saffroned for 1-2 mm.; *pterostigma* 1·2-1·6 mm., black with a small white area along inner margin and a larger triangular white area along the outer margin. [The peculiar formation of the pterostigma is shown in the enlarged fig.4 in the plate]; *membranule* almost nil; *triangle* of forewings abnormal, the proximal portion about twice as long as the distal portion; *triangle* of hindwings normal;* *only*

* Slightly abnormal in one or two specimens.

one cross-nervule in submedian space of all wings; 1-4 single cells following triangle of hindwings (generally 1-2). *Nodal Indicator* ‖6 6·8| / ‖4 6-8| Head: *eyes* brown above, yellowish beneath; orbits black behind, spotted with yellow; *vertex*, *antennæ* and *ocelli* black; *front* cleft medially, pale yellow with thick black hairs; *clypeus*, *labrum* and *labium* mustard-yellow; *mouth* edged with brown. Thorax: *prothorax* black, a short yellow collar in front, a central yellow spot, and a larger anal yellow spot. *Meso-* and *metathorax* hairy, black, a touch of yellow along dorsal ridge; a pair of *broad* straight antehumeral yellow bands, somewhat hooked inwards anally, followed closely in front and behind by a small yellow spot; below, on each side, a thick black band; rest of sides yellow, with an irregular black mark in the sublateral suture running to the coxæ and sending a short transverse branch upwards to join the black groundcolour in front; *underside* mustard-yellow with a pair of elongated black spots and a round dot between them; *notum* black, scuta and scutella yellow; several tiny yellow points at the wing-bases. *Legs* black with stiff spines, coxæ yellow. Abdomen subcylindrical, flat underneath, 1-2 slightly swollen, 3-5 cylindrical, 6-9 dilated, but not so much as in the two preceding species, 10 narrower. Colour: 1, very small, black above, a transverse anal line, sides yellow; rest of abdomen brilliant red in the mature insect; 2, with a black dorsal mark, irregular, and generally shaped like a stalked goblet; a touch of black on sides and on transverse carina; anal ends of all segments more or less shaded with dull black, either as a narrow anal band or a dorsal spot and a pair of distinct, very small, sublateral spots; 10 short, red. In the teneral insect only the tip of the abdomen is red, the rest being orange, more or less marked with black. *Underside* orange, ventral carina black. Appendages: *superior* 1-2 mm., wavy narrow sublanceolate, bases separated, tips almost touching; slightly hairy, orange-red, pointed. *Inferior* 0·9 mm., subtriangular, tip slightly upcurved, dull orange; a small bunch of hairs beneath it on 10.

Mature males of this species show no signs either of pruinescence or any darkening of thorax and base of abdomen.

♀. Total length 24-26·5 mm.; abdomen 16-17·5 mm.; forewing 18-19·5 mm.; hindwing 17-18·5 mm. Wings as in male; bases more suffused with saffron (2-3 mm.), pterostigma somewhat larger. Head and thorax as in male. Abdomen broad, subcylindrical, 2-3 slightly narrower than rest, 4-8 broadening, narrower again. Colour: 1, black with basal and anal transverse yellow lines. Rest of abdomen either fulvous, brown or testaceous according to the individual and age; a more or less irregular black dorsal line all the way down, swelling out at both ends of each segment, very broad on 8-9. On each side an irregular black sublateral band along 2, half of 3, and 4 6 or 7; these two bands are connected with the dorsal band by transverse black bands across the sutures, those of 2-3 narrow, the others broader, and those of 7-9 separated by a fine orange line along the suture itself; 10, orange with a black basal spot. *Underside* very flat, orange, with the ventral carina broadly black; broad black bands across the sutures, carrying a pale spot on each side; 2-7 somewhat hairy beneath. Appendages 0·5 mm., wide apart, straight, pointed, slightly hairy, orange with blackish tips; separated by the tubercular projection of 10.

Hab.—South-Western Australia: Wilgarrup, near Bridgetown. Very rare. December-January.

Habits similar to those of the preceding species. It occurs in a tract of boggy country through which a small brook runs. It is a stronger and probably more active species than the other two, and has a zigzag and irregular flight.

In order to grasp more fully the important differences between these three closely allied species, I append a table of comparison for the chief characters in which they differ, in neuration, size and colouration.

It seems fitting here to make a remark upon the group of allied genera, placed by authors at the end of the *Libellulinæ*, which show an aberrancy in the formation of the triangle of one or both wings. Too much stress has been laid upon the possession of this remarkable property as regards its value in generic distinctions. There is no doubt of its importance, but there is also

Characters.	N. australis Br.	N. Dalei, n.sp.	N. occidentalis, n.sp.
Size:—			
♂. Total length.......	20-21 mm.	23-25 mm.	24-27·5 mm.
♂. abdomen............	13-13·5 mm.	15-16 mm.	15·5-18 mm.
♂. forewing...	14-14·5 mm.	17·5-18·5 mm.	18-19·5 mm.
♂. hindwing...........	13·5-14 mm.	16·7-17·7 mm.	17-18·5 mm.
♀. Total length......	19-21 mm.	22 mm.	24-26·5 mm.
♀. abdomen............	12·5-13·5 mm.	14 mm.	16-17·5 mm.
♀. forewing	15-16 mm.	17·5 mm.	18-19·5 mm.
♀. hindwing...........	14·5-15·5 mm.	16·7 mm.	17-18·5 mm.
Neuration:—			
Antenodals of forewing	5	5	6
Postnodals ,,	4	5-6	6-8
Antenodals of hindwing	4	4	4
Postnodals ,,	4*	5-6	6-8
Number of discontinuous postnodals	1	2	2-4
Ratio of proximal to distal portion of upper side of triangle of forewings	1 : 1	2 : 1	2 : 1
Triangle of hindwings..	abnormal.	♂. normal. ♀. abnormal.	normal.
Number of cross-nervules in submedian space of hindwing....	2 (rarely 3).	1	1
No. of single cells following triangle of forewings in discoidal area	3-5, generally 5.	2-3, generally 2.	1-4, generally 1-2.
Sectors of arculus arising	at or near base of arculus.	one-third from base of arculus.	one-third from base of arculus.
Position of inner angle of triangle of hindwing	slightly beyond arculus.	at arculus.	at arculus.
Colouration:—			
Pruinescence in adult ♂	complete on thorax and base of abdomen.	slight darkening of thorax.	nil.
Antehumeral thoracic stripes..................	narrow.	narrow.	broad.
Black mark on front....	absent.	present in male.	absent.
Black markings on abdomen of male.........	on segs. 1-6.	on segs. 1-6 (smaller).	on segs. 1-2.
Shape:—			
Constriction of segs. 3-5	very considerable	moderate.	slight.
Dilatation of 7-9	very great.	considerable.	fair.

* One specimen with 6 on one side only.

no doubt that it is so subject to variation that it is a dangerous guide to generic division. In the case of *Nannodythemis* as defined by Brauer, the importance attached to it has been so great that, if insisted on, we are driven to the absurdity of placing the male of *N. Dalei in one genus* and the female *in another.* This is sufficient to show that it has no generic value whatever. But rightly regarded, it possesses for us a far deeper significance. For these "quadrilateral" *Libellulinæ* are survivals which take us back to a period long before the now dominant genera *Diplacodes*, *Orthetrum*, *Libellula* and many others had been formed. As *Nannodythemis*, *Nannophya*, and *Tetrathemis* are to the dominant *Libellulinæ*, so are *Neophya*, *Cordulephya* and *Pentathemis* to our present-day *Corduliinæ* (a group that can scarcely be called dominant). And in these three closely allied species of *Nannodythemis* we see taking place before our very eyes that excessive variation in the region of the triangle which was probably a heritage of an earlier period, when the "triangle" of the Anisoptera first became differentiated from the simpler quadrilateral cell of the Zygoptera. *N. australis* represents probably the oldest form, and tracing the gradual decrease of "abnormality" in the *hindwing* triangle through *N. Dalei* to *N. occidentalis,* we note the concurrence of greater size and more powerful build; the latter species suggesting at once that it would take but another step, viz., the change from an abnormal *fore-wing* triangle to a normal one, with another corresponding increase in size and strength of build, to give us the true Australian type of *Diplacodes* as represented by our *D. haematodes* or *D. bipunctata.* *Nannodythemis* then points to us the way by which the great dominant group of present-day *Libellulinæ* have ascended in the scale of development, and it is not impossible that a careful study of this and allied genera, both in the *Libellulinæ* and *Corduliinæ,* may yet reveal the exact hidden homology between those portions of the Anisopterid and Zygopterid wings which lie close to the arculus. With the aid of more material and careful study of individual variations in each species, I hope to give later on in another paper some interesting details about these remarkable "quadrilaterals," whose home is Australia and Papua.

EXPLANATION OF PLATE VI.

Fig. 1.—*Nannodythemis australis* Br., ♂ (× $2\frac{2}{3}$).
Fig. 2.—*N. Dalei*, n.sp., ♂ (× $2\frac{2}{3}$).
Fig. 3.—*N. occidentalis*, n.sp., ♂ (× $2\frac{2}{3}$).
Fig. 4.—*N. occidentalis*, n.sp., pterostigma of hindwing of ♂ (× 11).

STUDIES ON AUSTRALIAN MOLLUSCA. PART X.

By C. Hedley, F.L.S.

(Plates vii.-x.)

(Continued from Vol.xxx, p.546.)

Trophon paivæ Crosse.

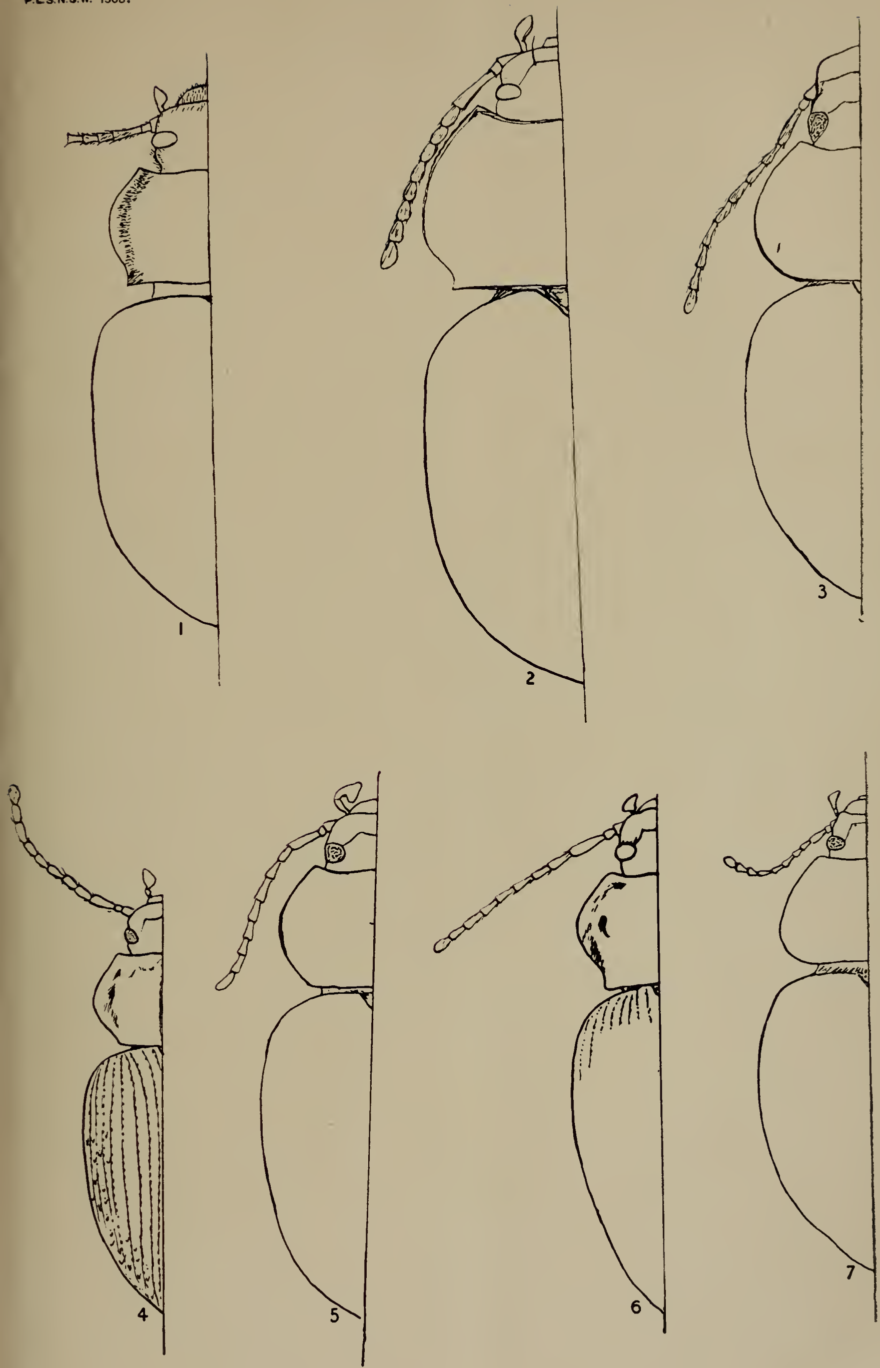
(Plate ix., fig.18)

A young shell, 3 mm. in length, of four whorls, is here shown. Two nepionic whorls are smooth and globose, the initial one set obliquely. Subsequent whorls are ornamented by about a dozen erect radial lamellæ, on the shoulder puckered into a spout and descending obliquely from whorl to whorl. As growth proceeds, the lamellæ do not enlarge in proportion, but multiply in number. Spiral cords appear on the fourth or fifth whorl, enlarge, and, on the sixth, predominate over the radials, which decrease to mere scales.

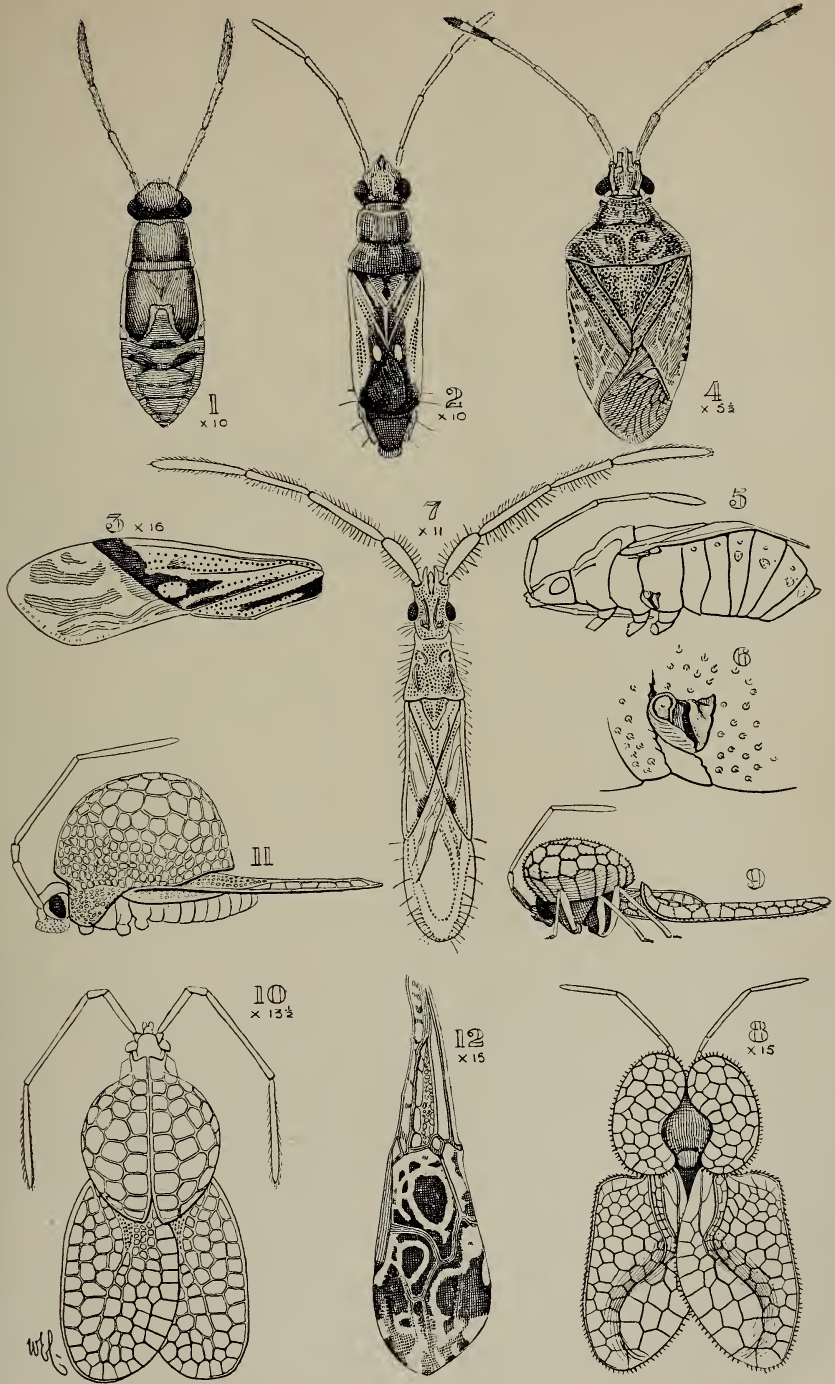
In early life the shell thus appears as a regular *Trophon*, but modification of sculpture in maturity has masked this affinity and induced authors to assign it to other genera. Hutton included *T. paivæ** in a genus *Kalydon* he had framed for Trophon-like shells without varices. In our waters that genus appears to me to be represented by *Ricinula adelaidensis* Crosse, and *Purpura neglecta* Angas. The apex of the latter† is quite different. In Moreton Bay *T. paivæ* appears to closely approach if not to merge into a large form which I take to be *Buccinum funiculatum* Reeve‡ and *Latirus strangei.*§

* Trans. N.Z. Inst. xvi. 1883 (1884), p.220.
† Kesteven, these Proceedings, 1902, xxvi. p.714, Pl.xxxvi. f.2.
‡ Conch. Icon. iii. Buccinum, 1846, Pl.viii. f.61.
§ A. Adams, Proc. Zool. Soc. 1854, p.316.

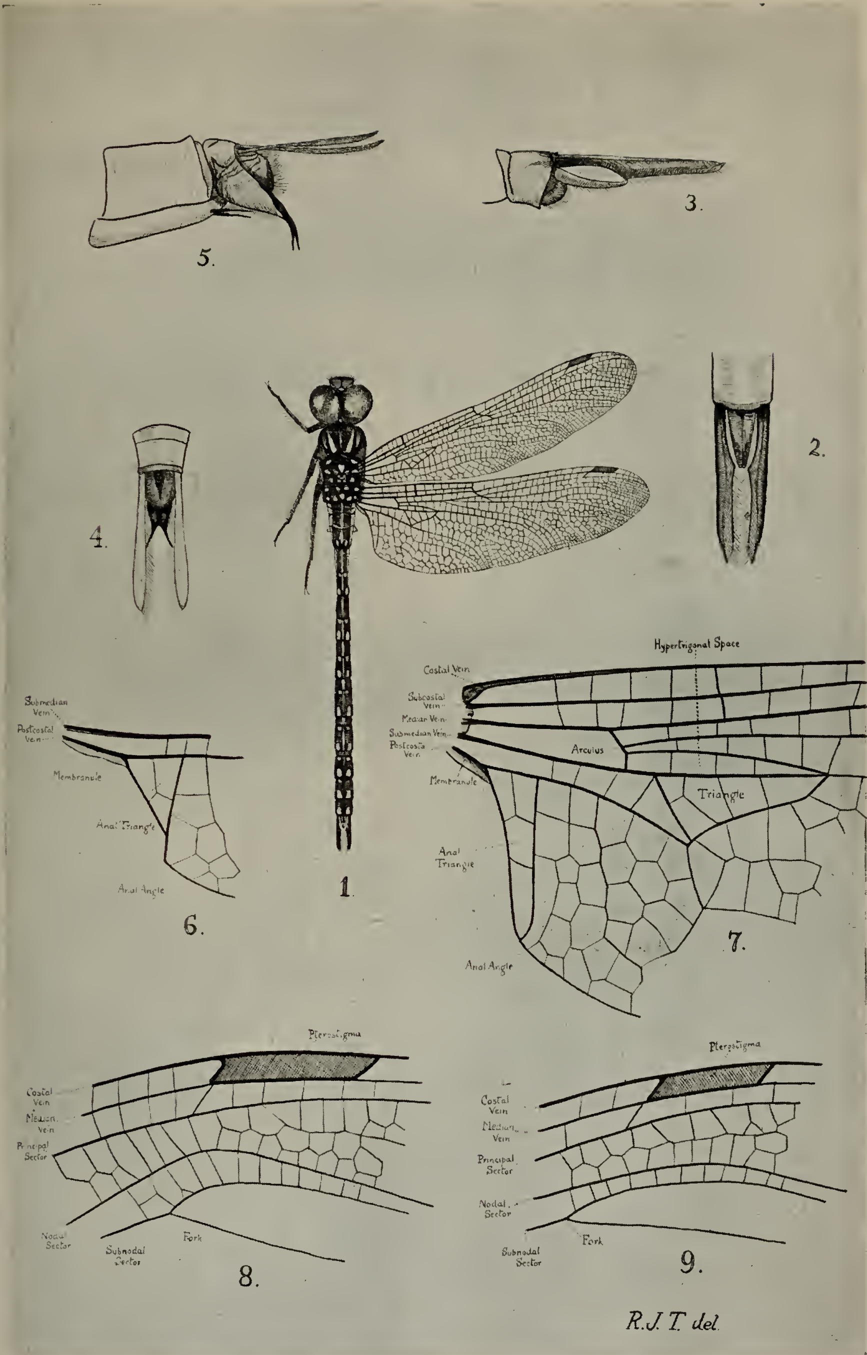
[Printed off August 13th, 1908.]



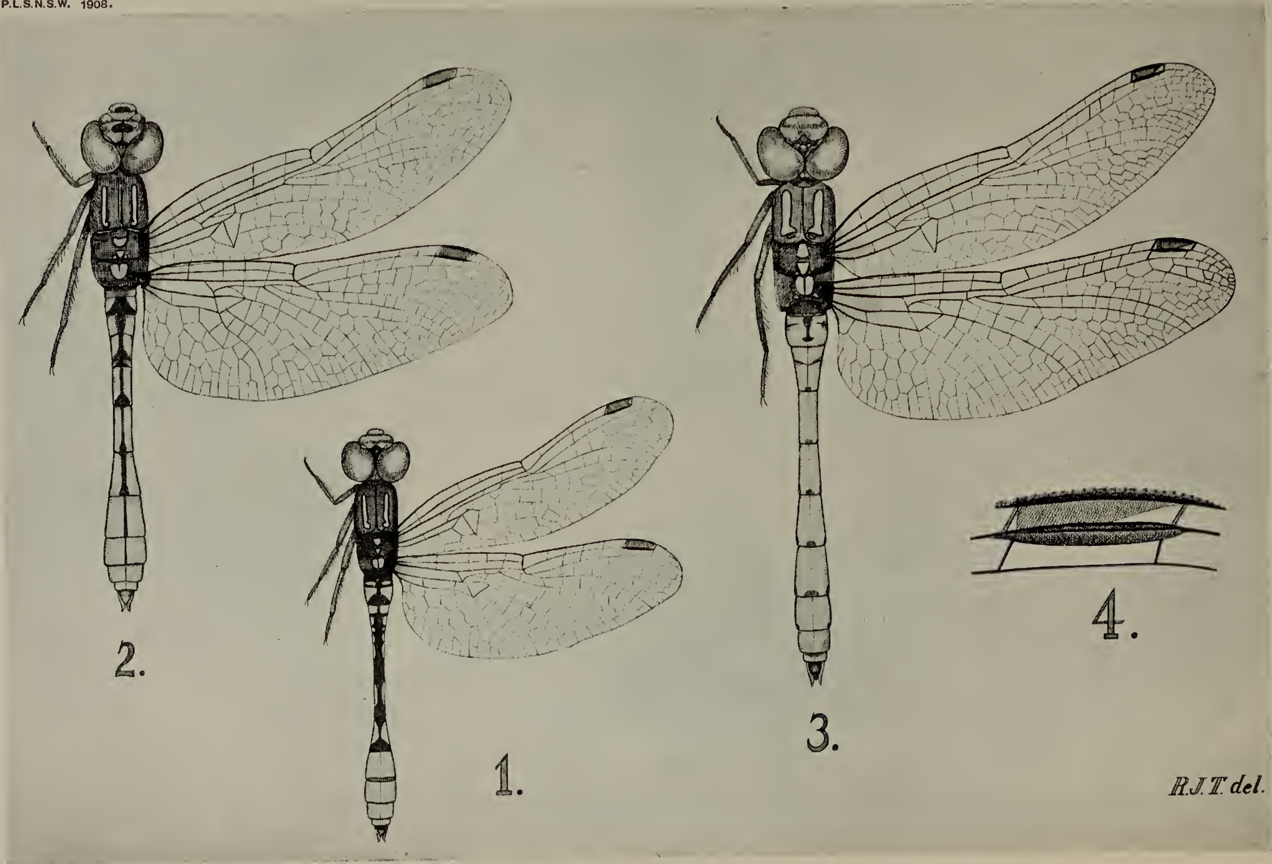
1.—*Adelium barbatum.*
2.—*A. hackeri.*
3.—*A. subdepressum.*
4.—*A. canaliculatum.*
5.—*A. bicolor.*
6.—*A. pestiferum.*
7.—*A. rotundum.*



1.—*Orthoea vincta.*
2. " "
3. " "
4. *Brachylybas variegatus.*
5.—*Brachylybas variegatus*
6 " "
7.—*Ontiscus vitiensis.*
8. *Nesocypselas dicysta.*
9.—*Nesocypselas dicysta.*
10.—*Holophygdon melanesica.*
11. " "
12.—*Ploiariodes medusa.*



1-5, 7 and 9.—*Austrogynacantha heterogena.* 6 and 8.—*Gynacantha Rosenberghi* Selys.



1. *Nannodythemis australis* Br. 2. *N. Dalei*, n.sp. 3-4. *N. occidemtalis*, n.sp.

VERMICULARIA CAPERATA Tate & May.

(Plate x., figs.37-38.)

Some notes on this species have already appeared in these Studies (vi., p.19). The protoconch, I find, consists of a small brown semitransparent Rissoa-like shell of 2½ whorls, 1·4 mm. long. A sudden change in form and texture expresses the change to adult life. The larva settles aperture downwards, shell prostrate. The first irregular adherent whorl encircles, then mounts upon and buries the protoconch. Thus the first adult coil is at right angles to the larval axis as in *Turbonilla*.

PYRENE PLURISULCATA Reeve.

Columbella plurisulcata Reeve, Conch. Icon. xi. 1859, Pl.xxxvi. f.233. *Æsopus filosus* Angas, Proc. Zool. Soc. 1867, p.111, Pl.xiii. f.6, *fide* S. Pace, Proc. Malacol. Soc. v. 1902, p.83.

The locality of this species was unknown to Reeve, whose name therefore escaped inclusion in Australian lists. The synonym of Angas was preoccupied in *Columbella* by Carpenter, Duclos and Dujardin. It was corrected or misreported in the Zoological Record as "filamentosus." Tenison-Woods* noted *C. filosa* to be a rare Tasmanian shell. Pritchard and Gatliff† record it from Western Port. Brazier took a sinistral individual in Sydney Harbour.‡

THAIS GEMMULATA Lamarck.

Purpura gemmulata Lamarck, Anim. s. vert. vii. 1822, p.239; Ency. Méth. 1816, Pl.397, f.3,*a*,*b*. *Purpura mancinella* auctorum non Linné.

Hanley has recorded§ the existence in the Linnean Collection of two adult shells marked "Murex mancinella." These conform to the original diagnosis, and must be regarded as types. But

* Proc. Roy. Soc. Tas. 1877, p.32.
† Proc. Roy. Soc. Vict. xviii. 1906, p.48.
‡ These Proceedings (2), ix. 1895, p.561.
§ Hanley, Ips. Linn. Conch. 1855, p.295.

they answer, he writes, to the *Ricinula spectrum* of Reeve and not to the shell universally accepted as *Purpura mancinella* Linné.

In default of its proper title, the Linnean species has received numerous epithets; thus it was named, in 1798, *Drupa carnus* by Bolten; in 1832, *Purpura elata* by Blainville; in 1839, *Purpura martiniana* by Anton; and in 1846, *Ricinula spectrum* by Reeve. Under Blainville's name the species is recorded from North Queensland by Melvill & Standen.*

But the shell to which the name *mancinella* has been erroneously transferred has been left that title in undisputed possession. Searching for a name to inherit its estate, I find *Purpura gemmulata* to be apparently the only claimant. Under the old style the species has been recorded by Brazier† from several Australian stations.

CLAVA SINENSIS Gmelin.

Murex sinensis Gmelin, Syst. Nat. xiii. 1791, p.3542. *Cerithium obeliscus* Bruguière, Ency. Méth. Vers, (2), 1792, p.472.

Most monographs give this species under Bruguière's name, but Pilsbry has pointed out that Gmelin's has priority. Both base their species on the same reference,‡ so the repetition is obvious. Bolten renamed it *Strombus muricatus*.

Menke recorded it§ from N.W. Australia, but it has hitherto escaped attention on the east coast. It is not rare in tropical Queensland, for I have taken it on the Palm, Green and Hope Islands.

ARGOBUCCINUM SUCCINCTUM Linné.

Murex succinctus Linné, Mantissa ii. 1771, p.551. *Murex clandestinus* Chemnitz, Conch. Cab. xi. 1795, p.127, Pl.195, figs. 1856, 1857; *fide* Hanley, Ips. Conch. Linn. 1855, p.456.

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* Melvill & Standen, Journ. Linn. Soc. Zool. xxvii. 1899, p.163.

† Brazier, Journ. of Conch. ii. 1879, p.187.

‡ Martini, Conch. Cab. iv. 1780, p.325, Pl.157, f.1489.

§ Moll. Nov. Holl. Specm. 1843, p.19.

The only reference in literature to this species as Australian seems to be that of Tryon* who curiously omits all the localities supplied by his predecessors, and cites only "Australia."

I have not personally collected a specimen, but I purchased an example from Mr. A. F. Hemsley, of Cooktown, Queensland, who told me that it was obtained in the neighbourhood of that port. Dr. Dall has instituted the subgenus *Paralagena* for the species.†

BUCCINUM ASSIMILE Reeve.

Under the name of *Cantharus* (*Tritonidea*) *assimilis*, Angas‡ described this species as found "under stones at low water, Watson Bay." His account suggested that he gathered what is now known as *Tritonidea australis* Pease. I therefore enquired of Mr. Smith if these names were synonymous. He replied that the species are distinct, but that Reeve's *assimile* is a synonym of the Mediterranean shell *Purpura picta* Scacchi. Bucquoy, Dautzenberg, and Dollfus§ wrongly cite it as a synonym of *Pisania d'Orbignyi* Payr.

So *Buccinum assimile* can be struck off the list of Australian shells. Another Mediterranean shell imposed upon our fauna is *Clathurella purpurea* Montagu, which, under the name of *C. reticosa*, Adams & Angas|| described as from Middle Harbour.

Again, Bertin¶ has reported the West Indian *Donax denticulatus* Linné as from Port Stephens.

STROMBUS CAMPBELLII Griffith & Pidgeon.

Griffith & Pidgeon in Cuvier's Animal Kingdom, Ed. Griffith, Vol.xii. 1834, p.600, Pl.xxv. fig.6.

Authors generally (for instance, Watson, Chall. Exped. Zool. xv. p.418) have applied to this species the name *Strombus*

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* Man. Conch. iii. 1881, p.15.
† Smithsonian Miscell. Coll. 47, 1904, p.132.
‡ Proc. Zool. Soc. 1867, p. 187.
§ Moll. Mar. Roussillon, i. 1882, p.27.
|| Proc. Zool. Soc. 1863, p. 420.
¶ Nouv. Arch. Mus. (2), iv. 1881, p.82.

campbellii Gray. Yet Gray does not appear to have referred to it in his writings. The real authors of the name are Griffith & Pidgeon.

Kuster* has erroneously identified Chemnitz Conch. Cab. (1) Pl.157, fig.1496, as *S. campbellii.* On comparison with Kiener, Strombus, Pl.25, figs.1-1*a*, it will be seen that the figure of Chemnitz represents not *S. campbellii* but *S. columba* Lamarck. Since Bolten† corrected the defective nomenclature of Chemnitz by supplying a binomial name, *Lambis plicata*, for this fig.1496, it follows that *S. columba* Lamk, should be superseded by *S. plicata* Bolten. Brazier has recorded‡ *S. columba* Lamk., from Darnley Island, 25 faths.

In the last Part of these Studies (ix. p.523) I noted that *Alaba sulcata* Watson, was based on an early stage of *S. campbellii.*

Though not often seen on the beach, *S. campbellii* commonly occurs in the dredge all along the Queensland coast. The most southern record is Port Stephens, N.S.W.§ Reeve states|| that Jukes obtained it at Sandy Cape, Queensland. I saw it in the Capricorn Islands. The "Alert" took it¶ at Port Molle. Forbes** reports it from off Cape Upstart. Schmeltz†† noted it from Port Denison. The "Chevert"‡‡ at Cape Grenville and Long Island. Haddon, between Hammond and Wednesday Islands.§§ From the Gulf of Carpentaria, Roth records|||| that the animal is eaten and the shell used for baby-rattles at the mouth of the Batavia River, where it is called "yung-ko" in the Nggerikudi language.

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* Conch. Cab. 2nd Ed., Strombus, 1845, p.69.
† Mus. Bolt. (2) 1798, p.65.
‡ These Proceedings, i. 1877, p.292.
§ Angas, Proc. Zool. Soc. 1877, p.185.
|| Conch. Icon. vi. 1854, Strombus, sp.45.
¶ Smith, Zool. Coll. "Alert," 1884, p.58.
** Voy. "Rattlesnake," ii. 1852, p.365.
†† Cat. Mus. Godeff. v. 1874, p.142.
‡‡ Brazier, these Proceedings, i. p.292.
§§ Melvill and Standen, Journ. Linn. Soc. Zool. xxvii. 1899, p.165.
|||| North Queensland Ethnog. Bull. iii. 1901, p.19.

FICUS COMMUNIS Bolten.

Ficus communis Bolten, Mus. Bolt. (2), 1798, p.148.

Considerable confusion has attended this genus. For Hanley* has shown that Linné confounded three species in the original *Bulla ficus*; while Smith† has discussed the obscurity of the Lamarckian species. By reviving the neglected name of Bolten‡ we gain not only by restoring the oldest name, but by avoiding the dispute of whether the subsequent name of Lamarck was bestowed on the Australian or the American shell.

Angas recorded this species as *Sycotypus reticulatus*§ from the mouth of the Macleay River. It has subsequently been taken as far south as Port Stephens. Along the Queensland coast it is not rare on sandy beaches. I dredged a fragment off the Hope Islands near Cooktown.

Under the name of *Sycotypus ficoides*, Brazier notes it|| from 15-30 fathoms off Darnley Island, where, so Jukes writes,¶ the natives call it "mabaer."

West of Torres Strait this species is replaced by *F. tessellatus* Kobelt.

In the Australian Tertiary the genus is represented by *F. altispira* Pritchard,¶¶ from Table Cape, Tasmania. This seems additional evidence that the temperature there was then higher than now.

MITRA CARBONARIA Swainson.

Swainson, Bligh Cat. Append. p.10, 1822 (reprinted Exotic Conchology, 1841, p. 37). *Mitra melaniana* Swainson (not Lamarck), Zool. Illustr. 2nd Ser., iii. 1832, Mitra, Pl.i. f.1.

In 1788 Chemnitz published, under a polynomial name, figures and description of a Mitra from the incongruous localities of the Guinea coast, Greenland and Tranquebar. Probably he had

* Hanley, Ips. Linn. Conch. 1855, p.206.
† Smith, Journ. of Malac. iii. 1894, p.66.
‡ Founded on Knorr, Verg. Pt.iii. Pl.xxiii. f.1.
§ Angas, Proc. Zool. Soc. 1877, p.182.
|| Brazier, these Proceedings, i. 1877, p.235.
¶ Jukes, Voy. "Fly," i. 1847, p.189; ii. p.286.
¶¶ Pritchard, Proc. Roy. Soc. Vict. viii. n.s. 1896, p.85, Pl.iii. f.2-3.

several species before him, one of which was *Volutomitra grönlandica* Beck. Binomial writers have bestowed on his shell the following names—*Voluta nigra* Gmelin, 1791; *Mitra castanea* Bolten, 1798; and *Mitra melaniàna* Lamarck, 1811. To this an Australian shell was subsequently referred.

But at that early date Chemnitz had received no Australian shells except those collected by Captain Cook's party. Figs.1430 and 1431 of Pl.151 of Chemnitz, exhibit a shell with less pointed spire, more rapidly increasing whorls, fewer and less oblique plications—clearly a distinct species from the Australian shell usually known as *M. melaniana.*

The Australian shell appears to have been first distinguished by Swainson in 1822. Ten years afterwards he resumed the study of it, stating that Lamarck had confused two species under one name; and that, whereas he, Swainson, had first intended to call the Australian one "*carbonaria*," leaving "*melaniana*" for the other, further consideration induced him "to alter this arrangement," and to figure "a full-sized specimen received from Australia" of *carbonaria* under the title of *M. melaniana* Lamarck. The type of *M. carbonaria* was in the Manchester Museum.

Mr. E. A. Smith writes to me of *Volutomitra digna* A. Adams,* "I agree with Tryon in placing this shell with *M. nigra = melaniana.* I am quite sure that it is merely an immature example of that species."

As *Mitra nigra*, Angas recorded the species from Sydney Harbour,† and, as *M. melaniana*, Pritchard & Gatliff mention it from Eastern Victoria.‡

LITIOPA MELANOSTOMA Rang.

Rang, Ann. Sci. Nat. xvi. 1829, p.307.

(Plate x., figs.30-31.)

Different views on the division of *Litiopa* are held by various writers. Thus Watson§ regards it as a single "species of

* Proc. Zool. Soc. 1854(1855), p.135; Thes. Conch. iv., Mitra p.6, Pl.361, f.115.

† Proc. Zool. Soc. 1867, p.193.

‡ Proc. Roy. Soc. Vict. xi. 1899, p.186.

§ Chall. Rep. Zool. xv. 1886, p. 572.

universal distribution in warm seas," while Locard* separates several species.

No one has yet remarked the occurrence of *Litiopa* in Australian seas. But I find a member of it occurring at Sydney and several points along the Queensland coast—Green Island, Hope Island, and Eclipse Island. This appears to be the same as one I obtained from New Caledonia, and therefore determined as *L. lymnophysa* Melvill & Standen.† The species is subject to considerable variation, besides a difference, probably sexual, of breadth, the colour ranging from white spotted with brown to uniform cinnamon-brown. Aged examples produce a thick bilobed callus ridge on the columella. The axial furrow, or incipient umbilicus, is more apparent in some instances than in others, and at its greatest development is bordered by a funicular ridge.

Dr. J. Richard, the Director of the Oceanographic Museum of Monaco, has kindly assisted me with examples for comparison of *L. melanostoma* from N. lat. 31° 38′, W. long. 42° 38′, in the Sargasso Sea. Certain differences appear. The Sydney shell is larger, comparatively broader, and develops an axial furrow and stronger columellar callus than the Atlantic shells. In consideration of the great range of variability in all pelagic shells, for instance in *Ianthina* and *Cavolina*, it seems to me best to record the Sydney shell as a form of Rang's species.

My figure is derived from a specimen 4·5 mm. long and 2·4 mm. broad, taken by the late Mrs. Starkey on Balmoral Beach, Sydney.

A good recognition mark is supplied by the exquisitely sculptured protoconch.

SCISSURELLA ROSEA, Hedley.

Hedley, Records Austr. Mus. v. 1904, p.90, f.17.

I find that this species, originally described from New Zealand, occurs also on the hither side of the Tasman Sea. Specimens

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* Moll. Exped. "Talisman," i., 1897, pp.498-500.
† Melvill & Standen, Journ. of Conch. viii. 1896, p.305, Pl.xi. f.72.

were collected by my wife at Eagle Hawk Neck, Tasmania; and Mr. J. H. Gatliff has sent it to me from Flinders, Victoria. The latter he recorded as *S. obliqua* Watson,* which Kerguelen shell seems from its figure to be of different contour. As in *Schismope atkinsoni*, the sculpture varies from cancellate to nearly smooth. The rosy colour of the apex is fugitive.

Haliotis scalaris Leach.

Padollus scalaris Leach, Zool. Miscell. i. 1814, p.66, Pl.28.

In the last Part of these Studies (p.521) it was noted that, whereas, in the latest monograph, this species was called *Haliotis tricostalis* Lamk., an earlier name, *Padollus rubicundus* Montfort, should be preferred. I now find that *Haliotis rubicundus* is preoccupied by Bolten† for another species. It is therefore necessary to resume the above name by Leach, which also antedates that of Lamarck.

Monilea apicina Gould.

Gould, Proc. Bost. Soc. Nat. Hist. viii. 1861, p.14.

This unfigured species, collected between 1853 and 1856 in Port Jackson by W. Stimpson, has never been recognised by Australian conchologists. Dr. Paul Bartsch has kindly sent me a photograph of the type preserved in the U.S. National Museum. This portrait enables me to refer Gould's species to *Monilea angulata* A. Adams.‡

Trochus tinctus Watson.

Watson, Chall. Rep. Zool. xvi. 1886, p.63, Pl.xvii. f.2.

Watson's account seems to apply so closely to an immature *Calliostoma allporti* that I think his name should be reduced to a synonym of the species Tenison-Woods described ten years previously.

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* Prit. & Gatliff, Proc. Roy. Soc. Vict. xv. 1903, p.181.

† Mus. Bolt. (2), 1798, p.14.

‡ A. Adams, Proc. Zool. Soc. 1851, p.190.

CANTHARIDUS EXIMIUS Perry.

Bulimus eximius Perry, Conchology, 1811, Pl.32, f.2.

For this shell Perry simultaneously proposed the names of *Bulimus carinatus* and *B. eximius.* It is interesting to note that Férussac* suggested that *B. carinatus* Perry appeared to be not a land- but a sea-shell.

On the ground that *B. carinatus* had page precedence, not priority, over its fellow, Messrs. Pritchard & Gatliff have selected† it for service, thus leading Dr. Verco‡ astray also. But Pilsbry has explained§ that *B. carinatus* Perry cannot stand on account of the earlier *Bulimus carinatus* Bruguière, 1789.

Dr. Bartsch kindly forwarded a photograph of Gould's type of *Elenchus ocellatus*,|| collected by W. Stimpson in Sydney Harbour. This enables me to identify it as a young *C. eximius.* The white dashes, to which the trivial name refers, commonly occur on Sydney examples.

This shell is shown in an aboriginal Tasmanian necklace in the Atlas to Péron's 'Voyage' (1824, Pl.xii. f.5). Such necklaces are also described by Ling Roth.¶ Modern local jewellers now employ it for various forms of trinkets. The Rev. T. Dove wrote** "a cluster of glistening shells was termed a merrina." Tasmanian fishermen, so I am told by Mr. W. L. May, still speak of *C. eximius* by this aboriginal name.

C. eximius is illustrated on p.220 of Swainson's Malacology (1840). Tenison-Woods thought†† that the *Elenchus splendidulus* of the same author‡‡ was identical, but I would regard that name as a synonym of the New Zealand *C. opalus* Martyn.

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* Tabl. Syst. Anim. Moll. 1821, p.88.

† Proc. Roy. Soc. Vict. xviii. 1906, p.65.

‡ Trans. Roy. Soc. S.A. xxxi. 1907, p.350.

§ Nautilus xvi. 1902, p.72.

|| Proc. Boston Soc. Nat. Hist. viii. 1861, p.14.

¶ Aborigines of Tasmania, 2nd Ed. 1899, p.133.

** Tasm. Journ. Nat. Sci. i. 1842, p.252.

†† Proc. Roy. Soc. Tasm. 1877, p.41.

‡‡ *Loc. cit.* p.352, footnote.

The radula of *Elenchus badius* Wood, is figured and described by Troschel.* The species spreads along the whole of extra-tropical Australia. On the east coast I have seen it from Caloundra, and on the west, Adams† cites it as *P. lineata* from Swan Point.

The shape of this shell is moulded by its environment, for the mollusc lives not on rocks but ever afloat on swaying bands of kelp. The stream has no grip on the smooth lines of *C. eximius*, as it would have on a normal keeled pyramidal *Cantharidus*. Some land-shells living on twigs and leaves have assumed a like form under like conditions.

Cantharidus lineolaris Gould.

Gould, Proc. Boston Soc. Nat. Hist. viii. 1861, p.14.

A photograph of Gould's specimen in the U. S. National Museum shows this to be the shell to which H. & A. Adams, twenty-two months later, gave the name of *Leiopyrga picturata*, and which was first figured in the Zoology of the "Alert."

Another photograph from the U.S. National Museum supports my conjecture‡ that *Bankivia lugubris* Gould, is a colour-variety of *Cantharidus fasciatus* Menke.

Calliostoma arruense Watson.

Trochus (*Ziziphinus*) *arruensis* Watson, Journ. Linn. Soc. Zool. xv. 1880, p.91; Chall. Rep. Zool. xv. 1886, p.57, Pl.vi. f.5. *Cantharidus torresi* Smith, Zool. Coll. "Alert," 1884, p.72, Pl.vi. f.A.

I owe the above synonomy to my correspondent, Mr H. B. Preston, who bases it on an inspection of types. It is a parallel case to *Pleurotoma sterrha* and *P. torresiana*, dealt with in the last Part of these Studies, in which a "Challenger" preliminary description was overlooked in naming an "Alert" species. Prof. Haddon took this shell at Murray Island, Torres Straits. It occurred to me at Masthead Island, but was misnamed *C. similare*

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* Gebiss d. Schneck. ii. 1879, p.236, Pl.xxiv. f.4.
† Proc. Zool. Soc. 1851 (1853), p.154.
‡ Mem. Austr. Mus. iv. 1903, p.334.

in my list. I have seen a form of *C. arruense* from New Caledonia.

Camita rotellina Gould.

Trochus (*Monodonata*) *rotellinus* Gould, Proc. Boston Soc. Nat. Hist. iii. 1860, p.180; U.S. Expl. Exped. p.191, Pl.xiii. f.222.

A single worn shell which I found at Green Island, North Queensland, enables me to add a genus to the Australian fauna.

Astralium pagodus Ten.-Woods.

Ten.-Woods, these Proceedings, iv. 1879, p.110.

These notes on obscure Australian Trochidæ may be concluded by remarking that the above name by Tenison-Woods was based on a juvenile example of *Trochus niloticus* Linné. The young of this shell differs from the adult whorls in form and sculpture. The error of regarding it as a distinct species had previously been perpetrated by Chemnitz and Lamarck.* Such a mistake is more excusable in foreign than in local workers.

Capulus nutatus, n.sp.

(Plate ix. figs.15-16.)

Shell small, rather thin, bilaterally symmetrical, low, broadly ovate. Apex at about four-fifths of the length, on the median line, minute, almost vertically inrolled. Colour rufous-brown, either uniform or variegated by pale rays. Sculpture: coarse concentric growth-lines are corrugated by numerous delicate radial folds. Length, 5·6; breadth, 4·8; height, 3 mm.

Hab.—Not uncommon in shell-sand around Sydney.

At first acquaintance I had regarded this as not adult, but a considerable series now convinces me that it does not grow appreciably larger than here described. The records from Sydney of *Cochliolepas subrufa* by Angas† and of *Hipponyx danieli* by Henn and Brazier‡ were doubtless based on the species under discus-

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* *T. marmoratus* Déshayes, Anim. s. vert. 2nd ed. ix. 1843, p.139, footnote.
† Proc. Zool. Soc. 1867, p.212.
‡ These Proceedings (2), ix. p.170.

sion, and on the assurance of its immaturity. From juvenile examples of that species (now known as *Capulus australis* Lamk.) the novelty appears to differ by greater symmetry and less height in proportion to breadth. *Amalthea coxi* Sowerby,* from Port Stephens, seems to me not molluscan, but the shell of a barnacle.

Rissoa praeda, n.sp.

(Plate x., fig.35.)

Shell small, solid, ovate-conic, imperforate. Whorls six, rather rapidly increasing. Colour uniform pale ochreous. Sculpture: the base as far as the periphery is smooth. Above the periphery are eleven massive perpendicular ribs which continue from whorl to whorl to the antepenultimate. The deep wide interstices appear at the periphery to be gouged out of the shell-substance. Both ribs and interstices are smooth. Apex bare of sculpture. Aperture a little oblique, ovate, angled above, externally protected by a heavy outstanding varix, inner lip with a thickened reflected edge. Length, 3·55; breadth, 2·15 mm.

Two specimens collected in Middle Harbour by the late Mrs. Starkey.

Type to be presented to the Australian Museum.

Rissoa incompleta, n.sp.

(Plate x., fig.36.)

Shell small, ovate-globose, rather thin, glossy, translucent, imperforate or very narrowly perforate. Whorls five. Colour uniform flesh-pink, varix white. Sculpture: about twenty-one sharp narrow perpendicular ribs, parted by broad shallow interstices, traverse the last two whorls from suture to periphery, where they are abruptly closed by a waved spiral cord. On the base the ribs faintly reappear. Upper whorls and base smooth. Aperture subquadrate, anteriorly subchannelled. Columella

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* Proc. Malacol. Soc. viii. 1908, p.17, Pl.i. figs.9-11.

vertical, nearly straight, outer lip protected by a massive projecting varix. Length, 2·75; breadth, 1·7 mm.

Hab.—Middle Harbour (the late Mrs. C. T. Starkey). Rare.

Type to be presented to the Australian Museum.

Since drawing up the above description, I have found numerous specimens in dredgings taken by Mr. W. L. May and myself, in 100 fathoms, seven miles east of Cape Pillar, Tasmania.

Rissoa procincta, n.sp.

(Plate x., fig.34.)

Shell small, thin, glossy, conical, perforate. Whorls four, rounded and deeply constricted at the sutures. Colour: on each whorl two spiral alternating bands of cream and pale brown. Sculpture, faint growth-lines. Aperture pyriform, rounded below, angled above, outer lip simple, inner reflected. Length, 2·55; breadth, 1·45 mm.

Hab.—Middle Harbour (Mrs. Starkey; one specimen).

Type to be presented to the Australian Museum.

Rissoa imbrex, n.sp.

(Plate x., fig.33.)

Shell elongate-conic, rather solid, perforate, protoconch turbinate, suture channelled, each whorl overhanging the next in imitation of a cone-in-cone structure. Colour dull white. Sculpture: along the periphery of each whorl runs a deep groove, bordered by a ridge on each side. On the base are two or three raised lines. With these exceptions the shell is smooth. Aperture almost entire, roundly oval, broadly reflected throughout, the reflection notched on the right by the peripheral groove, and on the left extended over a narrow axial perforation. Length, 3·6; breadth, 1·6 mm.

Hab.—Middle Harbour (the late Mrs. C. T. Starkey; a few specimens).

Type to be presented to the Australian Museum.

This species is related to a small group of spirally ribbed shells —*R. tenisoni* Tate, *R. layardi* Petterd, *R. agnewi* Ten.-Woods, and *R. unilirata* Ten.-Woods, among which it stands nearest to the last.

ODOSTOMIA IGNAVA, n.sp.

(Plate x., fig.32.)

Shell small, narrowly ovate, solid, glossy. Colour white. Nuclear whorls small, half-sunk in the topmost adult whorl. Postnuclear whorls six, regularly increasing, distinctly shouldered above, and rather flattened at the periphery. Last whorl large, rounded on the base. Sculpture: there are no spirals; on the earlier whorls are faint close ribs which gradually disappear on the older whorls. Aperture rather narrow, pinched above, rounded below. Fold scarcely visible. A broad and thick callus spread on the inner lip. Length, 4·85; breadth, 2·3 mm.

Hab.—Middle Harbour, Sydney (type; self); Trial Bay, N.S.W. (C. F. Laseron).

The compact shape and feeble fold lend to this shell the aspect of a Rissoa. It apparently belongs to the subgenus *Heida* Dall & Bartsch.*

EULIMA TOPAZIACA, n.sp.

(Plate x., fig.29.)

Shell small, narrowly ovate, polished, semitransparent, imperforate. Colour white. Whorls five, rapidly increasing, wound obliquely, contracted at the suture, apex blunt. Sculpture none. The columella and base of each spire-whorl visible through the shell. Aperture pyriform, rounded below, contracted and angled above where it tends to separate from the body-whorl. Lip simple, columella reflected, narrow. Length 2·55; breadth, 1·25 mm.

Hab.—Middle Harbour (one specimen collected by the late Mrs. Starkey).

Type to be presented to the Australian Museum.

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* Proc. Biol. Soc. Washington, xviii. 1904, p.13.

Since writing the above I have received from Mr. F. H. Baker specimens coloured uniform brown, which he collected at Port Albert, Victoria.

The shape of this eccentric *Eulima* is like that of *Rissoa*.

MANGELIA HILUM, n.sp.

(Plate ix., fig.17.)

Shell minute, acicular, thin. Colour amber-brown, passing to purple on the apex. Whorls five, wound obliquely, the first minute, the last two-thirds of the whole shell. Sculpture: fine spiral grooves which become more crowded anteriorly. Aperture long and narrow, suddenly contracted anteriorly, sinus deeply excavate, a thin sheet of callus spread on the columella, canal broad, short, a little recurved. Length, 3·85; breadth, 1·25 mm.

Off Vaucluse, Sydney Harbour (J. Brazier; one specimen from 12 fathoms). To be presented to the Australian Museum.

Since writing the above, the species has occurred in a collection dredged by Mr. W. L. May and myself, in 100 fathoms, seven miles east of Cape Pillar, Tasmania.

ARCA TRAPEZIA Deshayes.

Dr. H. A. Pilsbry informs me that the American localities assigned to *Arca trapezia* and its synonyms are wrong. He writes, "Semblas is evidently San Blas on the west coast of Mexico; but no such shell is known from that region, and we have nothing in American waters which could be reasonably identified with *trapezia*." Dr. Lamy, who has recently reviewed the genus, concludes* that the Australian shell is *A. trapezia*. Since the evidence of locality, on which I relied, proves erroneous, I now accept the name *trapezia* for the species discussed (*ante*, Vol.xxix. p.203) as *Arca lischkei*.

The old name for Darling Harbour, N.S.W., was Cockle Creek, in reference to the *A. trapezia* found there in abundance by the early pioneers. The locality of Akaroa, New Zealand, given by Dr. Lamy (p.248) for this species, is certainly an error.

* Journ. de Conch. liii. 1906, p.333, footnote, and lv. 1907, p.246.

Lissarca picta Hedley.

Austrosarepta picta Hedley, these Proceedings, xxv. 1899, p.430.

Not finding any genus to suit this shell, I proposed a new one for its reception. The figure of the type of *Lissarca** is useless for identification. But later I recognised my genus in an excellent illustration of *Lissarca* by Martens & Pfeffer.† Prompted by this, I suggested to Dr. Lamy, who was reviewing the genus, the propriety of withdrawing *Austrosarepta* as a synonym of *Lissarca*. He endorsed the idea,‡ as also did Dr. J. C. Verco.§ Whereas *Lissarca* was originally introduced as a subgenus of *Arca*, I would now recommend its transference to the Limopsidæ. The genus, which is chiefly Antarctic, now contains *L. miliaris* Philippi, 1845; *L. rubrofusca* Smith, 1879; *L. rubricata* Tate, 1886; *L. vivipara* Bernard, 1898; *L. picta* Hedley, 1899; *L. aucklandica* Smith, 1902; *L. rhomboidalis* Verco, 1907; and *L. notorcadensis* Melvill & Standen, 1907.

L. picta and *L. rubricata* seem to represent each the other in the Peronian and Adelaidean Regions respectively.

Chlamys radiatus Hutton.

Pecten radiatus Hutton, Cat. Marine Moll. New Zealand, 1873, p.82.

(Plate x., fig.28.)

This rare species has never been illustrated. Mr. E. R. Waite, Curator of the Christchurch Museum, has kindly lent me for study two imperfect specimens labelled by Prof. Hutton. The larger, 60 mm. high and 50 mm. long, is here figured. The species proves to be a particularly flat *Chlamys*, something like *C. serratus* Sowerby, but higher in proportion to length. The colour is buff to flesh-pink. About 20 ribs exceed the rest in size; between the primaries are intercalated three or four lesser riblets. All the

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* Phil. Trans. R. S. London, clxviii. Pl.ix. f.17.

† Jahrb. wiss. Anst. Hamburg, iii. 1886, Pl.iv. f.14, *a-e*.

‡ Journ. de Conch. lv. 1907, p.291.

§ Trans. Roy. Soc. S.A. xxxi. 1907, p.221.

ribs carry small dense scales. Stewart Island is the type-locality, but the individual here drawn came from the Chatham Islands. *Ostrea radiata* of Gmelin was afterwards transferred to *Pecten*, but it does not seem to imperil the name of the present species.

Pholas australasiæ Sowerby.

Sowerby, Thes. Conch. ii. 1849, p.488, Pl.cvi. f.73.

Probably because it is absent in the immediate neighbourhood of Sydney, this species has escaped notice in literature as native to New South Wales. Nevertheless it is common, and generally distributed along the whole coast.

Strigilla splendida Anton.

Tellina splendida Anton, Verz. M. Conch. 1839, p.5 ; Hanley, Thes. Conch. i. 1846, p.249, Pl.lvi. f. 39. *Strigilla splendida* Dautzenberg Fischer, Journ. de Conch. liv. 1906, p.226.

This species has not been recorded from Australia. Mr. P. G. Black gathered specimens on the beach at Townsville. My determination of these was confirmed by Mr. C. Gabriel, who compared Queensland specimens at the British Museum.

Strigilla euronia, n.sp.

(Plate ix., figs.22-23.)

Shell of medium size, subrhomboidal, compressed, rather thin, glossy, slightly inequilateral, ventral margin rounded, anteriorly and posteriorly truncate. Colour lilac, concentrically disposed in paler and darker zones. Smooth, except for the oblique scratches, which number thirty-six, commence at a short distance from the posterior margin, and suddenly terminate with great exactness at a perpendicular median line. The scratches are closer posteriorly, wider anteriorly, spreading apart from the umbo outwardly. The unscratched posterior end has fine concentric thread-sculpture. Length, 16; height, 14; depth of single valve 4 mm.

This species occurs, though rarely, as far south as Sydney. I frequently met with detached valves cast up on the sandy beach facing the ocean at Byron Bay, N.S.W. The example figured is from Moreton Island, Queensland.

The most northern point to which I have traced it is near Bundaberg, where Dr. T. May found it.

This species marks the first occurrence of its genus in Australia, and is contained in that section which Dr. W. H. Dall has named *Aeretica.** It is most nearly related to *S. senegalensis* Hanley. In the absence of actual specimens, I had indeed named and distributed it as that species. Now that Dr. Lamy, of Paris, has kindly given me authentic specimens of *S. senegalensis*, I am able to distinguish the Australian from the African shell. The posterior side of *S. euronia* is shorter and more rounded, and its anterior part is smooth; whereas *S. senegalensis* anteriorly has fine sharp concentric grooves. In size and colour the two species also differ.

STRIGILLA GROSSIANA, n.sp.

(Plate ix., fig.21.)

Shell rather large and solid, compressed, ovate-cordate, inequilateral, rounded anteriorly, and produced posteriorly. Colour externally white, banded and suffused with pale pink or purple, umbo pink; internally brilliant geranium-pink, with a narrow white border. Sculpture anteriorly concentric, then flexed first up and down, passing at one-third of the length into the fine oblique lines which cover the central area, along a well defined radial line at three-quarters of the length, the sculpture turns at an acute angle upwards, curves round, and concludes as concentric. Over all the eccentric threads run minor regular concentric growth-lines. Length, 24; height, 21; depth of single valve, 5 mm.

This handsome and distinct species is represented by a single imperfect right valve, collected in Moreton Bay by Mr. George Gross, to whom it is dedicated. The exact locality is the inner

* Dall, Trans. Wagner Free Inst. Sci. iii. 1900, p.1038.

beach of the south end of Moreton Island, about half a mile north of the sandhills.

CHIONE CAPRICORNEA, n.sp.

(Plate ix., figs.24-25.)

Shell massive, tumid, ovate, umbo prominent, posterior margin subtruncate, anterior rapidly rounded. Colour either uniform cream, cream with a few scattered brown dashes, or broad radiating stripes alternately cream and brown, lunule usually brown, interior pale yellow. Sculpture: about 36 narrow smooth concentric ribs, which near the anterior side are apt to be dislocated or to end prematurely; those continuing become sharper and more crowded, posteriorly they widen out for three-quarters of the length, then close up to end abruptly at the escutcheon. The ribs are about one-quarter the width of their deeply rounded interspaces, which are ornamented by close engraved concentric lines varying from six to twelve per furrow. The furrows are also crossed by dense microscopic scratches which under magnification offer the pattern of a brick wall. Lunule deep, cordate; escutcheon narrow, both roughened by fine concentric lamellæ. Inner valve-margin finely crenulate except dorsally. Pallial sinus narrow, sharply angled. Length, 47; height, 40; depth of single valve, 17 mm.

Hab.—Mast Head Reef, Queensland; 20 fathoms.

Young shells of this species were mistaken for *C. toreuma* Gould. The adult valve, now described, came to hand after my paper on the Mast Head fauna was completed, and shows the species to be distinct. The young shells, as often happens in this genus, are rounder than the adult.

Chione toreuma Gould, and *C. embrithes* Melvill & Standen, are the nearest relations of the novelty. By its lunule it is intermediate between them, but its greater length in proportion to height distinguish it from either.

These two species present such difficulty that a brief discussion of them may be acceptable. I find *C. embrithes* to range from the Gulf of Carpentaria through Torres Strait to Moreton Bay.

But I have taken *C. toreuma* only at Green, Fitzroy, and North Barnard Islands (*i.e.*, about 17° S. lat.). Though alike in size, colour, shape, and sculpture, they are immediately separable by the lunule, that of *C. toreuma* being comparatively narrow and shallow, but that of *C. embrithes* broad and deeply excavate. Smith* united *Venus jukesi* Desh., and *V. sculpta* Desh., to the earlier *V. toreuma* Gould, and described the yet unnamed *embrithes* as a form of it. Hidalgo,† on the contrary, divided *C. toreuma* from *C. jukesi*. His reference to Reeve's figures conveys the impression that the deeply lunuled shell is *C. toreuma*, and the shallow lunuled one is *C. jukesi*. But an excellent figure of *C. jukesi*‡ overlooked by all authors, when contrasted with the figures of Gould, and of Melvill and Standen seems to me to support the union of *C. jukesi* to *C. toreuma*.

In describing *C. embrithes*, Melvill and Standen merely state that it was "Hitherto mixed up and confounded with *C. toreuma*,"§ without reference to any previous appearance in literature of their novelty.

CUNA PISUM, n.sp.

(Plate ix., figs.26-27.)

Shell large for the genus, solid, inflated, globose-cuneate, inequilateral, produced posteriorly. Both lunule and escutcheon large, deeply impressed, smooth. Umbo usually eroded, bluntly rounded, approximate. Colour dull white. Sculpture: about thirty irregular concentric flat-topped ridges parted by narrow interstices. The anterior part of the valve carries half a dozen rays apparent through inflection of the concentric ribbing and gradually fading posteriorly. Ventral margin sharply finely crenulated. Length, 6; height, 5; breadth of conjoined valves, 4 mm.

One example dredged in 8 fathoms off Green Point, Sydney Harbour, by J. Brazier.

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* Zool. Coll. Alert 1881, p.93.

† Mem. Acad. Cien. Madrid xxi. 1903, p.290.

‡ Deshayes, Proc. Zool. Soc. 1853 (1854), Moll. pl. xix., f.2.

§ Journ. Linn. Soc. Zool. xxvii. 1899, p.195.

Type.—To be presented to the Australian Museum.

Since I last wrote on this genus, it has been reviewed and enlarged by Dr. Dall.*

CYAMIOMACTRA NITIDA, n.sp.

(Plate ix., figs 19-20).

Shell small, moderately solid, inflated, inequilateral, the anterior end rather pointed, the posterior truncate, very glossy. Colour rufous. Sculpture: the whole surface marked with faint and rather irregular concentric growth-lines, radial sculpture absent. The protoconch a distinct cap with a slightly thickened rim. Hinge contracted, the bifid cardinal projecting further than usual into the valve. Height 2·2; length 2·6; depth of single valve 0·9 mm.

In 20 fathoms, sand, five miles from Sussex Inlet, Wreck Bay, N. S. Wales, I dredged several living examples in December, 1905.

By its wedge-shape, lack of radial sculpture and hinge, this approaches nearest to the type of the genus. But it is contrasted with *C. problematica* by being much smaller, more inflated and glossy.

Since I reviewed this genus† an Antarctic member, *C. laminifera*, has been discovered by Dr. Lamy.‡ It seems to me probable that another Antarctic shell described as *Cyamium denticulatum*,§ can also be referred to this genus.

By the kindness of the Director of the British Museum and of Mr. E. A. Smith, I have been favoured with the loan of cotypes of rare unfigured gasteropods, and notes on others. From this source I have obtained the following information and illustrations of little-known Australian shells.

Mr. Smith writes (4 Nov., 1907) that he cannot now find the following five species in the British Museum Collection. Since

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* Dall, Trans. Wagner Inst. Sci. iii. 1903, p.1480.

† These Proceedings, xxx. 1905 (1906), p.540.

‡ Lamy, Expedition Charcot, Moll. 1906. p.11, Pl. i. f. 10, 11, 12.

§ Smith, Discovery Expedition, Moll. 1907, p. 3, Pl iii. f. 4-4b.

neither figures nor types of these are extant they may well be abandoned.

Mitra insignis A. Adams, Proc. Zool. Soc. 1851 (1853), p.132, Raine Island, N. Queensland (Lieut. Ince). Type of subgenus *Aidone*.

Ziziphinus nebulosus A. Adams, *loc. cit.* p.168, Raine Island (Ince). *Trochus nebulosus* Forbes, Voy. Rattlesnake ii. 1852, p.366, Bass Strait, 40-45 fths.*

Eleuchus vulgaris A. Adams, *loc. cit.* p. 171, Swan River, West Australia. "Perhaps only *E. iriodon*," E.A.S.

Monodonta granulata Gray, Append. King's Survey, ii. 1827, p.479.

Phasianella pulchra Gray, *loc. cit.* p.481.

Gibbula sulcosa A. Adams.

A. Adams, Proc. Zool. Soc. 1851 (1853), p.186; Ann. Mag. Nat. Hist. (2) xii. 1853, p.209.

This shell was, in the above description, reported by Adams as having been dredged by Mr. Jukes in 8 fathoms off Sir Charles Hardy's Islands, North Queensland. Such a circumstantial statement invites confidence, which in this cases is undeserved.

Angas continued the tale by announcing *G. sulcosa* from New South Wales.† Then Tenison-Woods traced it to Tasmania,‡ and Pritchard and Gatliff to Victoria.§

In correction, Tate and May refer the Tasmanian shell to *Gibbula picturata* Adams & Angas;|| while Verco identified the Victorian one as *Gibbula lehmanni* Menke.¶ Which shell from New South Wales was mistaken by Angas for *G. sulcosa* is not known to me.

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*Included by Reeve (Conch. Icon. xiv. 1863, Ziziphinus, Pl. ii. sp. 7) as a synonym of *Z. ornatus* Lamarck.

† Proc Zool. Soc. 1867, p.217.

‡ Proc. Roy. Soc. Tasm. 1877, p.42.

§ Proc. Roy. Soc. Vict. xiv. 1902, p.132.

|| These Proceedings, xxvi. p.404.

¶ Trans. Roy. Soc. S.A. xxix. 1905, p.172.

At my request Mr. E. A. Smith examined the type of *G. sulcosa* in the British Museum, and replied that it proves to be a variety of *G. ardens* von Salis, and the Australian habitat a blunder. *G. ardens* is a common and variable Mediterranean shell. Bucquoy, Dautzenberg, and Dollfus have reviewed it exhaustively in the " Mollusques Marins du Roussillon" (Fasc. ix. 1885, p.379), but the synonyms of Adams escaped their attention.

GIBBULA VENUSTA A. Adams.

A. Adams, Proc. Zool. Soc. 1851 (1853), p.187.

This was ascribed by its author to Australia, but Mr. Smith relegates it also to a variety of *G. ardens* von Salis. In this case bad work bred no further evil.

CLANCULUS ALBINUS A. Adams.

A. Adams, Proc. Zool. Soc. 1851 (1853), p.82; Pilsbry, Manual Conch. xi. 1889, p.160.

(Plate viii., fig.12.)

The " accessible information " on this species is valued by the latest monographer as " mere trash." Brazier has recorded that, in December, 1871, he found one specimen of this rare shell, with the apex broken, on the beach of Fitzroy Island, North Queensland.* This citation renders *C. albinus* an object of interest to Australian conchologists, and to facilitate its recognition a figure and description of a cotype from the British Museum are here given. Within the genus *Clanculus* the species should be intercalated near *C. clanguloides* Wood.

Shell large, very solid, deeply and rather widely false-umbilicate, globose-conic. Spire obtuse. Whorls about six in number, wound obliquely, slightly gradate, rounded at the periphery, a little descending and constricted at the aperture. Base rather flat, extending obliquely. Colour pale buff, punctate with small irregularly scattered crimson or brown dots. Sculpture: small

* Brazier, Journ. of Conch. ii. 1879, p.197.

grains of nearly uniform size are crowded in close spiral rows. On the last whorl are eighteen, on the penultimate seven, and on the antepenultimate six bead rows. Two or three spiral threads run along the shallow interstices which intervene between the rows. Aperture oblique, deltoid, choked by intrusions from right and left. From lip to lip a smooth thick but translucent callus spreads round the perforation. The very oblique columella arises deep within the perforation, and ends in a large projecting triplicate tubercle (the left intrusion); above the tubercle is a fold, and above that a small denticle. The opposite intrusion is a massive tricuspid rooted within the margin of the lip, and hanging deep into the aperture. On the palate between the perforation and right insertion are three short entering bars, followed by another winding far into the interior. Inside the periphery are three long entering infrapalatal ridges alternating with short ones at the entrance. Basal margin with half-a-dozen short transverse folds. Height, 18; maj. diam., 20; minor diam, 17 mm.

Greater size and paler colour are the features which separate *C. albinus* from *C. clanguloides* Wood.

Monodonta sulcifera A. Adams.

A. Adams, Proc. Zool. Soc. 1851 (1853) p.175.

The cotype of this unfigured species, lent me by the British Museum, represents an immature *Euchelus atratus* Gmelin.

Cantharidus suturalis A. Adams.

Thalotia suturalis A. Adams, Proc. Zool. Soc. 1851 (1853), p.173; Ann. Mag. Nat. Hist. (2), xii. Sept. 1853, p.204.

(Plate vii., fig.4.)

Shell small, solid, pyramidal, imperforate. Apex eroded, but whorls apparently six, flattened, slightly gradate, last descending a little at the aperture. Colour pale yellow, tessellated with small purple spots. Sculpture: low, flat-topped spiral ribs equal to the intervening spaces, on the last whorl twelve, of which half are basal. Aperture subquadrate, terminating below in a blunt tubercle. Height, 8; maj. diam., 8; minor diam., 7 mm.

Adams states that the type was taken by Lieut. J. E. Dring at Cape Upstart, North Queensland, under stones at low water. I have taken a variety of this at Sweers Island, Gulf of Carpentaria.

Cantharidus crenelliferus A. Adams.

Thalotia crenellifera A. Adams, Proc. Zool. Soc. 1851 (1853), p.173; Ann. Mag. Nat. Hist. (2), xii. Sept. 1853, p.204; Brazier, these Proceedings, ii. 1877, p.43.

(Plate vii., fig.5.)

The British Museum cotype is a small shell, conical, angled at the periphery and flattened on the base, the spire-whorls slightly bulging at their periphery. Whorls nine. Colour rose-red variegated by oblique flames of pale brown. Sculpture: the last and antepenultimate whorls have nine spiral strings, the outermost larger, apt to run in pairs and separated by spaces broader than themselves. They are crossed at a low angle by fine close threads which in their passage bead the strings and lattice the interstices. Base with half a dozen widely parted spirals; here the radials are finer and closer and chiefly affect the interstices. Aperture subquadrate, columella abruptly truncate anteriorly. Within the base of the aperture is a bilobed callus ridge, a sort of doorstep, and within the left margin another mass of callus. Length, 10; breadth, 7 mm.

The original description quotes the species from "Australia." Brazier records it from 25-30 faths. off Darnley Island, Torres Strait. A specimen from New Caledonia agrees well with the cotype before me. This suggests that the unfigured *Trochus artensis* Fischer* from New Caledonia may perhaps be a synonym.

* Journ. de Conch. 1878, p.208.

Cantharidus strigatus A. Adams.

Thalotia strigata A. Adams, Proc. Zool. Soc. 1851 (1853), p.172; Ann. Mag. Nat. Hist (2), xii. Sept. 1853, p.203.

Thalotia mundula Adams & Angas, Proc. Zool. Soc. 1864, p.37.

Trochus baudini Fischer, Journ. de Conch. xxvi. 1878, p.65; Coq. Viv. 1879, p.356, Pl.110, f.5 (not of Tate & May, these Proceedings, xxvi. 1901, p.460).

(Plate vii., fig.3.)

The cotype of *T. strigata* here figured is 18 mm. in length, painted with longitudinal stripes of white and red or green. The type-locality is Swan Point, near King's Sound, N.W. Australia.

Mr. Smith writes of *T. mundula*—"This is certainly only a young specimen of *T. strigata* A. Ad. We have the type of *mundula* presented by Angas, and I have very carefully compared it with *strigata*." The habitat of *T. mundula* is Shark's Bay, W. Australia.

I consider that *T. baudini* Fischer, was founded on a young *Thalotia strigata*. Prof. Tate assigned this name to a Tasmanian shell, but in this I cannot follow him; nor do I know any other Tasmanian shell which suits the figure of Fischer. The type of *T. baudini* was said to have been collected on King Island, Bass Strait; but there are other cases where shells from N.W. Australia are credited to Tasmania by the naturalists of the same expedition.

Cantharidus punctulosus A. Adams.

A. Adams, Proc. Zool. Soc. 1851 (1853), p.169.

This species was reported to have been obtained by Jukes in 4 faths. Swan River, W. Australia; and has not been again noticed in literature. A cotype lent by the British Museum shows the species to be synonymous with *Trochus nitens* Kiener.

Cantharidus moniliger A. Adams.

A. Adams, Proc Zool. Soc. 1851 (1853), p.169.

Reported to have been obtained by Jukes in 8 faths. Swan River, W. Australia. I consider the cotype lent me to belong to *Cantharidus pyrgos* Philippi, already discussed in these Studies.*

LIOTIA AFFINIS A. Adams.

A. Adams, Proc. Zool. Soc. 1850, p.50; Ann. Mag. Nat. Hist. (2) vii. April, 1851, p.332.

(Plate vii., figs.6-7.)

This unfigured species has been omitted from the last monograph, and indeed from subsequent literature generally. But it so closely approximates to the figure for *L. scalaroides* Reeve, given by Adams† himself as to suggest that the names are synonymous.

The cotype from the British Museum has, as usual, been sadly etched with acid. It may be described as follows :—

Shell very solid, subglobose, narrowly perforate. Colour (in present condition) white. Whorls five, the upper tabulate, the lower rounder, descending wtih greater obliquity as growth proceeds. Sculpture : the radials at last form oblique massive waves; advancing down the whorls they become wider-spaced, fewer and larger, so that the final whorl carries eight, including the varix, but the penultimate eleven. Conversely the spirals multiply while decreasing in comparative size; behind the aperture are 18 small threads, but on the antepenultimate 4 large ones. As each intercostal furrow runs into the umbilical border it ends in a small pit. On the base a solid broad callus overlies and swallows the ribs and surrounds the umbilicus. On the inner edge the radials reappear as denticles, below it merges into the peristome, above it winds as a screw-thread into the perforation. Aperture small, circular. Operculum similar to that figured for *L. peronii.*‡ Height, 10 mm ; maj. diam. the same; minor diam. 9 mm.

The locality given is "Australia." What I recorded from Masthead Island as *L. scalarioides* agrees with it It may be

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* These Proceedings, xxvi. p.19.
† Genera Mollusca, Pl.xlv. f.5*c*.
‡ Proc. Zool. Soc. 1850, Pl.viii. f.19.

here mentioned that a cotype of *Liotia Walkeri** Sowerby, proves identical with *L. devexa* described in the fourth Part of these Studies.

DELPHINULA CORONATA A. Adams.

A. Adams, Proc. Zool. Soc. 1850, p.51; Ann. Mag. Nat. Hist. (2) vii. p.332.

(Plate viii., fig.13.)

This name was given to a shell gathered by Jukes at Cape Upstart, Queensland. The cotype lent me is obviously *D. delphinus* Linné var. *melanacantha* Reeve,† of which it may sink as a synonym. No subsequent writer appears to have noticed this species.

NASSA AUSTRALIS A. Adams.

(Plate viii., fig.10.)

Nassa australis A. Adams, Proc. Zool. Soc. 1851 (1853), p.272; Ann. Mag. Nat. Hist. (2) xiii., Feb. 1854, p.156.

This hitherto unfigured and unrecognised species was, in the above description, reported from "Australia." The cotype figured is 24 mm. in length. It appears to agree with fig.51 of Nassa, Conch. Icon. viii. This illustration is quoted by von Martens‡ for *Nassa marginulata* Lam., var. *hepatica* Pulteney.

MITRA DELICATA A. Adams.

(Plate vii., fig.1.)

Mitra delicata A. Adams, Proc. Zool. Soc. 1851 (1852), p.137; Ann. Mag. Nat. Hist. (2) xv. 1853, p.54.

The cotype lent me by the British Museum is figured and described as follows:—Shell slender fusiform, contracted at the base, spire acuminate slightly turreted. Remaining whorls 10. Colour milk-white with two narrow orange bands each covering about three spirals, one below the suture, the other on the peri-

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* Proc. Malac. Soc. viii. 1908, p.16, Pl.i f.2.
† Conch. Syst. ii. 1842, Pl.211, f.4 and Pl.212, f.10.
‡ Journ. Linn. Soc. Zool. xxi. 1887, p.181.

phery, the latter is so divided by the on-coming whorl that part appears on the spire. Sculpture: radial ribs prominent, narrow, being less than half the interstice-breadth, polished, following one another up the spire but not with perfect regularity; on the base the radials break up into beads on the spirals, on the first whorl 12, on the last twice as many. Spirals interrupted by the radials and latticing their deep interstices by bars equal in breadth to the deep pits that separate them. On the penultimate whorl are eight spirals; on the last twenty, including two coarse irregular ones behind the canal. Plaits on the columella four, anteriorly decreasing in size but increasing in obliquity. Canal short, upturned. Throat ribbed within by a dozen raised spiral cords which are wider spaced posteriorly. Length, 19; breadth, 7 mm.

The cotype is worn and faded; a better specimen from Darnley Island has three embryonic and eight adult whorls in a length of 16 mm. The apex is small, acicular, of three small glassy whorls, inclined to the main axis. On the base is a third orange band entering the aperture immediately above the columellar folds.

The type is stated in the original description to have been procured by Jukes in 8 fathoms, off Cape York, Queensland. The species was next found by the Chevert Expedition in 15 fathoms at Darnley Island;* and I took it in 1906 near the Hope Islands, in 5-8 fathoms.

MITRA ASPERULATA A. Adams.

A. Adams, Proc. Zool. Soc. 1851 (1852), p.136.

(Text-fig. 1).

This figure is from a photograph of the unique type in the British Museum, for which I am indebted to Mr. E. A. Smith. The original locality is merely "Australia." The tip of the spire is broken off, the length of the last whorl is 10 mm., greatest diameter 5·5 mm., and the probable total length 20 mm.

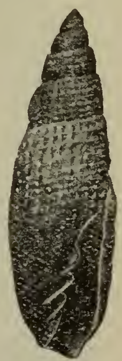

Fig.1.

* Brazier, these Proceedings i. 1876 (1877), p. 214.

Cominella maura A. Adams.

A. Adams, Proc. Zool. Soc. 1854 (1855), p.313.

The British Museum cotype easily falls within the variation-range of the protean *Cominella lineolata* Lamarck. This has already been conjectured by Tryon. The locality of Darnley Island, Torres Strait, is an obvious error, as the species does not range so far north.

Peristernia nodulosa A. Adams.

A. Adams, Proc. Zool. Soc. 1854 (1855), p. 313.

(Plate viii. fig.11).

This species has not been figured or again noticed in literature. It was originally reported from Australia, but I am not acquainted with an Australian shell like it. It would seem to be related to *Pyrula anomala* Reeve. The cotype received has been so severely etched with acid that the surface and upper whorls have gone. Shell massive, biconical, constricted on the base and below the suture. Five whorls remain. Heavy blunt nodules, about eight to the last whorl, are disposed in a peripheral row. Within the throat are seven entering lyræ. Base of the columella with an obscure tubercle or two. Canal short recurved. A funicular ridge extends from the canal backwards around a shallow axial perforation. Length 30 mm.; breadth 19 mm.

Terebra australis Smith.

E. A. Smith, Ann. Mag. Nat. Hist. (4) xi. April, 1873, p.264.

(Plate viii., fig.2).

The original localities are Swan River, and Paterson's Bay, Torres Strait. The cotype figured is 43 mm. long, and 9 mm. broad.

PLEUROTOMA COGNATA Smith.

E. A. Smith, Ann. Mag. Nat. Hist. (4), xix. June, 1877; p.490.

(Text-fig.2).

My figure is reproduced from a photo kindly sent by the author of the species. The unique type is reported from "Australia;" it is 24 × 7 mm.

Fig.2.

DRILLIA ESSINGTONENSIS Smith.

E. A. Smith, Ann. Mag. Nat. Hist. (6), ii. Oct. 1888, p.303.

(Plate viii., fig.8).

The cotype is rufous-brown, the peripheral tubercles touched with white. Length 19 mm., breadth 7 mm. I have seen this species from Torres Strait.

DRILLIA VENTRICOSA Smith.

E. A. Smith, Ann. Mag. Nat. Hist. (6) ii. Oct. 1888, p.301.

(Text-fig.3.)

My figure is from a photograph of the unique type, kindly forwarded by Mr. E. A. Smith. It is 27·5 mm. long and 9·5 mm. broad, and was dredged by MacGillivray between the Percy Group, Queensland, and the mainland.

Fig.3

CLATHURELLA MORETONICA Smith.

E. A. Smith, Ann. Mag. Nat. Hist. (5) x. Oct. 1882, p.299.

(Plate viii., fig.14.)

The cotype is 10 mm. long, 3 mm. broad; of a uniform cinnamon-brown. It was taken in Moreton Bay, Queensland, by F. Strange.

Daphnella souverbiei Smith.

E. A. Smith, Ann. Mag. Nat. Hist. (5) x. Oct. 1882, p,300.

(Plate viii., fig.9)

The cotype figured is white; 13 mm. long, and 6 mm. broad. It was reported from the Swan River, Western Australia.

Bittium turritelliformis [-e] Angas.

Angas, Proc. Zool. Soc. 1877, p.174, Pl.xxvi. f.14.

I suggested to Mr. E. A. Smith that my *Seila attenuata*, described in the first Part of these Studies, might be a synonym of the above species of Angas, if his figure and description could be construed with some latitude. Mr. Smith replied (i.vi.08)—"Angas never gave us any specimens, so perhaps he lost the type, being such a small object, or he may have returned it to Brazier. I think, however, that your shells are this species. Angas described the whorls as *convex*, so I regard the figure as inaccurate."

Since the type of Angas' species is lost, and his figure and description are bad, there would be some justification for abandoning his species. I would, however, prefer to assume that he dealt with a young *attenuata* and to withdraw my name in favour of his.

S. attenuata has been recognised in Victoria by Pritchard & Gatliff.*

EXPLANATION OF PLATES VII.-X.

Plate vii.

Fig. 1.—*Mitra delicata* A. Adams.
Fig. 2.—*Terebra australis* E. A. Smith.
Fig. 3.—*Cantharidus strigatus* A. Adams.
Fig. 4.—*Cantharidus suturalis* A. Adams.
Fig. 5.—*Cantharidus crenelliferus* A. Adams.
Figs. 6-7.—*Liotia affinis* A. Adams.

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* Proc. Roy. Soc. Vict. xviii. 1906, p.60.

Plate viii.

Fig. 8.—*Drillia essingtonensis* E. A. Smith.
Fig. 9.—*Daphnella souverbiei* E. A. Smith.
Fig. 10.—*Nassa australis* A. Adams.
Fig. 11.—*Peristernia nodulosa* A. Adams.
Fig. 12.—*Clanculus albinus* A. Adams.
Fig. 13.—*Delphinula coronata* A. Adams.
Fig. 14.—*Clathurella moretonica* E. A. Smith.

Plate ix.

Figs. 15-16.—*Capulus nutatus* Hedley.
Fig. 17.—*Mangelia hilum* Hedley.
Fig. 18.—*Trophon paivae* Crosse, (apex).
Figs. 19-20.—*Cyamiomactra nitida* Hedley.
Fig. 21.—*Strigilla grossiana* Hedley.
Figs. 22-23.—*Strigilla euronia* Hedley.
Figs. 24-25.—*Chione capricornea* Hedley.
Figs. 26-27.—*Cuna pisum* Hedley.

Plate x.

Fig. 28.—*Chlamys radiatus* Hutton.
Fig. 29.—*Eulima topaziaca* Hedley.
Figs. 30-31.—*Litiopa melanostoma* Rang.
Fig. 32.—*Odostomia ignava* Hedley.
Fig. 33.—*Rissoa imbrex* Hedley.
Fig. 34. ,, *procincta* Hedley.
Fig. 35. ,, *praeda* Hedley.
Fig. 36. ,, *incompleta* Hedley.
Figs. 37-38.—*Vermicularia caperata* Tate & May.

Note.—On p. 456, lines 24-25, after *Buccinum funiculatum* Reeve, add (=B. *contractum* Reeve, fide E. A. Smith).

WEDNESDAY, AUGUST 26TH, 1908.

The Ordinary Monthly Meeting of the Society was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, August 26th, 1908.

Mr. A. H. S. Lucas, M.A., B.Sc., President, in the Chair.

Dr. Frederick Hamilton-Kenny was elected an Ordinary Member of the Society.

The receipt of circulars from the Committee appointed by the Royal Society of Victoria, to consider the question of establishing some memorial of the late Dr. A. W. Howitt; and from the Anderson Stuart Testimonial Fund, was announced, and the attention of Members directed to them.

The Donations and Exchanges received since the previous Monthly Meeting, amounting to 9 Vols, 60 Parts or Nos., 5 Bulletins, 1 Report, and 7 Pamphlets, received from 43 Societies, &c., and 2 Individuals, were laid upon the table.

THE DISTRIBUTION, ORIGIN AND RELATIONSHIPS OF ALKALINE ROCKS.

By H. I. Jensen, D.Sc., late Linnean Macleay Fellow of the Society in Geology.

Ch.i. Introduction.

This paper is in the main a revision of a portion of a thesis submitted to the Sydney University with the view of qualifying for the Doctor of Science degree. The work on which the thesis is based was carried out while I held the position of Linnean Macleay Fellow of the Society. I am indebted to the University authorities for permission to republish.

To my teachers, Professor T. W. Edgeworth David, B.A., F.R.S., and Mr. H. Stanley Jevons, M.A., B.Sc., F.G.S., I owe a lasting debt of gratitude for the excellence of the instruction which they have imparted to me. To the former, in particular, I am indebted for my acquaintance with the broad principles of structural geology and for the constant interest which he has taken in my own work; to the latter I feel grateful for thorough instruction in petrology and for an introduction to the German masters of petrological science, for whom my esteem has in nowise been lessened by a closer acquaintance with the American authorities.

In my researches I have given particular attention to alkaline rocks, partly because since boyhood my interest had been attracted by the wonderful monoliths of the Glass House Mountains near my home at Caboolture, Queensland, partly because alkaline rocks have been investigated in great detail in other parts of the world, while in Australia, a continent marvellously rich in alkaline comagmatic regions, they have been almost totally neglected. On closer acquaintance, I soon found that alkaline rocks, in addition to having an interest for their own sake, might shed important light on the building of our continent and the broader features of structural geology.

Definitions.—By the term *alkaline rock* I understand any rock which contains a particularly high percentage of combined alkalies or which under the microscope contains a great abundance of soda-rich and potash-rich minerals. The actual percentage of alkali necessary to make a rock fall in this group depends on its basicity. Usually the rocks classed as alkaline also contain a particularly low percentage of MgO and CaO. These constituents, however, become very high in some basic varieties of alkaline rock, such as fourchite, camptonite and ouachitite, which are classed here on account of their constant association with alkaline rocks. Potash-rich leucite rocks which show a deficiency in certain common rockforming constituents I would also class as alkaline, although richness in soda and sodic minerals is the main feature of the group.

In general, therefore, the term *alkaline*, as applied to rocks, will be used in the same sense as Rosenbusch and his school employ it; that is, it will denote all such rocks as may be conceived to be the differentiation-products of a foyaitic magma.

In the following discussion the terms "uplift" and "depression" will be frequently used. Suess in 'Das Antlitz der Erde' has propounded the doctrine that all movements of the earth's crust are downward. The merits of this view will not be discussed here, although I believe that, in the mechanics of the earth's crust, not only is relative uplift possible, but it has frequently taken place. It must, however, be understood that in my discussion I have frequently used the term "uplift" where Suess would speak of a "negative movement of the sea," and "depression" where Suess would say "positive movement of the sea." The term "transgression" is used in the same sense as Suess would use it.

General Discussion.—Lyell, the great advocate of uniformity, laid it down as a general rule that in past geological epochs sediments were deposited, lavas were poured out, and intrusions were formed by the same processes which we see going on at the present day. He discountenanced particularly the ideas of gigantic cataclysms and deluges such as were imagined by earlier geologists to account for their observations.

Although Lyell's view is correct in a general sense, it becomes more and more apparent from a study of geology that there have been periods of comparative quiet and periods of intense disturbance in the history of our planet. This fact is admitted by Chamberlin and Salisbury in their 'Geology,' Vol. i., p.572.

Joseph Barrell* has shown that the early Cambrian, all over the earth's surface, was a period of great continental extension and uplift. During the Eopalæozoic (Cambrian, Silurian and Devonian), the continents again became largely resubmerged. These were periods of comparative quiet. In late Devonian and early Carboniferous times there were again great epeirogenic uplifts, but in late Carboniferous times subsidence predominated. The Permian and early Triassic were periods of elevation, whereas the Jurassic, Cretaceous, and Eocene were eras of subsidence in which many continents were worn down and partly submerged. In the middle Tertiary again great uplifts took place.

In a general sense this statement holds true, yet there were numerous exceptions. It is not hard to find some area of limited extent, the Sydney basin for instance, which subsided during the Permian and Triassic and underwent elevation during the Cretaceous and Eocene.

Just as we meet with periods of continental extension and periods of gradual submergence, so too we find that there have been periods of intense vulcanicity and of comparative quiet. In general, the volcanic epochs agree closely with the transition periods which ushered in the periods of continental extension and uplift. Thus, in every part of the world we find that the late Carboniferous and early Permian were remarkable for intense vulcanicity. In Australia great lava-flows and mighty granitic intrusions are assigned to these times; for example, in New South Wales we have the great granitic intrusions of the

* Journal of Geology, Vol.xiv. No.5, July-August, 1906.

New England district (Carboniferous and Permo-Carboniferous); the rhyolites and breccias of Barraba and Maule's Creek near the Nandewar Mountains (late Carboniferous); the rhyolitic lavas of Pokolbin and the basic lavas of the Kiama-Jamberoo area (Permo-Carboniferous).

Following close upon the Silurian period of subsidence, and preceding the late Devonian period of continental extension we notice also in early Devonian times an era of intense volcanic action. In this period immense quantities of rhyolite were poured out in Britain; the brecciated conglomerates of the Old Red Sandstone belong to this series. In Australia, in the same period, we had the rhyolitic extrusions of the Snowy River porphyries, the Yass rhyolites, the Jenolan granites (?), the Bathurst granite (?), the Tamworth rhyolites and rhyolitic tuffs, and probably some of the granite of the Moonbi Ranges. The biotite granites of Kosciusko probably belong to this period.

During the late Permian, the Triassic and the Cretaceous, Australia, like many other parts of the world, experienced a rest from volcanic activity. In the late Cretaceous again commenced a period of intense vulcanicity which lasted well into the Tertiary.

Not only in Australia do we find the Triassic and Cretaceous to have been periods in which shallow epicontinental seas developed and the Eocene a period of incipient volcanic activity, but in the United States, Brazil, Africa (East), and in Central Eurasia analogous conditions prevailed at the same time. In parts of Europe the era of epicontinental seas and the period of epeirogenic movements commenced somewhat earlier. Thus, in Tyrol gigantic igneous intrusions and volcanic extravasations took place in the late Mesozoic, and this era was, from that time until the final uplift of the Alps, the scene of repeated oscillations.*

Generally speaking the commencement of a period of volcanic disturbance was not coincident all over the earth, but would set in in some regions earlier than in others. Likewise, such a period would end earlier in some regions than in others. Thus,

* Suess, 'La Face de la Terre,' Tome iii.

the latest period of volcanic action commenced late in the Cretaceous and ended in the Pliocene; but in Java, and the East Indies generally, this period of vulcanicity commenced in the early Tertiary and still continues in parts with unabated violence.

We may conveniently say that in each geological province there have been three great "pyrogenic" periods since the commencement of the Palæozoic era, the first falling exclusively in the Palæozoic (chiefly Devonian), the second commencing at the close of the Palæozoic and lasting well into the Mesozoic (chiefly Permian), and the third commencing in the late Cretaceous and lasting well into the Tertiary. These periods we may call, for the sake of brevity, the Palæopyrogenic, the Mesopyrogenic and the Neopyrogenic, with the proviso understood that each does not necessarily fall into the corresponding era of the geological record.

Before the commencement of life, in the Archæan or Azoic periods, there was in every part of the earth intense vulcanicity.

The following table seems to summarise these facts.

Period.	Dominant Tendency	Volcanic Phenomena
Azoic	....	very abundant
Precambrian	transition	very abundant
Early Cambrian	elevation	infrequent
Late Cambrian	stability	rare
Ordovician	submergence	rare
Silurian	submergence	rare
Early Devonian	stability and transition	more frequent
Late Devonian	transition and uplift	very abundant
Early Carboniferous	uplift	frequent
Late Carboniferous	submergence	frequent
Permian	transition and uplift	very abundant
Triassic	uplift	very rare
Jurassic	stability	very rare
Cretaceous	submergence	very rare
Eocene	transition	very abundant
Miocene	uplift	frequent
Pliocene	uplift	less frequent
Pleistocene	uplift	infrequent
Recent	stability	rare

If we consider the sequence of events in the East Australian geological province, we arrive at the following set of conclusions:

1. Azoic.—In the Pre-Cambrian and Archæan eras great volcanic activity prevailed. The Kosciusko and Gippsland muscovite granites and gneisses and corresponding rocks in Tasmania, the fundamental granites of the Cobar massive, and many other masses now for the most part obscured by later sediments, were intruded at this time. Similar rocks underlie the Cretaceous of South Australia and Western Queensland, and extend over large areas in Western Australia.

The igneous rocks of this period comprise both acid and basic varieties, and both deep-seated and extrusive types. The basalt of the Antrim plateau, near Kimberley, in Western Australia, is one of the few examples of basic lava of very great antiquity.

The volanic rocks of this period are, as far as known at present, never alkaline.

2. Palæopyrogenic.—In this period occurred the intrusions of biotite granite of Mount Kosciusko and of the Alpine provinces of Victoria; the Bathurst and Hartley Vale granites with sphene; the elvan or quartz-prophyry of Mount Bischoff, Tasmania; other Tasmanian granites; the Victorian grano-diorites; the Moonbi granites, Tamworth tuffs and the Snowy River porphyries of New South Wales, &c., &c.

3. Mesopyrogenic.—During early Devonian times a narrow belt along the east coast of Australia was undergoing heavy sedimentation, evidence of which we see in the Shoalhaven district Devonian series, the New England(?) and Tamworth districts, and in the coastal ranges of Queensland, yet most of the continent was being slowly elevated. During late Devonian and Carboniferous times practically the whole of New South Wales was undergoing broad uplift and erosion. This was also the case with Queensland west of the Dividing Range, but considerable stretches of the east coast of the northern State were at the same time undergoing gradual subsidence and sedimentation. This latter movement was particularly marked in the Burdekin area.* By the end of the Carboniferous many land-masses

* Jack and Etheridge, Geology and Palæontology of Queensland; T. W. E. David, Presidential Address to the Linnean Society of New South Wales, Proceedings, 1893, p.571.

had been worn down so as to expose deep-seated intrusive bodies. Subsidence or transgressions of the sea followed in many places and Permo-Carboniferous sediments were laid down east of the continental masses. At this time commenced a new period of volcanic action ushering in the era of continental extension in the area of heavy Carboniferous and Permo-Carboniferous sedimentation, and the worn-down continental areas to the west were exposed to Mesozoic marine transgressions.

During this pyrogenic period most of the New England granites were intruded, as shown by C. E. Andrews.* In other parts gigantic basaltic flows took place, as, for example, the lavas of the Kiama-Jamberoo series. This period of volcanic activity ended with the eruptions evidenced by the tuffs in the passage beds between the Permo-Carboniferous and Triassic.

Some of the lavas of this period were rather inclined to be alkaline.

4. Neopyrogenic.—Andrews* has shown that in the New England district the intrusions were followed by a long period of plateau-dissection and peneplanation. Meantime steady sedimentation took place in the Triassic-Cretaceous basin to the west. During Cretaceous times there was probably a general lowering of the land-level throughout Australia. The close of the Cretaceous was signalised by a renewal of volcanic activity, of which Maitland found evidence in the trachytic tuffs of the Desert Sandstone, near Mackay, Queensland.†

Andrews considers the latest granites of New England to be possibly as late as the Cretaceous. I have myself found granite-porphyries and diorite-porphyrites (cp. the Noosa Head porphyrite), in the East Moreton district, Queensland, which are distinctly Post-Triassic.‡

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* "Geology of the New England Plateau." Records Geol. Survey, N.S.W. Part i. Physiography, in Vol. vii.: Parts ii. and iii. The Granites, in Vol. viii.; Part iv. Petrology, in Vol. viii.

† Geological Features and Mineral Resources of the Mackay District. By Authority, Brisbane, 1889.

‡ Note on a Glaucophane Schist from the Conandale Range. Proc. Linn. Soc. N.S. Wales, Vol. xxxii., p.701.

In New England the Cretaceous intrusions and Tertiary lava flows mark a number of periods of instability, which inaugurated renewed elevation of the plateau.

To the Neopyrogenic period belong in addition all the Tertiary lavas of Eastern Australia, including the alkaline volcanic masses of the Warrumbungles, Nandewars, Mittagong, East Moreton, Mount Flinders, &c., and all the Tertiary rhyolites and basalts of our eastern States.

Andrews has shown that the New England intrusions have assimilated to a notable extent the invaded rocks, a feature which has been observed in other parts of the world by R. A. Daley, A. E. Barlow, H. N. Winchell, A. P. Coleman, and A. Harker.*

The extensive researches of E. C. Andrews have established the following facts for a part of New South Wales—

(1) A period of subsidence of long duration and free from volcanic action preceded a pyrogenic period (in the case of New England, the Mesopyrogenic).

(2) The commencement of elevation was accompanied by immense igneous intrusions.

(3) A long period of rest followed elevation. During this period erosion and peneplanation were effected. Then followed subsidence or instability.

(4) Renewed volcanic activity (in New England, the Neopyrogenic) followed.

(5) Then came renewed elevation followed by stable conditions and erosion.

These facts seem to me to afford strong evidence in favour of Mellard Reade's theory of the formation of mountain-masses through rise in isogeotherms in sediments deposited during a period of prolonged subsidence. The isogeotherms rise; folding results; magmas rise from beneath through fractures and are thrust into zones of no strain in the sedimentary anticlines.

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* Andrews, New England Geology, Part iv., Records of the Geol. Survey of N.S.W., Vol. viii., 1907.

Further a close scrutiny of Part iv. of Mr. Andrews' great work and especially of Mr. J. C. H. Mingaye's analyses, accompanying this paper, reveals the fact that many of the New England granites possess higher alkalinity than usual in this rock-type. Mr. Card's petrological notes also prove many to be rich in sphene, hence titanium-bearing. A comparison with the Bathurst sphene granite shows that they are richer in alkali (especially soda) and titanium, though more closely allied to it than to the rocks of the alkaline areas. This feature is of importance when read in conjunction with the fact that Mr. Andrews finds evidence of very considerable assimilation of Palæozoic sediments.

The following comparison of analyses brings out this fact :—

i. Porphyritic microgranite, 2 m. E. of Tenterfield : alaskose.*
ii. Blue granite, 2 m. E. of Tenterfield : toscanose.*
iii. Post-granitic dyke, near Hopetoun Battery, Hillgrove : toscanose.*
iv. Bathurst sphene granite.*
v. Jellore trachyte, near Mittagong : toscanose (?) (D. Mawson).
vi. Timor trachyte, Warrumbungles : phlegrose (H. I. Jensen).

	i.	ii.	iii.	iv.	v.	vi.
SiO_2	73·68	65·36	70·74	66·69	66·68	65·90
TiO_2	·16	·36	·37	tr.	·20	·25
Al_2O_3	15·06	16·37	14·71	17·03	14·63	16·74
Fe_2O_3	·68	1·80	·33	3·15	2·18	1·72
FeO	·54	2·68	2·43	·69	2·31	1·99
MgO	·26	1·81	·89	2·50	·30	·06
CaO	·54	3·82	1·88	1·82	1·88	·09
Na_2O	3·36	3·40	3·29	1·21	6·12	6·35
K_2O	5·45	3·75	4·07	6·26	4·02	5·77

From the geology of New South Wales we may infer that Barrell's statement as to periods of elevation and of subsidence is in general correct, but yet these periods were not strictly coincident over large areas. J. Barrell's scheme fails in our part of the world in this respect, that large areas of Australia were, in Triassic and Trias-Jura times, undergoing gentle subsidence, submergence and sedimentation, processes which, in many parts,

* N.S.W. Mines Department.

continued uninterruptedly until the close of the Cretaceous. We can explain away the difficulty either by regarding the Australian Triassic basins as epicontinental seas, or by falling back on Tenison-Wood's hypothesis that our Triassic sediments are products of subaërial degradation (windblown, &c.), both of which suppositions are probably well-founded for certain areas.

Again, the Eocene was in our continent, generally speaking, a period of uplift which continued through the Miocene and Pliocene. Australia dates from the Eocene. Likewise North America, South America, Africa and Asia assumed at that time a configuration resembling that which they retain at present. The Andes, the Himalayas and Hindoo-Koosh Mountains and the Alps commenced to form in that period.

The Eocene, it appears, was an era of compression, folding, faulting and mountain-building in many regions, and of contraction, faulting and senkungsfeld-formation in other parts of the world. In very many regions most intense volcanic activity prevailed. There were compensating movements of elevation and subsidence, continued oscillations, and instability everywhere. Volcanic extravasation was especially great along the borders of those Mesozoic basins which were then undergoing regional uplift (or relative uplift).

If we now consider for a moment the character of the lavas poured out at this time, we find as a most noticeable feature that they were frequently of an alkaline nature, belonging to what the Rosenbusch school of petrologists call a foyaitic magma; we see also that such lavas were poured out largely along Eocene fracture lines adjoining Mesozoic basins of sedimentation.

In Australia these features are exemplified, as will be explained later, by the alkaline lavas of East Moreton, Mt. Flinders, the Nandewars, the Warrumbungles, Mittagong, Dubbo, the Canoblas, and Mount Macedon.

In the Abyssinian region, which resembles the Australian to a remarkable extent, we find the same features.*

* Min. Mag. Feb. 1903, Vol. xiii. No, 61; and Min. Mag. Vol. xii. No. 57.

In Brazil, alkaline rocks abound, but their age is very uncertain. However, here too, the work of O. A. Derby * seems to show that a vast plateau-uplift occurred after the prolonged period of depression and erosion of the Mesozoic, during which many marine transgressions spread over the Brazilian area. The Triassic and Cretaceous sediments there deposited have since been largely removed by erosion, so that the alkaline rocks are left surrounded by the rocks of the fundamental Archæan complex. Their age can, therefore, only be stated as Post-Archæan, or in some cases Post-Silurian or Post-Carboniferous.

In general, it may be stated that alkaline extrusions have chiefly taken place along the borders of Mesozoic epicontinental basins or transgressions which have been broadly uplifted without much folding. Such is the case with the foyaitic rocks of Arkansas, the Highwood Mountains of Montana, the Leucite Hills of Wyoming, the Apache Mountains of West Texas, and many other groups around the great American plains and arid erosion peneplains of Cretaceous and Laramie sediments. Such, too, is the case with the alkaline rocks of Abyssinia and Transvaal in the faulted regions around the African steppes. The alkaline rocks of Tyrol, Bohemia and Transylvania occur likewise in the faulted zone near the border of the elevated Mesozoic basins of Central Europe; and, whilst those of Tyrol have been estimated by most authors to be of late Mesozoic age, the other two areas are Tertiary. The monzonitic rocks of Tyrol are, however, only of moderate alkalinity, like some of those of the New England plateau described by Card and Andrews. The monzonitic magma from which all the basic and acid members of this series are differentiated (Brögger) is of such a character that it might easily have originated by a calcic intrusion having stoped in and assimilated at considerable depth a number of alkaline Azoic and Palæozoic rocks.

The Norwegian alkaline area (Gran, Laugenthal and Nordmarken) is generally considered to be a Palæozoic intrusive mass.

* Journal of Geology xv.-3. See also Q.J.G.S. Vol. xliii. No. 171.

It is known to be Post-Silurian, and probably Post-Devonian, but nothing more definite is known. It is certain from the grain-size of the nordmarkites, foyaites, laurdalites and laurvigites of the region that they consolidated at a considerable depth. It is therefore possible that these rocks too were intruded as late as the Eocene or late Cretaceous, and that Tertiary erosion has exposed them; for we know well that a vast amount of erosion can be effected in a long period like the Tertiary; and the researches of Hull and Spencer* would lead one to believe that Norway and much of Europe in late Tertiary and Post-Tertiary times stood 8,000 feet higher than at present, hence the power of glacial and pluvial erosion must have been far greater than at present.

At whatever age these Christiania foyaitic rocks may have been intruded, the fact remains that their district is the Scandinavian earthquake epicentre at the present day. It is also clear that it is situated on the faulted flanks of the Scandinavian horst and near the border of the Mesozoic basin of sedimentation which extended over Denmark, South Sweden and Central Europe.

The similarity of lithological associations and of stratigraphical relationship between all areas where alkaline rocks abound, is very striking:—they occur always near and sometimes within the massifs or horsts adjoining great plains of Mesozoic sediments. Therefore they occur in the very places where we should expect the greatest production of heat by the differential movement of great blocks severed by faulting, where some great masses of the earth's crust are drawn down and partially remelted, being crushed between other segments which remain stationary or are being elevated.

In many parts of Australia, the United States, Brazil and Eurasia we have Mesozoic sediments capping the horsts.

The age of the alkaline rocks is often very difficult to fix, but in almost all cases where a reliable determination has been found

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* For references see The American Geologist, Vol. xxxv. No. 3, p. 152; also Ch. iv., 'The Evolution of Earth Structure,' by T. Mellard Reade.

possible, the age has been found to be near Eocene. Where such a determination has not been found possible the alkaline masses intrude very old Archæan or Palæozoic strata.

In this connection it is àpropos to mention that the erosion of about 400 feet of Mesozoic sediments in the district of the Glass House Mountains, Queensland, would leave the plugs and stœks of alkaline rock surrounded by the Palæozoic and Archæan complex which underlies the Trias-Jura rocks of the district, and it would be impossible for any geologist to locate their age any nearer than as Post-Carboniferous or, in some cases, Post-Archæan.

In very many cases—possibly that of Mount Macedon is one—the Mesozoic sediments originally invaded have been denuded away.

The Association of Alkaline Rocks with the Archæan Complex.

From the foregoing discussion it is gathered that alkaline rocks are frequently found intruding very old rocks in such a way that their age cannot be determined, and in all other cases rocks representing the oldest Palæozoic and the Archean can be found at no great distance from the alkaline areas.

Instances of this fact have already been given, and many more will be discussed later when each alkaline region is dealt with in more detail. In the United States instances abound; in Africa we have only to point to the cases of Abyssinia and Algeria. In Asia we have the same associations in Siberia and Arabia; in Brazil we have another notable example. For Australia we have only to mention the fact that the Glass House Mountains are only a few miles from the extremely metamorphic schist-region of the D'Aguilar Range. The Nandewars have the late Palæozoic basin of New England to the east of them, while to the west there is the region of plains, under whose black soils and red loams we have an ancient complex or a thin capping of Mesozoic sandstone overlying this complex. The same holds true for the Warrumbungles. The Canobolas rise directly out of the region of metamorphic Palæozoic rocks; and their recent age is only to be realised by a study of their contours and of the surrounding peneplain. In the Dunedin district of New Zealand the same relationships occur. In Antarctica, too, alkaline rocks, trachytes, kenytes, and trachy-dolerites have been noticed in abundance,* and here too in association with extremely old schists, granites and gneisses.

These facts are significant, as indicating that alkaline rocks are, in the true sense of the word, continental rocks. They are intimately associated with continental areas of great permanence (like Africa), and with broken down faulted relics of continents (like Bohemia, Madagascar, Atlantis and Antarctica).

The Association of Alkaline Rocks with undisturbed Mesozoic Beds.

In the subsequent discussion of the various alkaline regions it will be seen that very frequently alkaline intrude horizontally bedded or gently inclined Mesozoic beds, particularly the Triassic and Jurassic.

The intruded Mesozoic sediments have rarely been folded to any extent but frequently they have been affected by great block-faulting and trough-faulting. In most cases these beds immediately overlie very ancient rocks. They therefore probably represent mere transgressions of the sea which have invaded the worn-down continents in Mesozoic times.

In Europe, especially in Würtemburg and Bavaria, in the areas where alkaline rocks are very plentiful, the surrounding Mesozoic rocks (Triassic) are frequently tilted at high angles, but the tilt is caused by block- and trough-faulting, never by folding.

In Asia the alkaline rocks occur on the borders of areas over which Mesozoic rocks lie horizontally. In Arabia horizontal Jurassic rocks overlie a Carboniferous transgression under which the Azoic complex is met with. The same holds true for Socotra, Abyssinia, and Somaliland, and for Africa generally. For America numerous instances of the association of alkaline rocks

* British Museum Report: Scott Expedition. Geology.

with horizontal Cretaceous, Jurassic, and Laramie beds will be discussed more closely later.

The position of the Glass House Mountains, Mount Flinders, the Nandewars, the Warrumbungles, and the Mittagong trachyte area in the midst of almost horizontal Trias-Jura and Triassic sediments has been explained in my former papers dealing with those regions, and in Taylor and Mawson's paper on "The Geology of Mittagong" (for references see later). These sediments are never folded to any extent except quite locally near Ipswich.

This relation even holds in far-off Antarctica, where Captain Scott's expedition found the ancient complex capped by a series of unfossiliferous sandstones showing the same lithological characteristics as the Hawkesbury Sandstones of New South Wales, viz., current-bedding, shale seams, and doleritic dykes and sills Through this series, known as the Bindon Sandstones, alkaline lavas have broken in places.

The very frequent occurrence of intruded but unfolded Mesozoic beds in alkaline areas serves to show us that these parts were frequently epicontinental seas in the Triassic period, and, in the Jurassic and Cretaceous, marine transgressions invaded them; but they were never the seat of a mighty and prolonged sedimentation such as is followed by orogenic uplift and folding.

This fact too serves to show us that the alkaline areas are strictly continental and belong to those parts of the earth's crust which have been for long periods affected only by cooling and contraction, and never by rise of isogeotherms and the consequent compression.

The Relation of the Alkaline Areas to the Distribution of Land and Sea in Past Geological Periods.

In a previous paper I have already shown that the alkaline rocks of Eastern Australia follow approximately a course which has, throughout the periods of the geological record, been a border zone between land and sea. Oscillations have led to sedimentation alternately on the one side or the other of this line. The diagrams illustrating this point are reproduced in figures 1-7 and 10-13.

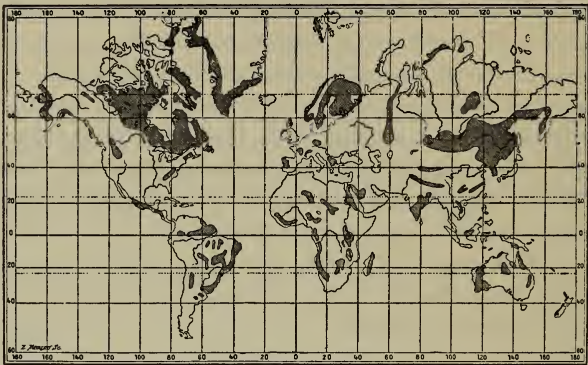

Fig. 1.—Map of the World showing Distribution of Archæan Deposits (after Lapparent).

If we now look into this relationship from a broader standpoint other matter of interest come into evidence. Figure 5 shows the distribution of alkaline rocks all over the earth.

Fig. 2.—Map of the World showing Distribution of Land and Sea at the End of the Carboniferous (after Lapparent).

By comparing this chart with Lapparent's map of the world showing the outcrops of Archæan shoreline deposits * (fig. 1), some relationship between alkaline areas and Archæan shores is faintly evidenced.

Next, by comparing Lapparent's map showing the distribution of land and sea in the Carboniferous with figure 5, a much more

Fig.3.—Map of the World showing Distribution of Land and Sea in the Jurassic (after Neumayr).

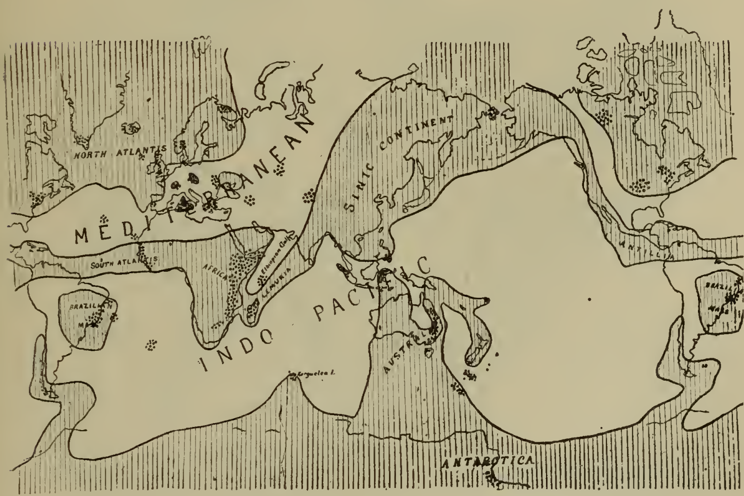

Fig.4.—Map of the World showing Distribution of Land and Sea in the Cretaceous. Land shaded: sea unshaded; alkaline areas dotted.

marked correspondence between the position of alkaline areas and of Carboniferous shore-belts is noticed.

The eastern border of the Gondwana-land continent practically coincides with the East Australian alkaline belt. The northern

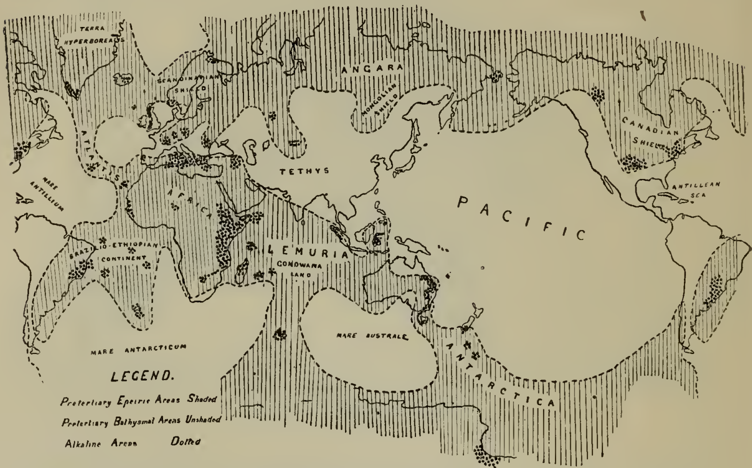

Fig. 5.—Map of the World showing Distribution of Alkaline Rocks and Epeiric Areas.

Fig. 6.—Map of the World showing Distribution of Atlantic and Pacific Coast-Types (after Neumayr).

border of Gondwana-land facing the Carboniferous Mediterranean is lined with groups of alkaline rocks which are met with in

Brazil, the South Atlantic, the Canaries, Algeria, Tunis, Abyssinia and Ethiopia, Arabia and Socotra, Sumatra and Celebes. The southern coast of Gondwana-land is represented by the alkaline outposts of the Transvaal, Kerguelen Island, Regatta Point, Tasmania, and Mount Macedon in Victoria. Several alkaline areas occur also in the heart of Africa, in Bourbon, and the Seychelles, areas which lie well within the Gondwana continent.

The Angara continent (the Mongolian Shield) is likewise fringed with alkaline rocks, and some alkaline rocks occur in the heart of it.

Fig. 7.—Map of the World showing Distribution of the younger Mountain-Chains (after Neumayr).

The North American Shield likewise has a border zone of alkaline intrusions. The North Atlantic, which then was a continental mass, is teeming with alkaline areas, *e.g.*, Iceland, Rockall Island, parts of the Hebrides and of Wales, the Azores, and numerous occurrences in the United States.

The Scandinavian Shield, the Bohemian horst, the massive of Central France, the Vosges and the table Jura, then islands, are also alkaline areas. The area covered by the great Carboniferous Mediterranean, is, however, generally avoided by alkaline rocks, which are not known in the Alps, the Himalayas, or in Further India, nor to any extent in the great Pacific basin.

Antarctica, too, then essentially a land-mass, though the Carboniferous transgression overlapped considerable areas, has its alkaline rocks scattered widely in its most absolutely unfolded areas. The Dunedin area, the Erebus area, Possession Island, Franklin Island, etc., are placed on the flanks of the Mesozoic Antarctica.

We see, then, that the existence of alkaline rocks in any area suggests that this area is a remnant of one of the primitive continents, Gondwana-land, Atlantis, Angara, Antarctica or Lemuria.

Let us now compare the distribution of alkaline rocks with the distribution of land and sea in Jurassic times as represented by Neumayr.* All the North American alkaline rocks lie in his Néarctic continent. All the South American and African occurrences are on or within the boundaries of his Brasilio-Ethiopian continent. Many of the African groups of alkaline rock are situated along the border of his Ethiopian Gulf which probably took its origin in the formation of a senkungsfeld within ancient Gondwana-land, accompanied by marine transgressions due to sedimentation. His Gulf of Queensland was probably formed in a similar way, and all the East Australian and the Otago alkaline rocks occur along its old shore-line. Those of Sumatra and Celebes also lie within Neumayr's Sino-Australian continent. Those of Siberia and Central Asia are situated along its northern coast-line. Those of Scandinavia, Bohemia, and the Ural were islands. Many of the alkaline areas of Central Europe were, however, submerged by a transgression of the sea; the number of islands in this area nevertheless shows that it was a true continental area invaded by transgressions which were perhaps invited by the formation of senkungsfeld-areas. It will be noticed that most of the island-occurrences of alkaline rocks also fall within the continents (figs.3 and 5).

On now comparing fig.5 with the distribution of land and sea at the end of the Cretaceous (fig.4) it is readily seen that the

* Erdgeschichte, Band ii., p.263.

same relations hold good. The alkaline rocks specially favour the land-areas and particularly a zone adjoining water-basins. Attention is invited to the distribution of alkaline rocks and of land and sea in Antarctica.

We must infer from all these facts that the alkaline rocks are situated on the lines of great faults along which differential movements of adjacent earth-segments have proceeded for long periods, producing shore-conditions.

Situation of Alkaline Rocks with regard to great Fold-Lines.

If we compare fig.5 with Neumayr's map (fig.7) showing the position of the younger folded chains, the fact stands out very clearly that these chains are entirely free from alkaline intrusives. The Rocky Mountains with the exception of a small portion of California and Utah, the whole Andes chain, the New Zealand Alps, the fold-range of the New Hebrides and of the Solomon Islands, the Himalayas, the Hindoo-Koosh Mountains, the Alps, and the chain of the West Indies are all avoided by alkaline intrusives. In all those regions which underwent prolonged sedimentation, almost uninterruptedly, through late Palæozoic and the whole of Mesozoic times and then became folded and elevated in the early Tertiary, the intrusives are calcic granites and gabbros, and the lavas consist of andesites, melaphyres and basalts. Such is the case with most of the areas of the Mediterranée Centrale of Neumayr and the Tethys of Suess, and most of the great Pacific area.

Thus, although granites and gneisses are considered to be typical of continental areas, they are in truth only typical of our present continents, for they occur abundantly in the centres of Mesozoic basins now raised into high mountain-chains; whereas alkaline rocks, which never occur in high folded chains but only in block-faulted regions, may be regarded as typical continental rocks, and those islands of our present seas which contain an abundance of alkaline rocks are in almost all cases relics of more extensive continents disrupted into fragments in the early Tertiary period, relics of Atlantis, of the Brasilio-Ethiopian Continent, of Gondwana-land, of Antarctica, of Angara, and of Lemuria.

In this connection it would be interesting, though perhaps not very profitable, to discuss the bearing of Jean's theory of a pear-shaped earth on the occurrence of alkaline lavas in the Sandwich Islands.

How far the alkaline areas coincide with or distance themselves from the old eroded mountain-chains becomes a more difficult problem, and one of less immediate interest. I know of no exact identity of an alkaline area with the core of an old mountain-chain, yet the alkaline belts often lie very close to eroded ranges. There appear to be no true alkaline intrusives in the old Carboniferous chain which runs along our coast to the south of the Shoalhaven River, nor in the heart of the old eroded ranges of Victoria, nor in the New England ranges, nor in the old Barrier and Cobar ranges. The tinguaites of Kosciusko occupy a different position, being situated in a block mountain, which may have been continental all the time from Ordovician or early Silurian to the present.

The Situation of Alkaline Rocks with Regard to Faults.

It has already been shown that alkaline rocks are often abundant in highly faulted areas, but not in those areas where faulting is due to compression and mountain-building. They are always associated with trough-faults, block-mountains and senkungsfeld-areas due to contraction. No foyaitic rocks occur in the immense overthrust regions of Scotland, but in the fragmented region of the Hebrides they are met with. Throughout the area of mythical Atlantis,* destroyed by mighty subsidences, they abound. Throughout that intensely fragmented portion of Gondwana-land now situated in the Indian Ocean between Madagascar, Arabia and Abyssinia, they are equally plentiful. Throughout Antarctica, which has been similarly fragmented, and in which the Scott Expedition observed faulted cliffs, the faces of

* "Atlantis" by Ignatius Donnelly.

block-mountains, up to 10,000 feet in altitude, alkaline rocks are also plentiful.

For the Australian alkaline area I have shown the possibility of great faulting in the East Moreton district, the existence of a senkungsfeld-area over the Narrabri plains, west of the Nandewars, and of another subsidence-area between the Darling Downs and Mount Flinders. More evidence of this nature may come out when the geotectonic geology of Australia has been more thoroughly investigated.

Alkaline Rocks with regard to Atlantic and Pacific Coast-Types.

A comparison of fig. 5 with Neumayr's map showing the distribution of the Atlantic and Pacific coast-types (fig. 6) shows us that practically all the world's alkaline areas are situated closest to coasts of the Atlantic type.

As the Pacific coast-type expresses the forces of compression and mountain-folding, whereas the Atlantic type indicates that the sea is making inroads into a faulted coast-line, the inference is evident.

I am therefore prepared to accept Prior's suggestion to call alkaline rocks eruptives of the Atlantic type, calcic ones Pacific, on the understanding that these names have no geographic significance, but mere imply the forces which were dominant in producing the lavas, namely, in the one case folding and compression, in the other trough-faulting and contraction. Yet, I think less confusing and more suggestive names could be chosen, for example, *Kat-epeirean* (concerned in the destruction of a continent) for those of the Atlantic type, and *An-epeirean* (concerned in the up-building of a continent) for those of the Pacific type.

Permanency of Ocean Basins.—It will be seen from the above that some of my views are in express antagonism to the theory of the permanency of ocean basins as propounded by Professor Penck and Sir John Murray.

Already Professor Suess has for a long time maintained that an Atlantis must have existed up to at least Middle Tertiary times. A. Russel Wallace has given strong biological evidence in favour of the very theory which he in the main opposes. The work of Hill and Spencer on oceanography and recent soundings in the Atlantic are by no means adverse to it. Much ethnological and mythological evidence has been advanced in favour of the hypothesis by other writers, and this evidence is at least interesting and suggestive if not strictly scientific (*cf.* 'Atlantis,' by Ignatius Donnelly).

The work of Wallace has likewise revealed that land-bridges must have existed up to a very recent period between the Malay islands; and Hedley has made it clear that there must have been at least Mesozoic land-connection between the New Hebrides, the Solomon Islands, Fiji, and Australia. Dr. Ortmann's great paper on the distribution of freshwater decapods and past land-connections is also full of suggestions. T. Mellard Reade in his "Evolution of Earth Structure" also shows himself strongly antagonistic to the doctrine of the "Permanence of Ocean Basins" in its literal sense.

The necessity for assuming a past land-connection between Australia and South America across the Antarctic continent becomes yearly more imperative.

Suess has given convincing proof of the existence of an Indo-African continent up to the end of the Cretaceous period, and the establishment by Professor David * of Darwin's theory as to the origin of Atolls makes the possibility of a Pacific continent less remote.

It has therefore been demonstrated by men of the highest scientific repute that Atlantis, Gondwana-land, Antarctica, the Wallace-Hedley continent, Lemuria, etc., are not mere scientific myths. It follows that many regions which were once dry land are now deep sea.

The converse seems also to be true to a certain extent for the reasons here summarised.

(1) The sediments overlying the present continents seem far too extensive to have been derived from themselves alone. If

* Funafuti Report.

the continents have had their entity wholly restored from time to time, there should be even less sedimentary rock left than we see at present, especially if the continental segments have undergone uplift after uplift, pinched in between subsiding segments.

(2) Chalk and many other formations formed in moderately deep sea are found in the heart of many continents. Abyssmal deposits if formed at the present slow rate would play such a minor part in the sedimentary series that when metamorphosed they might easily be overlooked. Such rocks as the Tamworth radiolarian tuffs and limestones may very well have been formed under abyssmal conditions.

(3) If only continental platforms and oceanic borders are heavily sedimented and a creep of land-segments takes place towards those zones (as suggested by Chamberlin and Salisbury in their 'Geology,' Vol. ii.) it follows that the continental shelves become overloaded and subside; rock-flowage of a compensating nature would then take place in the zone of shear from beneath them towards the continental area and restore the balance. The old continental platform, being then further sedimented and superloaded, and squeezed in between higher segments, tends to become folded, a process which would be aided by rise of isogeotherms. Consisting largely of sedimentary rock, it would eventually become specifically lighter than adjacent segments which would have had their gravity increased by rock-flowage from beneath the subsiding area. By a gradual subsidence of the heavy areas and an elevation of the lighter, the old continental shelf might become a lofty mountain range and the old continent an oceanic area. A continent might by this process gradually transplant itself from one part of the earth's crust to another.*

The volcanic sequence of alkaline areas tends, as will be seen later, to lend support to such an hypothesis. Alkaline rocks are continental and occur in areas of normal faulting above and pos-

* Compare T. Mellard Reade, "Geomorphic Changes" in "Evolution of Earth Structure."

sibly shear below. Their extrusion is generally followed by the eruption of basic lavas such as used to be regarded as oceanic. Subsidences in their regions often follow, leading to the formation of senkungsfeld-areas like the Great Rift Valley.

(4) Lastly, we have the evidence of the oceanic volcanic rocks which often bring to the surface masses of granite, gneiss or gabbro, but seldom fragments of Palæozoic or metamorphic sedimentary rocks, inclusions of which might be abundantly expected if the oceans had been regions of sedimentation for all time.

Yet it is quite possible, and indeed very probable, that some of the present land-areas have never been oceanic since the geological record began, and that some of the present ocean depths have never been land; but present depth can only be regarded as poor evidence when we think of the sediments of the deep Tethys and the Alpine Mediterranean now 12,000 to 30,000 feet above sea-level in Tibet, the Himalayas and the European Alps.

The Age of Alkaline Rocks.

Most of the alkaline rocks whose age it has been found possible to determine were intruded in or about the Eocene period; this point will be more clearly brought out in the more detailed discussion to follow. The fact that foyaitic eruptions attained their maximum at this time cannot be a mere accident. It is also significant that this was a period of gigantic crustal readjustments, of mountain-uplifts in some parts, of plateau-uplifts in others; a period of formation of vast subsidence-areas again in other parts and of fragmentation of old continents. Surely these great processes must have had something to do with the production of alkaline magmas.

Of course there are many areas of alkaline rock whose age is doubtfully placed in the Palæozoic, because the invaded rocks are very old. In only one case to my knowledge has a foyaitic rock been proved by means of included pebbles in sedimentary strata to be old Palæozoic, and that is the Montreal syenite to be referred to later. The alkaline basalts described by Card from the Kiama-Jamberoo series of New South Wales are known with certainty to be Permo-Carboniferous, and alkaline rocks of very recent age have been erupted from Erebus in Antarctica, and from Kenya and Ruwenzori in Central Africa. However, there seems to be no strong objection to assuming that those processes which made the Eocene a period of alkaline eruptions, set in earlier in some regions than in others, and are still going on locally in some circumscribed regions at the present day.

A common reason for assigning an old age to some of the alkaline bodies intruded into Palæozoic strata is the existence of a certain degree of schistosity in the border facies of the rock. The fact is generally ignored that the border facies of alkaline rocks always have a marked tendency to schistosity due to flowage under great pressure.

Ch. ii. The Possible Mode of Origin of Alkaline, Atlantic or Katepeiric Rocks.

We see from Ch. i., that most of the world's alkaline rocks of known age were intruded in the Neopyrogenic period, chiefly in the Eocene; and when of this age they occur under closely analogous surroundings. These facts, considered in conjunction with the comparative rarity of alkaline rocks (those of foyaitic magma), suggest that there was a common cause at work all over the earth to produce them. What this cause may have been we will try to enquire into from a theoretical standpoint.

Although alkaline rocks occur in many parts of the world, they cannot be said to be particularly abundant. We have many intrusives of foyaitic magma in New South Wales, yet the area which they cover is insignificant when compared with the area occupied by rocks of calcic magma. So it is also in other parts of the world.

We have also seen that the period to which most rocks of the Atlantic type belong was one of great folding, mountain-building, epeirogenic uplifts, subsidences and senkungsfeld-formation, and of intense crumpling of the earth's crust.

The idea therefore suggests itself that, in this period, many masses of the primitive earth-crust and of the earliest sediments which were largely chemical precipitates of an alkaline nature, were brought so deep into the interior of the earth's crust that they were refused, and in many cases chemically attacked adjoining rocks, variously acid and basic, and formed what is known as a foyaitic magma.

This fusion and mixing are supposed to have taken place at a depth many times greater than that at which the assimilation of the sedimentary beds by the New England granites took place. The mixing must have been perfect, leading to the transformation of all the alkaline salts of sedimentary beds and primordial oceanic precipitates to silicates.

It will be convenient here to summarise some supports for this view.

(1) True igneous rocks always possess certain chemical constituents present in their composition within certain limits. This fact is utilised to distinguish between schists derived from igneous rocks and those of sedimentary origin. A deficiency in any one of these chemical constituents or an enormous excess of one of them indicates that a rock has originated from a chemical precipitate or from a sediment. The forces of erosion and of redistribution of detritus by means of water always have the effect of concentrating particular constituents in particular beds. Now it is found that alkaline rocks universally, except when formed by mixture of magmas (like many trachy-dolerites), have a great deficiency of magnesia and lime, and they are specially enriched in soda, potash and halogens.

(2) If alkaline magmas originated purely by differentiation processes why was there such a prodigious expulsion of them in the Eocene? As differentiation has gone on at all times, and under much the same physical conditions, we should be led to expect in all volcanic epochs approximately the same sequence, and alkaline rocks intermixed with calcic rocks in some definite order of eruption and in much the same quantitative proportion. This would particularly be so if the planetesimal hypothesis of

the origin of our planet be accepted, according to which the earth grew by gradual accretions of meteoric material from without. In this case, unless we suppose that the earth received widely different kinds of material at different periods of its growth, we have a particularly good ground to expect the same plutonic and volcanic sequence in all areas and at all times, or to ask Dr. Chamberlin to explain more fully by what curious processes of differentiation the enormous differences in igneous succession have been brought about. A little thought given to this question will, I think, convince any petrologist that the variability of the Plutonic sequence is a powerful objection to the planetesimal hypothesis.

(3) The hypothesis that alkaline rocks may be derived from the assimilation or fusion of alkaline sedimentary beds at great depths, derives some support from the fact that foyaitic rocks usually contain chlorine and sulphates in proportions much greater than other magmas.

(4) One phase (and usually the first) of activity in an alkaline volcanic epoch is the eruption of plugs or mamelons of highly viscous, siliceous lava, such as would be formed by the refusion of alkaline sedimentary beds, or the mixing of such a molten mass with quartzitic rocks. In this connection it is significant to state that the fused alkalies, especially in the presence of water, exert great solvent power on quartz. The proportion of iron met with in these rocks is also very nearly that which would occur in a chemical precipitate from a supersaturated ocean, or drying up basin (*cp.* The Old Red Sandstones).

The Planetesimal Hyyothesis.—In his able Presidential Address to this Society* on geophysics, Mr. Thomas Steel, F.L.S., advanced some strong astrophysical objections to the planetesimal hypothesis.

If some of the mathematical opponents of the hypothesis were set to work to find objections to it with the same assiduity that some critics have displayed in finding objections to that of Laplace, I dare say it would be found just as vulnerable.

* These Proceedings, Vol. xxxii. p.1, 1907.

If planetesimals be formed by the tidal disruption of a pre-existing body and they are similar in composition to meteorites, it is hard to see where the earth's atmosphere and hydrosphere come from, especially the oxygen constituent. Dr. Chamberlin's exposition seems insufficient. A pre-existing body has to be assumed; and even the exposition of Dr. Chamberlin admits of the possibility of a gaseous early stage for his planetesimal earth.

The backward rotation of the outer planets is as difficult to account for on his hypothesis as on the Laplacian.

The satellites, instead of moving away from their parent planets, as they are supposed to do by Professor Darwin, should approach the planets, inasmuch as the latter, being the larger bodies, attract more planetesimals and therefore grow faster and have their power of gravitational attraction increased.

If the earth is long past its accretion-stage, all heat due to accretion should be gone or nearly gone, and all the earth's heat should be due to contraction.

We should also ask ourselves if the nebulous surroundings of the young earth would not check radiation to such an extent that any planetesimally formed body would be changed to the gaseo-molten stage.

If these problems can be satisfactorily solved without injury to the planetesimal hypothesis, there still remain two objections on geological grounds, viz., (1) that we have never found any trace of a fragmental zone composed of planetesimals in our oldest Azoic formations; and (2) that the irregularities in igneous succession are difficult to explain on the planetesimal hypothesis.

For these reasons I propose to review the origin of the earth's crust on the gaseo-molten hypothesis.*

As the process of cooling of the nebulous mass advanced, the earth became denser and denser, and finally the condensation of all the metallic and silicate material ensued. During this pro-

* See also Mr. Steel's Presidential Address, these Proceedings, Vol.xxx. p.616, 1906.

cess the laws of volatility and condensation controlled events. Now there would result an arrangement in layers in accordance with the laws of specific gravity, and solubility (liquation). In accordance with these laws we should probably get the following arrangement from the interior outwards:—(1) Pure heavy metals; (2) sulphides and oxides of the heavy metals; (3) silicates, phosphates, etc., of the heavy metals; (4) silicates of the earthy metals (Ca, Ba, Mg, etc.), and of aluminium with more or less alkali; (5) pure silica, carbonate of lime and smaller amounts of the substances mentioned in (4).

Most of the alkali probably still existed in the earth's primitive atmosphere as chloride, sulphate and carbonate, and other salts volatile at the temperature of condensation and solidification of the above-mentioned substances.

A rain of these alkaline salts would now take place on the earth's surface, and at the same time the crust, in consolidating, would commence to become wrinkled. Volcanic action of a most intense nature would become rife, and would aid to produce the earliest surface-inequalities and deformations. Frequently fissure-eruptions would cause extensive flows of silicate material over the cooled surface, and under the existing conditions of diminishing temperature these magmas would assimilate the alkalies of the alkaline snows. The alkaline rain still continuing, some beds of alkali might escape assimilation by becoming interstratified with siliceous grits formed by the erosion of primitive mountains. Volcanic action would liberate more and more magmatic water, and now, between a temperature of 100° and 300°, a very briny ocean would commence to form in the depressions. As the waters became cooler they would become less saline by the precipitation of the salts with which they were supersaturated. We would thus get $FeCO_3$, $MgCO_3$, $CaCO_3$, K_2SO_4, KCl, NaCl, and Fe_2Cl_6 successively precipitated, and interbedded with masses of siliceous detritus and with lavas.

Assuming this order of events to have obtained, we should expect the earliest crust to have consisted (when the atmospheric temperature had fallen to 100°C and under) of limestones, quartzites, spinel-rocks, andalusite-rocks, cordierite-rocks, wollastonite, and acid granites and gneisses rich in albite and orthoclase. The earliest lavas would have been essentially calcium-aluminium silicates which would now be represented by amphibolite, or if they had assimilated much alkali by calcic granite; and also more basic non-aluminous lavas from more deep-seated sources (peridotite, serpentine, augitite, etc.).

The earliest sediments would consist of chemical precipitates (carbonates of alkaline earths and chlorides of the alkalies principally), and detritus washed from the earliest lands. These bedded rocks would consist of limestone, dolomite, iron ores, salt beds, grits, conglomerates and shales, arkoses, tuffs and breccias.

Now these are the rocks whose metamorphic representatives we actually do find in the deepest Archæan; confused and mixed up with a network of intrusions of igneous rock, we get marbles, dolomites, iron ores, jadeite, conglomerate schist and gneiss, mica-schists, gneisses, and the metamorphosed representatives of tuffs and breccias (amphibolites and glaucophanites) in our fundamental complex.

The alkaline primordial sediments and precipitates became more and more depressed under the weight of Palæozoic and Mesozoic sediments.

Being easily fusible and hydrous, heat and pressure might easily liquefy them, or, at all events, turn them into a viscous fluid, when they would slowly move laterally towards regions of smaller pressure, namely, towards continental areas and particularly towards those parts where mighty faults had further diminished pressure by establishing communication with the surface. In the trough-faulting of such fractured continents subsiding blocks become squeezed between the standing segments and also exert great pressure upon subjacent magmas. In this way the alkaline viscous magma, now rendered siliceous and impure by chemical reactions with the rocks met with on its travels, would be squeezed out along the fault-planes.

The Eocene, being a period of immense crustal readjustments, produced favourable conditions for the expulsion of the magma.

This theory, which, I think, it will be admitted, has a strong scientific basis, is, of course, hardly capable of proof, but workers on alkaline rocks are invited to test it for their special regions. Its importance lies in the fact that it is consistent with the Laplacian theory of earth-origin, and diametrically opposed to the planetesimal. It therefore suggests another means of testing the relative merits of the two theories.

The view just advanced is in harmony with some of the ideas of Durocher and G. T. Prior on alkaline rocks.

Durocher divided magmas into two principal groups. Those which drew their lavas from primary magma-basins he styled "magmas of the first order"; those which drew their supplies from smaller reservoirs he called "magmas of the second order." Into the latter group he placed, with particular emphasis, magmas which give rise to trachytes and phonolites. If we consider the magmas of these smaller reservoirs to have arisen from the refusion of primitive sedimentary rock, his view is in complete accord with my hypothesis.

In his paper comparing the foyaitic rocks of Abyssinia with other alkaline rocks,* G. T. Prior describes them as conforming to the Atlantic type, because such rocks are rather plentiful in the Atlantic region. Although the term is unsuitable because of its geographic significance, there lies a germ of truth in it, namely, that the Atlantic Ocean is, for the most part, a senkungsfeld which until as late as perhaps Middle Tertiary times constituted one of the oldest and most durable of continents. Its disappearance was due to trough-faulting and fissuring. The Atlantic is therefore a destroyed continental plateau, just as the East African province is one on the high road to destruction.

The theory which I have put forward to account for the origin of alkaline rocks is, however, at variance with the "primitive fresh ocean" hypothesis advanced by Professor Joly in his exceedingly pretty paper on an "Estimate of the Geological Age of the Earth."†

* Min. Mag. Vol.xiii. No.61, Feb. 1903.
† Ann. Report Smithsonian Institution, 1899, p.247.

Professor Joly makes two assumptions—(1) that erosion has taken place at a uniform rate; (2) that the primitive ocean was less alkaline than the present. Both these premisses are debatable, but they need not be further argued here.

Joly's discussion of the fact that F. W. Clarke (U.S.A. Geological Survey) has shown that old metamorphic and igneous rocks contain more alkali than modern eruptives, need not be debated, as it is quite in accord with my theory.

Professor Joly goes on to show that by raising the earth's temperature to 1500° the metals Fe, Mg, Ca, K, and Na can exist only as silicates, and the atmosphere would consist of H_2O, CO_2, H, and HCl. NaCl would be unstable. Then he proceeds to show that when the temperature fell to 370° the waters would condense and there would be a sensible shrinkage due to cooling. The water would gather into depressions, and the increased pressure over the oceanic areas would squeeze out the magmas over the land. The acid waters acting on a magma of dioritic composition would take up elements in the following proportions: Fe 4·71, Ca 3·53, Mg. 2·64, K 2·35, Na 2·68; hence only 14 % of the salt in seawater was NaCl.

The arguments all seem to be very debatable. Acid waters at a temperature of from 100° to 370° would exert great solvent power on the rocks which they covered, and especially where they fell as rain. The ocean being for a long time at the higher temperature, it would take enough substance into solution to become supersaturated as the temperature fell. Hence some of the earliest sediments would be chemical precipitates. The amount of CO_2* in the atmosphere and in the sea being greatly

* F. W. Clarke has estimated the chemical composition of the earth's crust with the following result:—

O	47·02	Ti	0·41		
Si	28·06	H	0·17		
Al	8·16	C	0·12	Cr.	0·01 each.
Fe	4·64	P	0·09	Ni	0·01 each.
Ca	3·50	Mn	0·07	Cl	0·01 each.
Mg	2·02	S	0·07	F	0·01 each.
Na	2·63	Ba	0·05		
K	2·32	Sr	0·02		

Most of the C would have existed in the primitive atmosphere as CO_2.

in excess of the amount of HCl, mass-action would assert itself and lead to the precipitation Fe, Mg and Ca as carbonates, and the waters would by degrees become mainly supersaturated with alkali. The result would be that long before the commencement of the Palæozoic era the ocean would contain a great excess of alkali over other salts, just as at present, the chemical laws of solubility and mass-action ensuring this effect. The ocean should, indeed, in my opinion, have been more briny than at present, having continually received immense quantities of liberated magmatic water to dilute it.

Further, Professor Joly has neglected to give due weight to the importance of H_2SO_4 as an alkali-carrier and precipitant of Ca. Sulphur he neglects because it occurs in rocks only to the extent of 0 06 %, and is carried to the ocean by rivers in sufficient quantity to account for what is in the ocean. But the occurrence of gypsum deposits in sedimentary rocks shows that sulphur and sulphur acids have always been an important factor in the chemistry of the ocean, Sterry Hunt, rightly I think, assumed SO_3 to be an original component of the atmosphere.

Sterry Hunt's view that the waters imprisoned in the old sedimentary rocks are vastly richer in Ca and Mg than those of modern seas, and his belief that the alkalies and alkaline earths first precipitated the dissolved Fe and Al, and then decomposed $CaCl_2$ and $MgCl_2$ to carbonates and formed alkaline chlorides, are, as far as I can see, not at variance with geological facts, and seem to be well founded, but they do not lend support to Joly's theory.

Joly also advances the hypothesis that salt deposits are formed in inland seas by the evaporation of lakes, and not in isolated arms of the ocean. This view is not well founded, for frequently saline lake-deposits have been formed immediately after and have been laid down conformably upon marine strata, so as to indicate that the lake which gave rise to them was merely an isolated arm of the ocean (*cf.* The Etage Sarmatique of the Mediterranean; Suess).

Professor Joly's strongest argument is that sedimentary rocks are comparatively low in soda, and that if the soda in the ocean be restored to the sedimentary rocks the original composition, namely that of a dioritic magma, would be restored. In this connection it might pertinently be asked if sufficient analyses of sedimentary rocks have been made in a sufficient number of places to warrant computations being made. In granite-areas, where the sedimentaries have been derived from granite, poverty in soda must be expected, and most analyses of sedimentary and metamorphic rocks have been made in granite-areas. Further, potassium by its tendency to form insoluble compounds in the soil, is largely carried to the ocean in suspension and deposited in sedimentary rocks, but soda by its great solubility is retained in solution until an arm of the ocean is evaporated, or at least is only chemically precipitated in the deepest portion of the ocean where there is a tendency for soda-minerals to form. Until we can say that we know the total bulk of common salt in sedimentary strata and salt beds in the entire crust of the earth, and we understand thoroughly the nature of deep sea deposits, any computations such as Joly has endeavoured to make are in vain.

Joly's statement that there is an excess of Na over K in igneous rocks, whilst there is in general an excess of K over Na in sedimentary rocks is liable to strong objections. In the first place the great bulk of rock analyses are of volcanic rocks which are generally more soda-rich than their plutonic equivalents; and sodic rocks, containing as they do many rare minerals, have been more frequently analysed than normal rocks, hence an estimate based on averages of rock-analyses has no quantative value, especially so when we remember that some of the largest areas in the world are made up of potash-rich granite and granite porphyry. A single analysis of a large area of rock of homogeneous composition suffices for all practical purposes.

Further, as I have already indicated, the supposed excess of potash over soda in sedimentary rocks cannot be said to be established, inasmuch as a correct estimate has first to be obtained of the volume of all the salt beds in the world, and of all the deep sea deposits, and this has to be reduced and added to the average composition of the sedimentary rocks.

The sedimentary rocks analysed having been in most cases slates and schists examined for a special purpose, are in most cases of shallow water origin and naturally rich in potash carried to the sea as mud, or precipitated from solution in glauconite, phillipsite, harmotome, or other zeolites.

Professor Sollas, in his work on "The Age of the Earth," has given space to Joly's theory, and has raised other arguments against it which need not be discussed here.

Now, why are volcanic rhyolites and other volcanic rocks generally richer in soda than plutonic rocks? If assimilation has played an important part in the formation of volcanic magmas, it follows that more soda would be abstracted than potash, inasmuch as soda exists in the sedimentary series as the soluble and volatile chloride, whereas potash exists mainly in the form of insoluble and non-volatile silicates.

The Evidence of the Crystalline Schists.

Grübenmann in his excellent work "Die Kristallinen Schiefer" divides these rocks in accordance with mineral composition and textural features into three broad divisions—(1) the *kata*-rocks which have been formed in the deepest zone where the original characteristics have been completely lost through slow chemical recrystallisations brought about by very high temperature, very strong hydrostatic pressure and weak stress. (2) The *meso*-rocks which were formed in the middle zone, where temperature was lower, hydrostatic pressure weaker, but stresses very powerful; these forces produced chemical recrystallisations in accordance with Van't Hoff's volume law and Riecke's principle. (3) The *epi*-rocks formed in the upper zone at a still lower temperature where hydrostatic pressure was faint or absent, but stresses great. Under these circumstances mechanical deformation was induced in rocks.

The crystalline schists are distinguished from igneous rocks by their texture, structure, curious mineral composition and their chemical composition. Certain chemical constituents always present in igneous rocks within definite limits may be present in proportions greatly exceeding or much below those limits. This is accepted as an indication of selective weathering and arrangement by means of water. The same feature is a characteristic of alkaline igneous rocks.

The crystalline schists of the deepest zone contain many minerals in common with alkaline rocks, *e.g.*, albite, orthoclase, microcline, microperthite, cordierite, spinel, garnet, sodalite, nepheline, etc., etc. This similarity is, however, to be mainly attributed to hydato-igneous action, or hydrous fusion, under considerable pressure in both cases. The abundance of microcline-microperthite phenocrysts in alkaline rocks does, however, show that the magma rose from the deeper parts of the lower and middle zones where orthoclase and albite can crystallise together in the one molecule.

Crystalline schists occur at the base of all sedimentary rocks and as the central mass of mountain-chains. All the oldest schists carry the imprints of having originated in the deepest zone; the younger schists have the characteristics of the upper and middle zone. The absence of fossils in these rocks is to some extent compensated for by the wonderful uniformity in the characters of the oldest basal Archæan formations. The sequence is everywhere similar. Even the divisions of the Algonkian display such uniformity that each can be recognised and identified in regions remote from one another. The deepest zones, the katarchæic of Finland, are, according to Sederholm and Frosterus, formed of red granite and show no trace of sedimentary origin. Similarly in America the sedimentary rocks pass, with depth, more and more into gneisses. Sederholm, Grübenmann and many other workers on the schists believe that some of these basal formations of gneiss, granite and schist are part of the original consolidation-crust of the earth. The uniformity of character over the whole earth observed in these rocks is particularly suggestive of this belief. In the younger mountain-chains where schists have been produced by contact with huge laccolitic masses, instead of finding very great thicknesses of schist of uniform composition there is a constant change; each bed is of only comparatively slight thickness and extent, and differs sharply from the overlying and underlying beds.

The above facts are quoted from Grübenmann largely in his own words.

It is also stated by the same author that all known kinds of sedimentary rock have been found metamorphosed into schist except salt-beds. Salt-deposits are found in Tertiary, Mesozoic and Palæozoic formations, but are apparently not met with in the metamorphic, Azoic series. This does not necessarily mean that salt-beds were not formed in Azoic times, but it does show that they are incapable of resisting metamorphosis, and are either rendered plastic (like glacier-ice) and flow away, or they chemically attack over- and underlying siliceous rocks and form an alkaline rock.

In Tables A and B (pp. 530-531) the chemical composition of some alkaline, sodic, sedimentary rocks is recorded, and it can readily be seen that they are closely related to alkaline igneous rock.

Jadeite, which has the approximate chemical composition of elæolite syenite, is a rock belonging to the deepest zone, and it has, as far as known at present, no *meso-* and *epi-*equivalents. In some localities its associationship suggests sedimentary origin.

Chloromelanite is a rock which belongs to the lower and middle zone, and its equivalent in the upper zone is glaucophane-albite schist. These rocks have close affinities with theralitic and monzonitic magmas, and are known in some cases to have been derived from alkaline sediments.

All such rocks might very well have been derived from a chemical combination of alkaline beds, the precipitates of the early ocean, with adjacent rocks, and increase of pressure would tend to squeeze out such magmas in the form of alkaline lavas. The existence of jade only in the lower zone might be due to salt beds which formed later than the primitive ocean period having been of much smaller thickness and extent, and consequently

TABLE A. (Analyses quoted from Rosenbusch, 'Gesteinlehre').

—	Granulite Gneiss, Baden.	Granulite, Isl. Ahl. Finland.	Grey Mica Schist, Tyrol.	Hornblende Gneiss, Quebec Prov.	Mica Gneiss, Hessen.	Albite Sericite Schist, Taunus.	Arfvedsonite Gneiss, Cevadaes, Portugal.	Halleflinta, Sala, Sweden.	White Mica Phyllite, Wald.	Albite Sericite Schist.	Albite Sericite Schist.	Sericite Schist, Wiesbaden.	Grey Phyllite, Bergen.
SiO_2	76·10	74·15	69·45	69·24	66·73	70·99	65·88	65·00	62·83	56·58	59·91	55·84	54·05
TiO_2	—	—	—	—	—	0·14	tr.	—	0·70	—	0·44	0·51	0·89
Al_2O_3	11·19	14·52	14·24	14·85	12·23	13·77	16·03	14·58	22·44	22·21	15·00	15·62	21 24
Fe_2O_3	1·66	0·85	—	2·62	1·31	0·38	2·56	3·04	—	3·23	1·85	4·86	—
FeO	tr.	—	6·54	0·45	4·18	3·91	1·84	0·94	4·32	2·42	5·62	8·25	7·70
MgO	0·22	0·39	1·35	0·97	1·49	0·37	0·29	1·96	tr.	0·19	4·56	1·39	4·49
CaO	0·45	0·64	2·66	2·10	3·25	0·42	0·25	2·72	—	0·88	1·44	0·50	1·69
Na_2O	3·62	3·23	4·02	4·30	6·14	3·13	7·44	4·94	5·51	4·33	6·09	1·70	2·94
K_2O	6·91	6·55	2·52	4·33	2·53	4·81	4·66	5·38	2·74	6·40	2·44	6·14	5·26
H_2O	0·18	0·61	0·52	0·70	0·62	1·50	0·34	0·44	0·90	3·07	2·43	5·19	1·76
P_2O_5	—	—	—	—	0·22	—	0·02	—	—	—	—	—	—
MnO	—	—	—	—	—	—	—	0·64	—	—	—	—	—
S	—	—	—	—	—	—	—	—	—	0·09	—	—	—
Sum	100·33	—	—	99·56	99·46	—	—	99·64	99·38	99·53	99 83	100·00	100·00

TABLE B (quoted from Grübenmann, "Die Kristallinen Schiefer").

i. Jadeite, Mörigenam, Bielersee.
ii. Chloromelanite, Mörigen am Bielersee.
iii. Chloromelite (Kieselstein), Moränen von Rivoli.
iv. Hornblende Chloromelanite, St. Marcel, Piedmont.
v. Biotite Plagioclase-Schist, Simplon Tunnel.
vi. Sericite Glaucophane Schist, Lavintzie, Valde Bagne.
vii. Chlorite Glaucophane Schist, Lourtier, Valde Bagne.
viii. Kata-biotite-orthoclase Gneiss (Katarchæic), Kaaja, Finland.
ix. Mica-poor Kata-orthoclase Gneiss, Schwarzwald (sedimentogene).
x. Kata-biotite-sillimanite Gneiss, Senftenberg in Kremstal, Lower Austria (sedimentogene).
xi. Pyroxene-gneiss, Waldberg, Sweden; transition type between katarchæic (vii.) and sedimentogene (ix.).
xii. Two-mica-orthoclase Gneiss (Antigorio type), Simplon Tunnel.

	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.
SiO_2	58·39	55·11	55·11	54·59	44·95	47·95	45·96	68·74	75·80	71·54	60·52	71·58
TiO_2	0·13	0·36	—	—	2·62	4·28	4·68	0·30	—	0·31	1·13	0·13
Al_2O_3	22·77	13·49	9·66	9·74	16·33	14·10	12·77	15·32	11·59	14·02	19·37	13·84
Fe_2O_3 .. .	2·42	10·09	7·55	11·99	3·67	8·59	6·00	1·25	1·88	2·16	1·67	1·54
FeO.......	0·27	1·52	—	1·06	7·25	4·95	8 14	1·32	tr.	0·53	2·10	0 64
CaO	1·70	5·05	12·04	7·24	6·04	4·38	5 99	1·52	0·59	1·00	3·83	1·52
MgO	1·27	2·54	7·33	5·03	4·38	4·24	4·87	1·15	0·22	0·66	0·97	0·51
K_2O	0·27	0·37	—	0·24	7·72	4·12	0·98	3·14	5·68	5·93	4·62	5·41
Na_2O.....	12·39	11·42	7·84	9·32	3·34	3·97	6·06	6·73	3·67	2·81	4·78	3·17
H_2O- ...	0·08	0·11	0·33	0·37	0·11	0·08	0·07	0·12	0·21	0·18	0·23	0·03
H_2O+ ...	0·24	0 24			3·82	3·29	3·42	0·68		1·01	0·45	1·65
							CO_2 1·37					
	99·93	100·75	99·86	100·16	100·23	99·95	100·31	100·27	99·64	100·15	99·67	100·02

their absorption would take place without producing such an alkaline mixture.

The chloromelanite and glaucophane-albite schists of the middle and upper zones may often have been produced by the very slow elevation of a deep zone chloromelanite whereby the latter is gradually transmuted to the *meso-* and *epi-*types.

Alkaline gneisses (alkali-felspar-gneiss), glaucophane schists and many other metamorphic rocks have also affinities with the foyaitic magma.

Now the question arises whether it is not most likely that these alkaline schists are always altered igneous rocks, altered foyaitic lavas and sills. This query has already been partly answered, and we may further object to such an origin on the ground that the upper and middle zone equivalents of jade are unknown. If jade had been derived by metamorphosis of alkaline igneous rocks its *epi-* and *meso-*varieties should be even more plentiful than the *kata-*variety.

It might also be asked if the great abundance of alkaline lavas in the Tertiary (Eocene particularly) and their comparative rarity in older formations may not be due to old alkaline lavas and intrusives having undergone chemical alterations leading to loss in alkali and gain in lime and other constituents. We have no evidence whatever of any such change taking place. Those undoubted Palæozoic intrusives such as the alkaline rocks of the Kiama-Jamberoo series in New South Wales show no evidence of any such change. The silicates present in alkaline igneous rocks are much the same as those of deepseated schists and are therefore such as would resist metamorphosis unless imbedded for an extremely long time in the upper zone and the top part of the middle zone, and we have no metamorphic rocks in those zones strictly corresponding to the nepheline-syenite magma.

As far as I am aware, the foyaitic rocks which have long been supposed to be of Palæozoic age, as in the United States, Brazil and Norway, and which lie surrounded by the schistose rocks of the upper and middle zones, have never shown any passage, or indication of alteration, into chloromelanite, glaucophane-albite schist, glaucophane-albite-epidote schist, or sericite-glaucophane schist or jadeite. This fact alone to a great extent helps to prove that their intrusion was subsequent to the production of schistosity in the surrounding rocks. A faint schistose parting in the border facies is only the result of flow and pressure in cooling.

All these points do, in my opinion, offer very suggestive evidence for the theory here suggested as to the origin of the foyaitic magma; and to Grübenmann's excellent work I feel grateful for greatly helping to clear my mind on the subject of crystalline schists.

The "deepest zone" of crystalline schist-formation (Grübenmann) corresponds to the zone of shear of van Hise, or the zone of "rock-flowage" of American authors generally. In this zone the most readily liquefiable rocks would naturally first be squeezed away laterally on the accumulation of sediment above. The shear zone rises closest to the surface under the continents (see Chamberlin & Salisbury, "Geology," Vol. ii.), hence here we have most opportunity of finding alkaline magmas exposed by denudation or expelled to the surface. Under the raised ocean-basins which now form the Alps and the Himalayas (the Mediterranée Centrale and Tethys), if not squeezed away laterally they exist only so deep as not to be exposed to the surface by denudation.

It must again be emphasised that a belt of alkaline rocks often occurs, in fact generally occurs, between an area of highly metamorphic rocks of the fundamental complex with Eopalæozoic and an area over which these same rocks are capped with almost horizontally bedded Mesozoic rocks. This suggests that the alkaline line is the fracture-line between an elevated and a subsided segment of the earth's crust. The alternate sedimentation on one side or other of the line is an expression of the statement of Suess that the Rückland of one cycle frequently becomes the Vorland of the succeeding cycle, sometimes the one, sometimes the other segment being drawn down at the faster rate.

In the intense folding of the Archæan and Eopalæozoic rocks in the neighbourhood of alkaline areas and the horizontality of late Palæozoic and Mesozoic rocks of these parts we are reminded of another remark of Suess, viz., "la force plissante a jadi agi sur toute l'étendue du globe, tandis qu'elle est localisée ajourd 'hui dans des régions speciales." This localisation of the folding force to geosyncline areas commenced in the Middle Palæozoic. Lapparent's map of the distribution of the Archæan, so widely scattered about the globe, shows the same point (fig.1). Thus Archæan and Palæozoic lands have frequently become Mesozoic and Neozoic seas and *vice versâ.*

Those regions in which Mesozoic sedimentary rocks have undergone no disturbance are mostly continental areas which were only intermittently inundated by transgressions. Whenever folded rocks of later age than Eopalæozoic occur on continental areas the folding is of a superficial nature. Where trachytic rocks occur associated with folded rocks the folding is superficial. We have only to call to mind Gilbert's view that the causes of movement are superficial in the Appalachians, deepseated in the Basin Ranges. The alkaline rocks of the United States lie for the most part near and east of the former range. So also the folding of the Carpathians is superficial, deepseated in the Alps, superficial in the Jura, deepseated in the Pyrenees.

The breaking-up of continents must unquestionably be the result of secular contraction. By the gradual shrinkage of the deeper contracting zones of the earth, the outer non-contracting shell is in places left unsupported by the drawing inward of the strata beneath it. This results immediately in great fractures and subsidences of portions of the unsupported dome. Occasionally when a cavity or macula is formed in this way, magmas are squeezed into the hollow from adjoining sedimented areas. These would be alkaline in nature, and might subsequently be partly extruded on the fracturing of the crust.

Having now reviewed the processes by which alkaline rocks may have been derived, I will give a short sketch of the geographic distribution, geological association and age of all the chief occurrences of alkaline rocks. The list is necessarily very incomplete, but each student can add to it for himself.

Ch. iii. Occurrence of Foyaitic Rocks.

A. Europe.

1. *Christiania Gebiet, Norway.**—In this district we have one of the largest alkaline areas in the world, and thanks to the work of Brögger it is the most thoroughly examined. There is a complete series of intrusive rocks ranging from the most acid to the most basic. The oldest masses consist of proterobase and diabase; next in age are the granites and granitites; then come the nordmarkites, and still later the more alkaline series comprising the rhombenporphyr, laurdalite and laurvigite, and lastly gabbrodiabase, augite, porphyrite, mandelstein, melaphyre, and tuffs.

Whether there is any definite relationship, pointing to a common origin, between the calcic groups (such as gabbro and granite) and the alkaline (such as nordmarkite, laurvigite, etc.) seems to be extremely doubtful. It has been shown that some rocks, such as proterobase, camptonite, and essexite, belong sometimes to the one and sometimes to the other group.

But in the study of the different members of the alkaline group of the region Brögger has found a complete series comprising proterobase, camptonite, farrisite, foyaite, ditroite, laurdalite, rhombenporphyry, soda-minette, tinguaite, nordmarkite, sölvsbergite, grorudite, lindöite, bostonite, etc., some being coarse-grained and occurring in large masses, others fine-grained or porphyritic, occurring in small lamprophyric and aplitic dykes (Brögger, *op. cit.* Vols. i. and iii.).

The sequence has also been determined, and it is shown that the earlier masses were little differentiated and had the composition of laurdalite, whilst the more differentiated acid and basic dykes were intruded later, often into a plastic mass which had not yet assumed the solid condition.

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* "Die Eruptivgesteine des Christiania Gebiets." Vols. i., ii. and iii. By Dr. Brögger.

By an exhaustive study of the chemical characters of these rocks Brögger has shown that certain dykes are complementary to other dykes.

This very interesting series intrudes metamorphosed rocks of Silurian age. Although the intruded sedimentary rocks have been greatly altered, the line of junction between them and the intrusives is well defined.

The whole mass is surrounded by and occupies a subsidence area in an elevated Archæan massive. The elevation of the massive and the intrusion of the alkaline rocks took place later than the Silurian.

2. *Alnö Area, Sweden.**—The nepheline syenites occupy the north-east and north parts of the island of Alnö. The most remarkable feature of this mass is the association with the foyaite of a mass of limestone containing nepheline-syenite minerals. The limestone shows no sign of metamorphism, but is clearly a differentiation-product of the foyaitic magma. It contains nepheline in pegmatitic intergrowth with calcite, ægirine and felspar. All that author's observations tend to show that the limestone has been fused up or dissolved in a foyaitic magma too poor in silicic acid to decompose it, and on cooling it has crystallised out of the magma the same as other minerals.

There are numerous differentiation-products ranging from normal syenite and nepheline, pyroxene-syenite to a basic hyperite and jacupiraugite. The dykes given off by the mass and cutting it comprise melilite basalt (alnöite), tinguaite, and a remarkable group of dykes consisting principally of calcite and zeolites, the dyke-form of the massive limestone into which the foyaite passes.

The whole mass intrudes Archæan gneiss, and as it exhibits no evidence of dynamic action it can be said to be Post-Archæan. There is no real passage of the nepheline-syenite into the surrounding gneiss, yet the line of junction is hard to fix. Against the gneiss the syenite becomes devoid of nepheline and contains

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* A. G. Hogböm, "The Nepheline Syenite of Alnö," Geol. Foren. Stockholm, Forhandl. xvii. 2 and 3, 1895; also Min. Mag. xi. p.250.

biotite, and becomes also somewhat schistose in appearance. The gneiss becomes poorer in quartz near the line of junction, and its minerals become corroded and resorbed, giving place to many of the syenite minerals. It appears therefore that the intruded mass has been strongly attacked by the intrusive.

Since in the primeval basins one would expect limestones precipitated with alkaline salts, it is fair to ask if, in view of Hogböm's proof as to the origin of the limestone, we may not consider the foyaite too the result of the refusion of alkaline beds by basic intruded masses.

3. *Serra de Monchique Rocks of Portugal.**—The alkaline rocks cover an area of 60 square kilometers, and comprise many varieties of nepheline-syenite, foyaite, pulaskite, etc., and in the border zone sanidinite. Dykes of tinguaite, bostonite porphyry, nepheline syenite porphyry, camptonitic tinguaite, monchiquite, and camptonite are represented. At Picota occurs a leucite-tinguaite vitrophyre. The basic group comprises nepheline tephrite, nepheline basanite, amphibole-monchiquite, and amphibole-biotite-camptonite, fourchite and ouachitite.

Of rare minerals lävenite is mentioned, and also moirée microcline and analcite secondary after leucite. Near the contact the intrusive rocks become fine-grained and dense.

In the foyaites and pulaskites interesting masses of basic rock frequently occur which Kraatzlan and Hackmann describe as due to contact with the slates. It seems to me that these may admit of a different explanation (*cf.* basic inclusions in orthoclase basalt, W.67, Warrumbungle Mountains, and in the monchiquitic lamprophyre, N.18, Nandewar Mountains).

The contact-effects of the monchique mass on the greywacke and Culm slates prove it to be later than early Carboniferous. The mass is situated on a north and south line, an anticlinal

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* E. Kaleszinsky's Report in Neues Jahrbuch für Mineralogi B.B. iii. 1884; and "The Nepheline Syenites of Sierra de Monchique" by K. von Kraatzlan and V. Hackmann, Tschermak's Min. u. Pet. Mitth. xvi. 1896, pp.197-307.

axis of Post-Cretaceous age (see Geol. Map of Portugal), and although no direct evidence of age has been found except that it is newer than the Culm, it seems to the writer that it may even be as late as early Tertiary. Further, Archæan rocks form the backbone of the Iberian Peninsula.

4. *Kola Peninsula, Finland.*—A very interesting mass of foyaitic rock has been described by Hackmann and Ramsay from Umptek, Kola *

5. *Tyrol Area.*†—The Tyrol igneous rocks are of Mesozoic age. The earliest probably belong to the late Triassic period. Brögger has shown that the following succession obtained:—

(1) Camptonite and liebnerite porphyry.

(2) Granitite (Predazzo and Cima d'Asta).

(3) Tonalite, banatite and adamellite.

(4) Monzonite.

(5) Gabbrodiabase, pyroxenite, augite porphyrite, mandelstein, and tuffs.

After a careful perusal of Brögger's investigations it seems to me quite feasible that (1) and (2) are differentiation-products of one and the same calcic magma, and (3) and (4) mixtures of (2) and (1) with sedimentary rock which the intrusive rock fused up and assimilated in a deepseated magmatic reservoir. The first two were expelled from the reservoir before assimilation had progressed far, the third and fourth after long stoping, and the last after the acidic portion of the mixture had consolidated.

The monzonites and tonalites are not true alkaline rocks, but are here referred to as they form a link between the calcic and alkaline.

The Tyrol mass occupies the position of a senkungsfeld or subsidence-area.

6. *Mittelgebirge of Bohemia.*—J. L. Hibsch‡ found the following succession in alkaline rocks of Tertiary age ;—

* Founia, B.ii, No.2, Der Nephelin-Syenit der Umptek.

† Brögger, Die Eruptivgesteine des Christiania Gebiets, Vol. ii.

‡ See Sonderabdr. aus den Sitzungsber. d. deutsch. natur. medicin. Vereins von Böhmen. "Lotos" 1897, No.1. Quoted from Brögger. Vol.iii.

(1) Older basalts and nepheline basalts.
(2) Tephrites poor in Mg.
(3) Essexites.
(4) Phonolites very poor in Mg and Ca.
(5) Trachyte very poor in Mg and Ca.

This area therefore affords a very complete series of alkaline rocks. The mass lies to the south of the German area of Mesozoic sedimentation, and is situated on the flanks of the Bohemian massive.

The volcanic range of the Siebengebirge in the Rhenish provinces occupies a similar position where the Mesozoic sediments of North-west Germany (Grès bizarres and Vosgian Grits) have been folded and faulted against the Black Forest and Vosgian horsts. The lavas here too are of Tertiary age.

The early Tertiary intrusive bosses and lavas of Banat occupy a closely analogous position, being situated on a N.N.E. to S.S.W. fault-line east of which there is a vast Mesozoic basin, and to the west the ancient massive of South-west Hungary and Croatia (mica schist, etc.).

The Banat igneous rocks are to a great extent alkaline (trachytes, etc.). (See 'La Face de la Terre,' Ed. Suess, Tome. i. p.209).

7. *Mountain-Masses of Transylvania.*—On a continuation of the great Carpathian line of folding and faulting to the south we find the mountain-masses of Transylvania. Here great intrusions of nepheline syenite have taken place, as at Ditro, and great lava flows of trachyte as in the range of l'Hargitta.* This alkaline series is continued into Roumania and Moldavia, where similar rocks occur at Dobrogea.† The situation of these rocks is analogous to those already mentioned, since they have the Servian-Balkan massive to the west, and the area of Mesozoic sedimentation to the east. Whether the syenites of the Balkan mountains are related to the alkaline group has not yet been determined.

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* Suess, 'La Face de la Terre, Vol. i. p.634.'

† Murgogi, 'Genesis of Riebeckite,' Amer. Journ. of Science, Vol. xx. Aug. 1905.

8. *Other Areas.*—In addition to the alkaline areas mentioned there are numerous other areas where alkaline rocks occur. A brief summary will be given.

(a) The nepheline syenites of the province of Miask, Ural Mountains, occupying a position relative to the great Russian plain similar to that occupied by the Kola and Transylvanian areas.*

(b) The soda-micro-granite of Rockall Island, west of Ireland. This is probably Post-Triassic.†

(c) The soda-trachytes of Ischia‡ (Scarraputa, Ischia). These rocks are remarkably like our Australian ægirine trachytes. The island of Ischia is situated on the border of the Ionian senkungsfeld. Age: Tertiary.

(d) Soda-trachytes, pantellarites, comendites, and leucite basalts occur abundantly in the Naples volcanic area, which is situated on the border of the Tyrrhenian senkungsfeld. Age: Tertiary to Recent.§

(e) Phonolites and trachytes with nosean and leucite from the Laacher See. Tertiary.||

(f) Nepheline phonolites of the Haute Noire. Tertiary.

(g) Soda-trachytes of the Auvergne Mountains. Tertiary; superimposed on the massive of Central France.

(h) Soda-trachyte of Kelberg, Eifel; overlying Devonian rocks. Lava Tertiary (same as (e,) Laacher See).

(i) Soda-rhyolites of Hekla, Iceland, of pre-glacial age.¶

(j) Microgranite with riebeckite, Ailsa Craig;** the microscopic character of this rock corresponds to that of some of my Glass

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* L. V. Pirsson, Amer. Journ. of Sci. Vol. ix. 1900.

† Geol. Mag. N. S. Decade iv. Vol. vi. Apr. 1899.

‡ G. von Rath, Zeitschr. f. d. deutsch. Geol. Gesel. B.18, 1866; and H. S. Washington, Amer. Journ. of Sci. Vol. i. May, 1896.

§ Washington, 'The Roman Comagmatic Region'; and 'Some Analyses of Italian Volcanic Rocks.' Amer. Journ. of Sci. Vols. viii. and ix.

|| Hubbard, Tscher. Min. Mitth. Bd. viii. Heft 5.

¶ Beitr. z. Kentn. der islandschen Liparit, by H. Backstrom; Abstract in Min. Mag. x.

** J. H. Teall, Min. Mag. Vol. ix. p.219.

House Mountain pantellarites. This rock intrudes Silurian slate, and is therefore Post-Silurian, but there seems to be no reason why it may not be as recent as the early Tertiary—the time of volcanic activity in the New Hebrides.

At Easter Eildon Hill* near Melrose, and at Mynydd Mawr, Wales,† occur riebeckite trachytes supposed to be of Palæozoic age.

(k) The Azore lavas, also Tertiary, and overlying a remnant of Atlantis.

(l) A very important mass of alkaline rocks (largely phonolites) is found in the subsidence-areas of Franconia and Schwabia immediately west of the Bohemian massive, between Thüringerwald and the Harz Mountains. The subsidence-areas preserve Jurassic and Triassic rocks deposited during transgressions of the sea in Mesozoic times. These sedimentary strata are split into thousands of fragments by step-faults between the Harz Mountains and the Neckar. At Högbau in Würtemberg there is in this subsided plateau a subsidence-area with radial and peripheral fractures through which phonolitic lavas and tuffs have been emitted. The fracturing is mainly of Tertiary age.

B. Asia.

This continent not having undergone any thorough geological exploration, has not yet furnished many examples of rocks of foyaitic magma.

In Armenia great eruptions took place in Eocene times, and many of the lavas expelled were trachytes. Here again lavas of alkaline character were expelled along the faulted flank of the great Eurasian fold-axis. (Suess, Vol. i. fig.82. The mountains of Armenia are situated on the line of 'Effondrements recents de la Mediterranée' and on the 'Limite septentrional du 1er Etage Mediterranean').

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* Harker's Petrology.

† 'On the Occurrence of Riebeckite' in Britain by Prof. Grenville A. J. Cole. Min. Mag. Vol. ix. p.219.

In Sumatra alkaline trachytes and phonolites have been noted but no details are known. Very ancient crystalline rocks (schists, etc.) are known in this island, and the lavas have burst through them and the overlying Carboniferous and Eocene sediments.* The volcanic rocks range from Miocene to Recent.

The Island of Socotra has microgranitic intrusives bearing riebeckite, probably of Tertiary age, and is, according to Suess, probably a fragment of the Abyssinian massive separated from it by the subsidence of the Gulf of Aden. The alkaline rocks have intruded the Archæan fundamental complex, and probably also the overlying Cretaceous sandstone.

From Celebes a number of leucite basalts, leucitophyres, leucitites, and melilite nepheline basalts have been recorded by A. Winchmann.† Here too the lavas are early or middle Tertiary, and lie close to ancient schistose rocks and border on gigantic earth-fractures.

Both Sumatra and Celebes are looked upon as horsts or relics of ancient continents, Sumatra being like Socotra, a remnant of Lemuria (the Indo-African continent), and Celebes a remnant of the Sino-Australian continent of Neumayr. In these positions then we have the alkaline lavas as in Bohemia, Central France, etc., superimposed on horsts.

In those ranges of the Tien-Chan group which are directed north-west, occur diabases, melaphyres, dolerites, *teschenites*, and porphyrites; in those directed north-east, granites, granitites, porphyroids, *syenites*, *orthophyres*, gabbros, etc.; in those directed east and west, gneiss and ancient crystalline rocks.‡ Therefore in this great mountain-group both plutonic and volcanic alkaline rocks occur. I have unfortunately not been able to peruse any of the papers in which their occurrence is described. However, here again the situation is closely analogous to occurrences elsewhere. The Tien-Chan Mountains are situated to the north of

* Verbeek, Top. en geol. Beschr. v. Sum. Westkust, 1883.

† Naturkund. Tijdschr. Ned. Ind. Part iii. p.315, quoted from Min. Mag. Vol. xi.

‡ Suess, 'La Face de la Terre,' Vol. i. pp.616-620.

the great basin of Mesozoic sedimentation which extends across the Tibet and Himalayan region, and to the south of an Archæan massive which escaped Mesozoic sedimentation. Portions of the Tien-Chan area were subjected to sedimentation by transgressions of the sea in Triassic, Jurassic and Cretaceous times. Folding, according to Suess, is towards the south. The volcanic rocks are considered to be of Tertiary age.

Alkaline rocks from Eastern Siberia have been described by H. S. Washington in the American Journal of Science, Vol.xiii.

Eurasia being made up of a number of portions of widely different origin, and containing parallel mountain-ranges due to step-faulting as in North-east Asia, mountain-knots having the nature of horsts, like those of Bohemia and the Harz; mountains folded towards the south like the Himalayas, and those folded towards the north like the Alps, is so complex that it is often difficult to interpret the relationship of its alkaline rocks to earth structure.

A few generalisations may nevertheless be made out.

(1) It is noticeable that the alkaline rocks may be situated on horsts, as in Central France and Bohemia, that is on the fractured relics of very ancient continents. The foyaitic rocks of Christiania occupy a subsidence-area on the southern edge of the Scandinavian massive, those of Högbau on a subsided portion of the Bohemian massive. Those of Armenia line fractures which intersect this northern relic of the Indo-African continent. The foyaitic rocks of Kola lie on the border of the Scandinavian massive, and a portion of the same continent which in early Tertiary times was severed by means of fractures and subsided, thus cutting off Spitzbergen from Scandinavia. To the north-east of Kola lay an area of Mesozoic sedimentation. The Miask alkaline rocks lie on the eastern flank of the Russian massive, where it borders on the basin which in Mesozoic times extended from the Kola Sea and Arctic Ocean down to the Aral and Caspian Seas.

(2) Alkaline rocks are found on the borders of great Mesozoic sedimentary basins, and sometimes on areas over which such seas have transgressed for brief periods, but they are not found in the

centres of such basins, and are never met with in great folded ranges composed mainly of these sediments like the Alps and Himalayas.

(3) Alkaline rocks may occur in folded ranges on the flanks of horsts where folding is mainly superficial and fracturing plays the more important part as in the Tien-Chan Mountains, the Carpathians, Transylvania, and the Banat region, and possibly South-west Portugal is also such an area.

(4) The monzonites and adamellites of Tyrol which occur in the Alpine regions are *not truly alkaline*, though they furnish a link between the calcic and alkaline series. The modern lavas of Vesuvius, Etna and Stromboli have similarly alkaline affinities. Both these areas, and many others in which similar rocks are found, occupy anomalous positions. The Tyrrhenian area is a subsided portion of the Pelitoranian massive, and constitutes the subsided Rückland of Apennine folding, yet it is now an area of heavy sedimentation, and changes are probably going on whereby this area is becoming the centre of a basin, or perhaps a Vorland. Such rapid readjustments naturally produce confused conditions whereby the lavas erupted have affinities both with continental and oceanic volcanic rocks, and are in fact alternately alkaline and calcic, or a mixture of both. The Tyrol area formed a portion of the subsided Rückland at the time of the commencement of the Alpine folding, being situated close to the western border of the Servo-Croatian massive, but it is at the same time a portion of the Adriatic subsidence-area, the subsided Vorland of the Apennine fold (Suess).

Complexities of this kind are frequent in Eurasia, but are not common in continents like South America, Africa, and Australia, which form homogeneous masses.

(5) The alkaline lavas of many of the Ionian and Ægean Islands* rise along the fractures which produced, in the Tertiary epoch, the basins of the Eastern Mediterranean and Ægean. These basins constitute subsided fragments of a plateau (Suess).

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* 'Petrograph. Sketch of Ægina and Methana,' by H. S. Washington, Journ. of Geol. Vol.ii. No.8.

C. Africa.

The coastal zone of Morocco and Algeria is composed chiefly of volcanic rocks amongst which alkaline lavas play a prominent part. They are mostly of early Tertiary age. The lavas overlie upturned schists, granites, and phyllites which belong to the Pelitoranian massive. This massive was continuous from North Africa, across Malta and Sicily, to Sardinia in Mesozoic times, and was fractured and broken up after the Cretaceous. It constituted the Vorland against which the Cretaceous sediments of the Atlas Mountains were folded.

Behind the volcanic zone we have the Atlas region of Mesozoic sedimentation, and on the southern border of the Sahara commences the real African massive. In the folded Atlas Range alkaline rocks do not seem to have been met with, but on the border between the Saharean area of Mesozoic sedimentation and the old fractured African continent they have been noticed, as at Lake Tschad, Kordofan, etc. Again, they occur in the Cape Verde Islands superimposed on subsided fragments of the African continent; and further foyaites occur in the Los Archipelago, and olivine gabbro at Freetown (Sierra Leone), apparently interstratified with horizontal sedimentary beds. The latter consist of red sandstone and interbedded shales overlying Archæan rocks, and were probably deposited at the time of the Jurassic transgression which affected a great part of Africa. To my mind it is highly improbable that these rocks are altered interstratified lavas, inasmuch as they are called gabbro and foyaite, names applied to coarse-grained hypabyssal rocks. They are probably true sills or laccolites of Post-Jurassic age.

Alkaline trachytes and allied foyaitic rocks have been recorded from Transvaal, and the Drakenberg Mountains, between Natal and Transvaal, are principally volcanic. This part of the world has undergone no movements involving folding or horizontal displacement since early Palæozoic time. Faulting has, however, been very extensive, and has been accompanied by considerable vertical movements. Throughout the late Palæozoic and Mesozoic periods South Africa was a portion of Lemuria. Absence of folding is proved by the horizontality of the Karroo strata (Permo-Carboniferous), and of later sediments such as the Uitenhage (Cenomanian). The latter were deposited in erosion-valleys in the Karroo in the period of the Cenomanian transgression. In Madagascar similar conditions obtain. The Drakenberg Mountains consist of Tertiary eruptives, including trachytes, andesites, and probably alkaline rocks also, which have been erupted along a fissure-line. The intrusion of laccolites of the Cedar-tree type has slightly tilted the Karroo sediments to the west.

In the north of Madagascar, also a horst or relic of Indo-Africa, alkaline lavas occupy a considerable area, and are, as in Bohemia, Sumatra, Central France, and Brazil, practically superimposed on the massive. They are all of early or middle Tertiary age, and have issued, as at Högbau in Würtemberg, along radial and peripheral cracks.

The alkaline lavas of Kenya and Kilimanjaro in East Africa have been poured out along the immense faults which border the Great Rift Valley of Africa on the east. The volcanoes of Kenya and Kilimanjaro are practically situated in a trough which runs parallel to the Rift Valley, and constitutes a continuation of the Lake Nyassa Rift (see Suess). This area is therefore a portion of Africa which is being broken up by intense faulting.

East of Lake Tanganyika similar lavas occur overlying horizontal Carboniferous rocks, but they are nevertheless of Tertiary age.

From Somaliland riebeckite trachytes and phonolites have been recorded, and are considered to have been erupted in the Eocene. These rocks are found along a rift running parallel to the Rift Valley. The horizontal Mesozoic sediments, deposited at the times of the Jurassic and Cenomanian transgressions, which overlie sometimes almost horizontal Carboniferous rocks and sometimes very old Palæozoic and Archæan rocks in East Africa, Arabia and Socotra almost at the same level, prove that these three lands were continuous during the Mesozoic, and have been severed in the Tertiary period by enormous trough-faults. The alkaline rocks have been produced (and are still produced in the Kenya region) at the same time as the development of these trough-faults.

From an Australian point of view, one of the most important alkaline areas in the world is that of Abyssinia. The fundamental rocks are, according to Blanford,* the Archæan and Metamorphic. Between the metamorphic rocks and the traps (which designation includes the alkaline lavas) there is found a series of sandstones and limestones, the latter of which contain Jurassic fossils. Dr. Schimper, the collector of a large number of specimens of Abyssinian traps now in the British Museum, describes them as volcanic. Prior, apparently on petrological grounds alone, classes them as hypabyssal. His position seems to me unjustifiable, inasmuch as the collector's field-observations are more important in deciding this question than minute structure worked out in the laboratory. Further, Blanford's sketches (*loc. cit.*) show a physiographic type resembling that met with in the Warrumbungle Mountains, New South Wales, viz., a development of flat-topped mesas capped with lava and buttes of igneous rock. My experience of alkaline rocks shows that the lavas frequently possess the same petrological characters as the corresponding fine-grained dyke and sill rocks.

The rocks examined by Prior are remarkably like the Australian riebeckite trachytes, phonolites, sölvsbergites, etc., both in microscopic structures and chemical characters.† They include rocks classed as grorudite, paisanite, tinguaite, trachyte, sölvsbergite and basalt. The sequence seems to be the same as observed in Australia, the basic rocks being later than the alkaline ones. The age of the flows is not certain, but they appear to be certainly Post-Jurassic, and as similar rocks of Eocene age are known in Somaliland whose geological structure is analogous to that of Abyssinia, it appears probable that the Abyssinian foyaitic lavas are also Tertiary.

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* Geology and Zoölogy of Abyssinia.

† See G. T. Prior, Min. Mag. Vol. xii. p.255, and compare with my Papers on Australian areas cited elsewhere.

We see then that in Africa, a continent exhibiting great homogeneity, the alkaline rocks are universally connected with the Tertiary faulting and fracturing by which the Indo-African continent was broken up. These rocks are most plentiful in the most fractured regions, as around the Gulf of Aden, the Rift Valley, and the Mozambique Channel. In the highly folded regions of protracted Mesozoic sedimentation they have not been met with, but horizontally bedded Mesozoic rocks of Jurassic age are occasionally found in the areas over which they occur.

D. North America.

In this Continent there is a magnificent development of alkaline rocks.

Before dealing with other localities I wish to draw attention to a paper on the Okanagan Batholith, by R. A. Daley,* which has an important bearing on the origin of alkaline rocks.

The geological history of the Okanagan Batholith may be summarised as follows :—

(1) Metamorphosis of Palæozoic sediments, and the intrusion of a basic complex, and differentiation in Carboniferous times.

(2) Irruption of a batholith of granodiorite in the Jurassic period.

(3) Rapid denudation of the granodiorite in the Jurassic, and its covering with Cretaceous sediments in the next period.

(4) Orogenic disturbances, accompanied by the crushing and shearing of the granodiorite, and the folding of the Cretaceous strata.

(5) The intrusion of the Kruger *alkaline body* consisting of nepheline syenite and malignite in Tertiary or very late Cretaceous (Post-Laramie) times; and

(6) The Tertiary irruption of a batholith of soda-rich Similkameen horn-bi-granite or monzonite.

(7) In later Tertiary times the irruption of a batholith younger granite (the Cathedral batholith).

(8) Olivine basalt intrusions.

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* Bull. Geol. Soc. of America.

It is interesting to note the correspondence in age and character of these intrusions with those determined by E. C. Andrews in his New England Geology,* but of still greater interest is Daley's theory that all these igneous irruptions are derived from a more deep-seated magmatic reservoir, in which a huge basic intrusion has by stoping in and solution assimilated Palæozoic sediments and subsequently differentiated.

The Leucite Hills of Wyoming,† the chief rock-types of which (wyomingite and orendite) have the composition of monchiquite, stand in the midst of the Red Desert and form a huge dome, approximately 30 by 40 miles, constituting perhaps an arid-cycle conoplain like the Ortiz Mountains, U.S.A., and the Warrumbungle Mountains, N. S. W. From this area about 5000 feet of Laramie beds have been removed by denudation. The elevation of the dome was subsequent to the deposition of the Green River Shales. The mass consists of necks, dykes, intruded sheets, flows, etc.; some of the laccolites are now represented by mesas.

The nature of the rock does not seem to be very varied, being everywhere a somewhat basic leucite rock.

A striking point is that the Red Beds were laid down on a submerging land-surface of considerable relief‡ just as the Trias-Jura beds of the Warrumbungle area and the Cretaceous beds west of the Warrumbungles were laid down on a similar submerging continental area. In both regions ancient granites and crystalline rocks were exposed before the period of sedimentation.

In the "Petrography and Geology of the Highwood Mountains, Montana,"§ L. V. Pirsson has shown that these mountains form a group of eroded volcanoes rising out of almost undisturbed Cretaceous strata (*cf.* the Warrumbungles in N. S.W., and Glass House Mountains, Q., rising out of almost undisturbed Trias-

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* Records Geol. Survey of N. S. Wales, Vols. vii. and viii.

† Kemp and Knight, Bull. Geol. Soc. of Amer. Vol. xiv. pp.305-336.

‡ Bull. Geol. Soc. of Amer. Vol. xvi. pp.205-214.

§ Dept. of the Interior: U.S. Geol. Survey; Bull. No. 237, also Amer. Journ. of Sci. Vol. xx. July, 1905.

Jura strata). All the highest summits are composed of trachytic and andesitic tuffs, breccias and flows (*cf.* N. S. W. occurrences).

The area of extrusive flows is defined by the 5000 feet contour (*cf.* the Nandewars). The earliest flows were composed of adamellose or trachy-andesite, the later of basalt (as in N. S. W. areas). Many interesting types of alkaline rock have been described from this region, as for instance shonkinite (Highwood Minette), absarokite, and several varieties of monzonite.

The differentiation-phenomena recorded in the paper are of considerable interest, and are also discussed in Brögger's work on the Eruptive Rocks of the Christiania District, Vol. iii.

The intruded rocks are considered to be of early Tertiary age.

Nothing has so far been published on the petrography of the Ortiz Mountains, New Mexico, but from a paper by Ida H. Ogilvie* we learn that they form a high altitude conoplain consisting of Cretaceous strata tilted by an igneous laccolite and subsequently denuded. The intrusion is of Tertiary age.

J. E. Wolff † has described certain nepheline rocks from the Crazy Mountains, Montana. They form dykes in Cretaceous sandstone, and consist of augite, biotite, nepheline, plagioclase, magnetite, olivine, and hauyne, being therefore allied to monchiquite and theralite.

Wolff and Tarr have described acmite trachytes from the Crazy Mountains, Montana. These rocks occur as dykes cutting the Laramie as sheets parallel to the bedding, and as thick laccolites. They are associated with theralites.

From Texas nepheline syenites, phonolites and allied rocks have been described by Osann.‡ The rocks occur in the Apache Mountains. The Mount Ord Range contains true nepheline syenite with a border phonolitic facies. In the Sawtooth Mountains, west of the Apache Mountains, there is an alkaline syenite which passes into rhomben-porphyry at the margin. The dyke

* American Geologist, July, 1905.

† Neues Jahrbuch, Vol.i. 1885, p.69.

‡ A. Osann, Tscher. Min. Mitth. Vol.xv. p.394.

rocks of the Sawtooth Mountains include tinguaite, bostonite, paisanite, etc. The lavas are chiefly phonolitic.

The age of the Texas intrusions is Post-Cretaceous, and probably as late as Eocene or Oligocene. Cretaceous and Laramie sediments overlie in this region very ancient Palæozoic and metamorphic rocks.

From Oklahoma in the Headquarters Mountains, a low range at the extreme west border of the Wichita Range, alkaline granite containing hastingsite and riebeckite pegmatites have been recorded by F. Rogers Stanford.*

Numerous trachyte areas occur in the Colorado, Utah, and Uintah plateaux, but the petrology of this region has escaped my notice, and I do not know how far these rocks can be termed alkaline or not. Their position, as flows and sills of Post-Cretaceous age along Tertiary fault-lines in a greatly fractured plateau, is analogous to that occupied by the alkaline rocks in Madagascar and Abyssinia, but the western and south-western portions of the United States have been subjected to continuous sedimentation from the Carboniferous period to the Middle Tertiary, and a complete series of Mesozoic sediments is frequently met with in perfect conformity. Earth-movements in the south-western parts of the United States have been mainly vertical movements caused by trough-faulting, folding being limited to special localities where a fragment which has subsided more rapidly than adjoining fragments has been crushed between them. The conditions under which the lavas of Utah and Colorado have been produced are therefore closely analogous to those accompanying the East African alkaline extrusions.

One of the most important alkaline areas in North America is that of Arkansas, described by J. Francis Williams.* The rocks described comprise pulaskite, nepheline syenite, tiuguaites, quartz syenite pegmatites, fourchite, monchiquites and peridotites. They occur as dykes and laccolites intruding the rocks of the

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* Journ. of Geol. xv. 3.

* Ann. Report Geol. Survey of Arkansas, 1890, Vol.ii.

so-called "Ouachita Uplift," consisting of slates, sandstones, and novaculites of Lower Silurian age, and bordering these lie Lower Carboniferous rocks resting conformably upon the Silurian. The sedimentary rocks are but slightly disturbed, and whatever folding or fracturing has occurred, took place before the intrusions. For various reasons, the chief of which is that closely related rocks occur in adjoining districts intruding Cretaceous sediments, the age of the Arkansas alkaline rocks is considered by Williams to be Eocene. In this region no earth-movements involving great compression have transpired since the commencement of the Silurian period.

In New Jersey monchiquite dykes and nepheline syenite dykes occur intruding the Hudson River and Oneida stages of the Lower Palæozoic. No later sediments occur in the region, so that it is impossible to fix the age of the intrusions. Similar dykes have been met with in the States of New York, Maine, Massachusetts and adjoining States.

Numerous dykes of bostonite, camptonite, fourchite, diabase, and monchiquite occur in the Lake Champlain district, and have been ably described by Kemp and Marsters.* These dykes intrude Palæozoic sedimentary rocks, the latest of which are the Utica slates. Their age is therefore unknown.

Post-Silurian elæolite syenites from Montreal have been described by A. Lacroix,† and are also referred to by T. S. Hunt.‡ They include trachytes and phonolites, and are associated with dolerites and diorites. Harrington and Adams mention analcite-bearing rocks and teschenites from the same district. Nepheline syenite has been described from Red Hill, New Hampshire, by W. S. Bayley,§ and by Bayley and Eakins from Litchfield, Maine.|| Similar rocks have been described by F. D. Adams from Dungannon, Hastings Co., Ontario,¶ forming a large mass

* "The Trap Dykes of the Champlain District," Bull. 107, U.S. Geol. Surv.

† Comptes Rendus, 1890.

‡ Geological Survey of Canada, 1863.

§ Bull. Geol. Soc. of Amer. Vol.iii. 1892, p.250.

|| Bull. Geol. Soc. Amer. Vol.iii. 1892. p.232.

¶ Amer. Journ. Sci. xlviii. p.10, 1894.

in the Laurentian which has been intruded. The Montreal syenites were intruded after the Trenton and before the Lower Helderberg Series were deposited, and are therefore of Upper Silurian age.

W. S. Bayley* describes an intrusion of basic rock of Palæozoic age which marginally through assimilation and fusion of the country rocks (the Animikie slates and indurated quartzites) passes into a red rock, a kind of quartz-keratophyre. The latter is occasionally riebeckite-bearing. Strong chemical and mineralogical evidence is given in the paper to show that the typical red rock is simply the sedimentary rock fused and recrystallised, and that the connecting links between the red rock and the gabbro are mixtures of the intruding magma and the intruded rock in various proportions.

In the region of the Lower Mackenzie River and Bear River, Canada, phonolitic mountains rise out of Archæan and Cretaceous formations. The Cretaceous and late Palæozoic rocks of this region represent mere transient transgressions, and the volcanic rock is Post-Cretaceous.

From Greenland nepheline-bearing and melilite-bearing rocks have been described by Törneböhm.

All the foregoing alkaline rocks found along the eastern border of the North American horst, from Arkansas to Montreal, occur in a region which has scarcely undergone any folding since Archæan times. The Palæozoic sediments are horizontal or nearly so. The intrusive rocks, whether Tertiary or Palæozoic in age, have been produced under circumstances similar to those existing in the Abyssinian region in the volcanic era. There has been faulting accompanied by vertical movements, and the formation of trough-faults. Such was also the case in the Apache Mountains and the Sawtooth Mountains of Texas. In the Black Hills of Dakota, along the fault which borders the Rocky Mountains on the east in this region, alkaline rocks have also been extruded.

* "Eruptive and Sedimentary Rocks of Pigeon Point, Minnesota," Bull. 109, U.S. Geol. Surv.

Soda-rhyolites of Tertiary age have been described from California by C. Palache.*

Trachytes occur in the Elk Mountains and Wasatch Mountains of the South-western States, but they have never been shown, to my knowledge, to belong to the alkaline division.

Wherever rocks of true foyaitic composition have been described in North America, they occur on the faulted outskirts of that continental massive which has preserved a passive character, from the Cambrian to the present day, over which the sediments deposited by Silurian, Carboniferous and Cretaceous transgressions remain almost horizontal. The regions in which they occur have not, since the Cambrian and Lower Silurian, been subjected to any considerable sedimentation, and certainly to no tangential movements.

Alkaline rocks appear rare or wanting in regions subjected to true folding-movements in late Palæozoic, Mesozoic, or Tertiary times.

In addition to the areas hitherto mentioned there are very many other alkaline areas in the United States which without exception occur in such surroundings as have been described as typical for alkaline rocks.

The following are the most important of them :—

(1) The Petrographical Province of Essex County, Mass., described by Dr. H. S. Washington.†

(2) Red Hill and the Belknap Mountains, New Hampshire, described by L. V. Pirsson and H. S. Washington.‡

(3) The Little Rocky Mountains in Central Montana, described by W. H. Weed and L. V. Pirsson.§

(4) The Bearpaw Mountains, Montana, reviewed by W. H. Weed and L. V. Pirsson.||

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* Bull. Dept. Geol. Univ. Calif. Vol.i. p.61.

† Journal of Geology, Vol.vi. No.8, and Vol.vii. Nos.1, 2, 3 and 5; also Amer. Journ. of Sci. Vol.vi. 1898.

‡ Amer. Journ. of Sci. Vols.xx., xxii. and xxiii (1905, 1906, 1907).

§ Journ. of Geol. Vol.iv. No.4; also Amer. Journ. of Sci. Vol.l.

|| Amer. Journ. of Sci. Vol.ii. 1896, and Vol.i.

These researches, and many other valuable researches, as those of Dr. Washington on "The Igneous Complex of Magnet Cove," etc., we cannot here review, but a thorough study of them is of greatest value to any worker on alkaline rocks.

E. South America.

Syenites and trachytes are abundant in the Andes of Chili and Bolivia but do not, to my knowledge, belong to the alkaline series. However, in Brazil, rocks of true foyaitic character have been detected.

O. A. Derby* describes nepheline syenites, tinguaites, and phonolites from Cabo-Frio, Campo Grando near Rio de Janeiro, Tingua, Itamibe, Itajuba, Caso Branca, and Xibirica in States of Sao Paulo, Rio de Janeiro, and Minas Geraes, Brazil. The rocks intruded are Upper Palæozoic limestones of Carboniferous or Permian age, and overlying them a series of sandstones without fossils. The latter may be of Mesozoic age, but are believed to be Permian or Carboniferous.

In connection herewith it is of interest to remark that the Carboniferous rocks of Brazil are for the most part horizontal and undisturbed. In parts they are covered by Jurassic or Cretaceous sediments also uniformly horizontal, laid down in an era of marine transgression, but land-conditions predominated throughout the Mesozoic period.

The petrological characters of the Tingua rocks have been described by Franz Fr. Graeff;† others from the Provinces of Minas Geraes and Sao Paulo have been described by J. Machado.‡

Many of the nepheline syenites and allied rocks of Brazil rise out of biotite gneiss or Archæan schist in districts where later sedimentary rocks are not known. In these cases, of course, the age cannot be determined, yet there is a strong probability that

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* Q.J.G.S. 1887, Vol.xliii. No.171.

† Untersuchung von Elaeolith-syeniten von der Serra de Tingua, Brazilien. Neues Jahrbuch, 1887, Bd.ii.

‡ Tscher. Min. Mitth. N.S. Vol.ix. p 318, 1888.

they are all contemporaneous and of Post-Carboniferous age; they may even be as late as Tertiary.

I might mention in this connection that the removal by denudation of a few hundred feet of sandstone in the district of the Glass House Mountains, Queensland, would leave them standing in the midst of rocks at least as old as Carboniferous. It is likely therefore that many of the alkaline rocks of America now associated only with Eopalæozoic or Archæan sediments may be as late in age as the Glass House Mountains but on account of higher relief have had their Mesozoic sediments denuded away.

The only other alkaline rocks from the South American region which I know of are the Tertiary(?) phonolites of the Little Island of Trinidad,* Gough's Island, Ascension, St. Helena, and the Island of Fernando Noronha.†

South America therefore conforms to the plan which we have already found to hold good elsewhere, viz., that alkaline rocks do not occur in the folded ranges or in areas of great sedimentation, but they are found on the faulted portions of plateaux or continental masses which have only been submerged at considerable intervals, and then only for a brief period.

Ch. iv. Australasia.

From Possession Island, a relic of ancient Antarctica, ægirine (nepheline?) phonolites have been recorded by G. T. Prior ‡

Kerguelen Island consists of numerous lava-flows of which the oldest consists of trachyte and phonolite, the later of basalt.

New Zealand.—Professor P. Marshall, of Dunedin, has described a fine series of foyaitic rocks from the Province of Otago.§ The back country of the Province of Otago is composed of gneisses and schists. The volcanic area has undergone many vicissitudes in the Tertiary epoch, and the eruptive rocks are, according to Hutton's view, Post-Oligocene, according to the

* G. T. Prior, Min. Mag. Vol. xii.
† G. T. Prior, Min. Mag. Vol. xi.
‡ Min. Mag. Vol. xii.
§ "Geology of Dunedin," Q.J.G.S. Vol. lxii. 1906, pp. 381-424.

Geological Survey, Post-Cretaceo-Tertiary. They exhibit numerous similarities to those of East Africa described by G. T. Prior.

The east of the Province of Otago forms part of a subsidence area or senkungsfeld, the greater part of which is now submerged. The west of the Province forms a highly folded complex of Archæan and metamorphic Silurian rocks, west of which again lies the great subsided continental area which joined problematical Antarctica and the Sino-Australian area together, and which is separated from the horst by a fault-line from which Tertiary lavas have flowed. This fault is probably a continuation of the great Samoa-Tonga-Taupo fracture.‡

The rocks described by Professor Marshall are hornblende foyaite, augite diorite, tinguaites, ulrichite, trachydolerite, camptonite, teschenite, trachyte, phonolite, kaiwikite, leucitophyre, andesite, nepheline basanite, melilite basanite, dolerite, basalt, etc.

The conclusion is also arrived at by the author that in certain cases there was a mixture of a basic calcic magma and an alkaline magma before eruption.

In comparing the analyses made by Dr. Marshall we can trace many affinities between the different rocks, but we find only one analysis which is near the mean of two others, viz., that of the nepheline basalt which agrees closely with the mean of the Papanui dolerite and the Leith Valley dolerite. If we take together the two tinguaites analysed and the ulrichite, and take the mean of the three analyses it will be found to agree closely with the mean of the foyaite and camptonite. The camptonite and foyaite may therefore be considered to be differentiation products of the tinguaite-magma.

Tasmania.—Now turning to Tasmania, we have rocks of foyaitic magma represented by the Port Cygnet series and by the Middle Tertiary nepheline basalts, melilite basalts and melilite-eudialite basalts.†

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* These Proceedings, 1906, pp.662, 665.

† R. M. Johnson, "Geology of Tasmania."—Twelvetrees, "Nomenclature and Classification of Igneous Rocks," A.A.A.S. 1904.—Dr. Fred. Parnell Paul, "Beiträge zur Petrographischen Kentniss," Tschermak Min. Mitth. 25th Band, iv. Heft.

The rocks of the Port Cygnet group, which in many respects bear close resemblance to Australian alkaline rocks, are considered, without very much evidence, to be of lower Mesozoic age. They are definitely known to be later than the Permo-Carboniferous and to antedate the Pliocene, but direct evidence to fix their age more closely appears to be wanting.

The alkaline basic rocks found in cones near the Shannon River are definitely known to be of Middle Tertiary age, the same as similar Australian occurrences. It seems strange that the intermediate rocks of the foyaitic magma should be so far removed in age from the more basic ones, and future research may possibly prove the intermediate rocks to be later than hitherto supposed.

The alkaline rocks described by Dr. Paul (*loc. cit.*) comprise—

(a) *At Regatta Point, Port Cygnet*:—Augite syenite poor in quartz, nepheline syenite, essexite, jacupiraugite facies of nepheline syenite, melanite-hauyne syenite porphyry, garnet-bearing mica sölvsbergite, tinguaite, garnet tinguaite, porphyry, nephelinite, etc.

(b) *At Shannon Tier*:—Melilite-nepheline basalt, eudialite-nepheline basalt.

(c) *Near Hobart*:—Nepheline basalt and kongadiabase.

Although very complete petrological descriptions of these rocks have been given, their chemical characters and field-relations are not sufficiently dealt with, or perhaps not investigated, hence little can be said of the differentiation which has taken place. Further, the volcanic or plutonic sequence is not worked out.

The existence of such minerals as melanite and garnet in some of these rocks is suggestive of an assimilation of sedimentary rocks having taken place. The kelyphite borders round the garnet crystals are significant in this connection.

Both New Zealand and Tasmania are looked upon as the faulted remnants of the Antarctica land-mass over which Mesozoic sedimentation has been but slight, and tangential movements producing folding have been very feeble since the Carboniferous. Fracturing, on the other hand, has taken place on a gigantic scale.

Victoria.—At Mt. Macedon in Victoria occurs a series of phonolites and alkaline trachytes described by Professor J. W. Gregory.* He remarks that it is possible that Mt. Macedon was formed at the beginning of the great series of eruptions which ended with the formation of the basalt plains of Victoria. He considers it to be the remnant of a great volcano which emitted lavas and tuffs of intermediate to acid character. The sequence was apparently first dacites, then trachytes and sölvsbergites, then trachy-phonolites and andesites, and lastly basalts. If we leave out of consideration the dacites, concerning the supposed age of which and connection with the alkaline lavas, the work of Professor Skeats has lately cast serious doubts (proving them Palæozoic), the age and sequence as well as petrological character of the rocks are identical with those of the Warrumbungles and Nandewars in New South Wales.

The Macedon group is situated on the south-western extremity of the highly metamorphic Ordovician complex of Victoria. No Mesozoic sediments occur in the vicinity. To the south lies a subsidence-area, the Pliocene Melbourne basin.

At Macedon the following lavas are represented—geburite dacite, trachy-phonolite, sölvsbergite, andesite, and basalt. The andesite appears to occupy an intermediate position between the basalt and the trachyte, but sufficient analyses have not been made to permit of any deductions as to magmatic differentiation. The analyses published by Gregory are very poor, and seem quite unworthy of reliance.

New South Wales.

The Cambewarra Trachyte and Alkaline Basalts of the Bumbo Flow and Minamurra Flow.†—These rocks belong mainly to the Permo-Carboniferous period. The succession which has been ascertained was as follows :—

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* Proc. Roy. Soc. of Victoria.

† "Geology of the Kiama-Jamberoo District," by Jaquet, Card, Harper, Mingaye, and White. Records Geol. Survey of N.S. Wales, Vol. viii. Part 1.

1. Blowhole Flow basalt, a basic flow; magmatic name Andose. Total alkali, 5·94 per cent.

2. Bumbo Flow; magmatic name Shoshonose and Monzonose (orthoclase basalts). Total alkali, 7·89 to 9·19 per cent.

3. Saddleback Flow dolerite; magmatic name Andose. Total alkali, 5·96 per cent.

4. Cambewarra Flow trachyte; magmatic name Monzonose. Total alkali, 9·37 per cent.

5. Minamurra Flow; magmatic name Camptonose. Total alkali, 7·28 per cent.

6. Bong-Bong Flow of alkaline basalt; magmatic name Andose. Total alkali, 4·79 per cent.

All the foregoing flows are of Permo-Carboniferous age. Lastly we have—

7. The Robertson Flow of Post-Triassic basalt. Total alkali, 3·33 per cent.; magmatic name Auvergnose. This rock contains analcite and is closely related to the basalts intruding the Triassic rocks of the Sydney Basin (*e.g.*, the Prospect mass).

The intrusive rocks of the Kiama-Jamberoo district comprise—

1. Nepheline syenite, later than Permo-Carboniferous.

2. Dhruwalgha tinguaite, Post-Permo-Carboniferous; a rock containing nepheline, sodalite, arfvedsonite, barkevicite, ægirine, etc.; magmatic name Laurdalose.

3. Wallaya dolerite, a basic intrusive sheet in the Permo-Carboniferous.

4. Dykes of monchiquite, dolerite, ophitic dolerite, olivine basalt, and trachyte.

While the data given by the authors are not quite complete enough to permit of the working out of the minute details of the magmatic differentiation which has taken place here, as Brögger has done for the Christiania rocks, the conclusions arrived at by the authors are nevertheless of the highest interest and importance. They are in fact of the opinion that in early Permo-Carboniferous times, or perhaps earlier, a great mass of very basic rock invaded the earth's crust of this area. By stoping in and assimilation the invaded rocks, which must have been of a highly alkaline nature, were partially incorporated in the magma. Before assimilation had progressed far, a portion of the mass broke through to the surface, forming the Blow Hole Flow, and the vent thus formed gave after this event more and more alkaline lavas produced by assimilation at a depth. Occasionally more calcic varieties burst through.

Later on another vent was formed at the Cambewarra end of the reservoir, and from it flowed at first alkaline lavas formed by the assimilation-process mentioned.

From other fissures pasty alkaline magmas were expelled from time to time from the surface of the magma-reservoir, and were forced into the strata above in the form of sills. These injections gave rise to the tinguaite and nepheline syenite mentioned above.

Lastly, the mixed magmas having cooled, basic magmas were drawn from the more deep-seated and still molten portions of the reservoir. These eruptions were probably contemporaneous with the Post-Triassic basalts of Sydney which are analcite-bearing, and which frequently contain coarse fragments of peridotite as at Pennant Hills (Dundas Quarry), and of trachyte or syenite (as at Prospect).

In connection with the occurrence of analcite in the diabase of the Robertson Flow and of Prospect, and the theory that these lavas were emitted from a magmatic reservoir in which great assimilation of sedimentary strata had gone on, one might briefly refer to a paper on "The Plumose Diabase and Pelagonite from the Holyoake Trap Sheet," by B. K. Emerson.* It is here contended that the formation of analcite is due to the drawing into the magma by vortex-motions in it of a mass of mud.

The Tinguaites of Barrigan.—These rocks are referred to in Mr. Carne's monograph on the Kerosene Shales and Torbanites of New South Wales. They form a number of rounded mountains near Barrigan, and their age is definitely later than Permo-Carboniferous. These rocks are laccolitic and

* Bull. Geol. Soc. Amer. Vol.xvi.

may be as late as Cretaceo-Tertiary. No dykes of them have been noticed in the Triassic strata of the district. However, Triassic rocks do not occur in the immediate vicinity, so that this fact is of doubtful value. The intrusive rock is remarkably uniform in character, and Mr. Card has informed me that it is extremely like the tinguaite from Abyssinia described by Prior.

Leucite basalts have been described from Byerock and El Capitan near Cobar, N.S.W., by Messrs. David and Anderson.* The Rev. J. M. Curran had previously written a note on leucite basalts from these localities.† In 1891, J. M. Curran described another leucite basalt from Harden, N.S.W.‡

The Byerock and El Capitan leucite basalts are considered to be of Tertiary age, and they burst through Silurian slates and the granites intruding the Silurian.

Stonier§ has described a leucite basalt occurring in similar country at Lake Cudgellico.

The chemical composition of some of these rocks is given in the Records of the Geological Survey of N. S. Wales 1904, Vol.viii. They are so constituted that they might well have been derived by an ultrabasic magma having assimilated a stratum extremely rich in potash.

Nepheline Basalts.—Mr. G. W. Card has described a nepheline basalt from the Capertee Valley.|| This rock intrudes the Permo-Carboniferous, but has not been noticed to pass into the overlying Hawkesbury—hence its age may or may not be greater than the Hawkesbury. Like the Cambewarra volcanic rocks, it lies on the rim of the Sydney coal-basin. Mr. Card has also identified nepheline in Post-Triassic basalts of the Hawkesbury area.¶

In a south-west direction from Sydney around Mittagong and Bowral we have a group of trachytic intrusions and necks which

* Records Geol. Survey of N.S. Wales, 1889, Vol. i. Part 3.

† Proc. Linn. Soc. N.S. Wales, 1887, p.974.

‡ Journ. Proc. Roy. Soc. N.S. Wales, xxv. p.210.

§ Records Geol. Surv. N.S. Wales, Vol. iii. Pt.3.

|| *Loc. cit.* Vol. vii. Pt.2.

¶ *Loc. cit.* Vol. vii. Pt.3.

have invaded the Hawkesbury, and are therefore Post-Triassic in age. Messrs. Taylor & Mawson, who studied the petrology and geology of this area,* regarded the intrusions as of late Cretaceous age. In addition to trachytes and syenites of the alkaline facies they found essexites, picrites, and basalts in the vicinity. The trachytes and syenites were first erupted, the essexites, picrites, and basalts coming later. The position of this mass is on the outskirts of the Sydney coal-basin. Mr. Taylor has since discovered outlying members of this group (green ægirine trachytes) at Goulburn.

Almost north-west of the Mittagong alkaline area we have the Canoblas Mountains near Orange. The chief igneous rocks found here are old Palæozoic (?) greenstones, alkaline trachytes of Tertiary age, and more basic rocks. The igneous sequence is, according to Mr. C. A. Süssmilch, F.G.S., the following:—

1. Greenstone (hornblende diorite porphyry) and rhyolites, after the eruption of which there was a very prolonged cessation of activity lasting through all the Mesozoic periods.

2. Trachytes which bear close resemblance lithologically, mineralogically and chemically to those of the Nandewar Mountains, N.S.W., and the Glass House Mountains, Queensland.

3. Andesites and basalts, some of which are very porphyritic in andesine, and seem to me to have the appearance of being related to the alkaline series like the basalts of Exmouth in the Warrumbungles.

4. Later Middle Tertiary calcic basalts.

As far as has been ascertained up to the present, we have no evidence of such complete series of alkaline rocks, with intermediate types linking the acid to the basic, as in the Warrumbungles and Nandewars.

The trachytes intrude Palæozoic rocks. No Mesozoic rocks occur near them, so the exact age can only be guessed at. However, the crater-rings are so fresh that they cannot be older than early Tertiary.

* "Geology of Mittagong," Journ. Proc. Roy. Soc. N.S.Wales. Vol. xxxvii.

The Canoblas stand on the southern flank of the Permo-Carboniferous basin which stretches, with a few interruptions of residuals of older rocks, as at Wellington, from Orange viâ Mudgee to Narrabri and Moree. The Triassic sea lay to the north and north-west, but its sediments have been removed by erosion, if any ever were deposited in the Canoblas district. The definite relation of the Australian line of alkaline rocks to the area of Triassic sedimentation is here lost.

Probably the Canoblas sit on a fracture which crossed the land-tongue which joined the New England mass to the Goulburn mass, and which escaped Triassic sedimentation.

Permo-Carboniferous sediments were probably deposited on a portion of this land-tongue across the Cassilis Geocol.* Indeed the Gunnedah Coal Measures, which extend as far south-west as Dubbo, belong entirely to the Upper Freshwater Coal Measures, and were deposited probably later than those of Newcastle. It is highly doubtful that these two basins were ever continuous. Again, the Triassic of Dubbo, Coonabarabran, and the western plains does not appear to be Hawkesbury, but rather Trias-Jura, the same as the Clarence River and Ipswich Beds.

In the Canoblas so little petrological work has been done on the alkaline rocks that little or nothing is known regarding the magmatic differentiation.

The next locality at which foyaitic rocks are found in New South Wales is at Dubbo. Near Dubbo, 5 miles south-west between the Peak Hill and Oberley Roads, there is a hoary mass of alkaline trachyte, locally known as "The Gib." It consists of a fine-grained holocrystalline sölvsbergite which has for the most part a microgranitic fabric. This is undoubtedly the plug of a volcano. Dykes of trachyte intersect the Trias-Jura strata in the neighbourhood. Specimens of a beautiful arfvedsonite trachyte have also been collected by Mr. C. E. Murton, Geological Surveyor, in the Parish of Dungarry. These rocks have been

* Term used by T. G. Taylor, Proc. Linn. Soc. N.S.Wales. Vol. xxxi. Part 3.

referred to in my papers on the Warrumbungle and Nandewar Mountains. In the Parish of Benolong Mr. Murton has also collected specimens of nepheline phonolites described by Mr. Card as Miaskose.*

On my own visit to Dubbo I found near The Gib a formation of quartz porphyry (granite) which probably belongs to the Palæozoic, but Post-Silurian series of igneous intrusions. It has no affinities at all with the alkaline rocks which in places intrude it. The Triassic strata of this region are fairly thin and rest on the quartz porphyries mentioned, and on Palæozoic schists belonging to the Cobar massive. They thicken towards the north and north-east, where they overlie the Upper Coal Measure formation; possibly their greater development in the Warrumbungle area may be the downthrow by a peripheral faulting of the whole area lying within the curve of the Castlereagh.

In travelling across country from Coonabarabran viâ Mundooran and Cobborah to Dubbo I noticed that very frequently the summits of the ridges crossed consisted usually of sandstones and conglomerates of the Triassic facies, whereas the formation in the valleys consisted of sandstones and shales of the Permo-Carboniferous type, giving a more clayey and fertile soil. In the valley of the Talbragar Triassic beds are also found in erosion hollows in the Permo-Carboniferous formation.

The Warrumbungle Mountains.—The geology of this group I have discussed more fully elsewhere.†

The Warrumbungle mass commences a little over 50 miles north by east from Dubbo, and is situated on a line of weakness which pursues a N.N.E. or N. by E. direction from Dubbo to Narrabri. All along this line alkaline rocks are met with.

The physical features and land-forms of this area are described in my paper (*loc. cit.*). The volcanic mass is looked upon as a dissected lava-conoplain, and the surrounding country to the south-east, south, west and north as an arid-cycle peneplain. I had an

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* "Mineralogical Notes," by G. W. Card, No.10, Records Geol. Surv. N.S. Wales, Vol.viii., Part 3.

† These Proceedings, 1907, Vol.xxxii. p.557.

opportunity last year to visit the volcanic area of Dunedin, whose rocks are so nearly related petrologically to the Warrumbungle ones, and I was struck forcibly with the difference in appearance of the two regions. In New Zealand the alkaline rocks form rounded hills covered with grass; the valleys are V-shaped. In the Warrumbungles the mountains form steep cones or flat-topped tables with precipitous walls, and the valleys widen by the retreat of vertical cliffs. The differences observed are those which distinguish between normal erosion and arid erosion.

Old rocks, such as granite and schist (Silurian ?) occur at Gilgandra; at Tundebrine biotite granite underlies the Trias-Jura at no great depth, having been brought to the surface in the lavas. At Goorianawa granite forms the bottom of the borehole. At Scabby Rock true slate—with quartz reefs—apparently of Gympie age has been turned up by the trachyte-plug.

The geological history of the Warrumbungle area is identically the same for the Nandewar and Dubbo areas. The line of weakness passing through these three areas constituted practically the coast-line in late Palæozoic time up to the end of the Carboniferous. The land lay to the west of it and the sea to the east. In the early Permo-Carboniferous the land-area was extended right up to the western border of New England, over which area, however, sedimentation continued. In very late Permo-Carboniferous, when the New England uplift took place, a lacustrine area was formed between it and the old Cobar massive. Here sandstones of the Upper Coal Measures were deposited. This area was now drained and a long period of erosion followed. In Trias-Jura time the sea invaded the western portions of the same area, which might appropriately be termed the Gunnedah Basin, from the north. A withdrawal of the sea from most of the basin followed, and in the Cretaceous period the Triassic and Permo-Carboniferous beds of the area were reduced to a peneplain. The Cretaceous sea only overlapped a small area of Triassic sedimentation, but extended over a wide area to the west and north.

A lake-period followed in the Tertiary. It is interesting to note that in Cretaceous times the position of land and sea with regard to the Narrabri-Dubbo line was practically the reverse of what it was in the Carboniferous, the sea being then to the west and the land to the east. The New England late Palæozoic sea was, however, of very considerable depth, as evidenced by its limestones and radiolarian beds, but the Mesozoic seas of Central Australia and of the Gunnedah Basin in particular, were only of slight depth, and may be looked upon as mere transgressions.

The Permo-Carboniferous of the Gunnedah Basin has, in the Warrumbungle region, a sharp south-east dip; the overlying Trias-Jura is almost horizontal, having but a slight north-west dip. Consequently earth-movements of some amplitude must have taken place between the Permo-Carboniferous and the Trias-Jura, but there is *no evidence of intense folding* since the Carboniferous. In the Nandewars, where the Permo-Carboniferous strata are well exposed, the sharp dips are due to faults, the folding movements in the sediments having produced only gentle dips. It is different in the southern end of the Nandewar Mountains, at Maule's Creek; here the folding connected with the epeirogenetic uplift of New England has been very much more intense, and was accompanied by fractures through which rhyolitic lavas were extruded. The faulting in the Bullawa Creek area is much later and connected with the alkaline intrusions.

In the Warrumbungle Mountains we meet with a complete series of alkaline lavas, ranging from very acid to very basic.

The order of eruption was the following:—

1. Comendite, pantellarite, and arfvedsonite trachyte erupted first as tuffs into cones of which the pasty lavas were often squeezed as a plug. Flows occurred in the central part of the volcanic district where activity was most intense.

2. Nosean, pseudoleucite ægirine, and arfvedsonite phonolites as plugs and flows.

3. Phonolitic ægirine trachyte and alkaline andesites (keratophyres and lahnporphyry), as vast flows, probably from fissures.

4. Alkaline basalts and trachydolerites.

5. Calcic basalts, found mainly outside and encircling the alkaline areas.

Fossil leaves from the trachyte tuffs have been examined by Mr. Henry Deane, M.A., F.L.S., and found to be Tertiary. The eruptions appear therefore to have commenced in the Eocene, and the freshness of the later lava-cones suggests that some may be as late as Pliocene. The sequence is the same as that observed in the Nandewars, in the Glass House Mountains, in the Mittagong-Bowral group, in the Macedon area, and in fact in all localities in the Australian region where alkaline rocks occur.

At various points between the Warrumbungles and Nandewars, on the Narrabri-Dubbo line, small eruptive cones and plugs of alkaline rock occur, as at Scabby Rock in the Pilliga Scrub.

In the Nandewar Mountains, about 20 miles east of Narrabri, we again come upon a great series of alkaline rocks. These rocks have also been described by me elsewhere.*

Here, as in the Warrumbungles, the signs of arid erosion are unmistakable, but a certain very recent rejuvenation of streams in both regions shows that the arid cycle is past its maximum.

In the Nandewars we meet with Palæozoic (Carboniferous and Permian) rhyolites and quartz porphyries, andesitic rocks of the same age, and ancient tuffs and breccias just as in the Canoblas. A very extended period of quiet followed. The next eruptions gave dolerites, which appear to be Post-Triassic, probably late Cretaceous, as lavas of this character were erupted on the Cretaceous peneplain. A period of erosion followed, when extensive faulting took place and alkaline lavas were extruded from the fissures. The first were essexite in composition, being probably a mixture of doleritic and trachytic magma. Then followed intrusions and extrusions of pantellarite, arfvedsonite trachyte, and very felspathic ægirine trachyte. Pulaskite porphyry, akerite and allied rocks were then intruded, whilst at the same time flows of ægirine trachyte, nepheline phonolite, and alkaline andesite took place.

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* Proc. Linn. Soc. N.S.Wales, 1907, Vol.xxxii. p.842.

Dykes of bostonite and monchiquitic lamprophyre were also formed.

The last eruptions consisted of alkaline basalt, trachy-dolerite, and normal olivine basalt. Although I have no fossil evidence to fix the age of the eruptions with certainty, the lavas being later than beds known by the Glossopteris, Gangamopteris, and Nœggerathiopsis leaves in them to be Upper Coal Measures, also later than beds at Deriah Mountain classified by the Mines Department on direct evidence as Triassic, and overlying the remnants of a peneplain carved in the Cretaceous (The Mole Peneplain), must be Post-Cretaceous, that is probably Eocene or Miocene. The basalt crater-rings are often so fresh that the basic eruptions can hardly be older than Middle Tertiary. Of course the Post-Tertiary arid cycle has tended to preserve the mountains here and in the Warrumbungles, but I have shown that there is strong evidence of a wet era preceding the arid one. Erosion must necessarily have been more rapid then.

The centre of the Nandewar group probably occupies the position of intersection of two important fault-lines, one running N.N.W.-S.S.E., along which most of the alkaline lavas have been expelled, and one running N.N.E.-S.S.W., the Dubbo-Narrabri line of weakness. Between these two fissures a great area of country capped with Coal Measure and Triassic sediments has subsided in Tertiary times. The downthrow cannot be as old as Cretaceous, for no part of the area is affected by the Cretaceous transgression. It is probably contemporaneous with the Tertiary subsidence of New England. Certain parts of the basin subsided much more than others, probably by the agency of transverse fractures. Thus at Narrabri about 1500 feet of fluviatile material of Tertiary age overlie igneous rocks of Cretaceo-Tertiary age similar to the dolerites and essexites of the Nandewar Mountains. This portion may have subsided 3000 feet.

We have thus observed that all the alkaline rocks of New South Wales lie along a continuous curve surrounding the Permo-Carboniferous basins. Probably a number of faults join so as to form a continuous line of weakness.

Commencing at Kiama, the line runs N.W. to Orange, thence N.N.W. to Dubbo, thence N.N.E. to Narrabri. The whole of the area within the curve probably remained stationary in the Eocene following upon its long period of elevation in Cretaceous times. Certain areas like that lying between the New England massive (bordered by the N.N.W.-S.S.E. fault of the Nandewars), and the Cobar massive probably were completely severed by intersecting fractures and formed subsidence-areas. A high mass of Palæozoic rocks, probably a horst, the Bathurst-Wellington mass, borders the Gunnedah Basin on the south.

The fault-line along which alkaline rocks have been erupted universally divides the outcrops of ancient Palæozoic rocks, which formed the late Palæozoic and early Mesozoic land-masses, from the Mesozoic and Permo-Carboniferous sediments which were pinched between them, and in some parts folded. The alkaline lavas are not found in the centres of sedimentary basins like New England and the Sydney Basin, but only along the fractured continental borders of Mesozoic seas and their continental shelves, where slight transgressions of the sea occurred at intervals. Folding is nowhere intense, but fracturing has been considerable in Tertiary time along the line.

Incidentally the Dubbo-Narrabri line happens to be parallel to the line of strike of the Mesozoic sediments of the Gunnedah Basin, and consequently is at right angles to the direction in which the uplifted Mesozoic has been gently pushed (or folded).

The main importance of the line, however, lies in the fact that it is a line which was a shore-line throughout late Palæozoic and Mesozoic times. In the Carboniferous the continental area lay to the west of it and the sea to the east. In the early Permo-Carboniferous a portion of the area comprising the Gunnedah Basin was elevated, and at the end of the Permo-Carboniferous when the New England area emerged, this same portion became resubmerged, probably as a vast lake. In the Mesozoic the Kiama-Dubbo segment of the curve still remained with land to the west and sea to the east, but the Narrabri-Dubbo portion had land (New England) to the east and sea (the Cretaceous) to the west. This line has therefore been a hinge in all the earth-movements which have taken place since the Silurian. It has escaped very heavy sedimentation. For these reasons it became fractured—or pre-existing fractures widened—in the great earth-movements of the early Tertiary, and as there was no heavy load of tenacious sediments to block the upward passage of magmas, even those of a highly viscous character were able to reach the surface.

A very interesting physical feature of the Warrumbungle and Nandewar districts is the very great abundance of powerful springs in the mountains. These occur chiefly above the artesian intake, at elevations of from 2000 to 4000 or 5000 feet above sea level, and are especially abundant in the volcanic rock, or at the edges of intrusions of it. In every part of Australia we find springs abundant in areas of igneous rock and crystalline schist, whereas over sedimentary areas, in the west at any rate, springs are not met with. There is no doubt that the water of these springs comes from very deep-seated sources. Why is it restricted to certain areas? The answer seems to me to be that it escapes in other parts as well, but is absorbed before reaching the surface by the mantle of artesian and subartesian strata. Hence these mountain-springs prove to my mind that Professor Gregory's theory of the origin of artesian water is at least in part correct.

I now propose to deal briefly with the possible mode of origin of the alkaline rocks.

In their mineral composition and chemical composition the ægirine trachytes of dark greasy green colour are intermediate between the corundum basalts (W.40) and the arfvedsonite trachytes (W.16, W.17, W.38). Hence the monzonose, being also a more abundant rock-type, may be considered the parent magma.

Again, "The Spire" orthoclase basalt (W.67) is chemically and mineralogically very near the mean between a typical dolerite (such as N.17 from the Dingo Creek laccolite, Nandewar Mountains) and a trachy-andesite; and there can be little doubt that this rock owes its characters to a mixture of magmas. The doleritic constituents occur in bunches of fragments which are relics of a dolerite which has been assimilated by the alkaline magma. The xenogenic nature of the fragments and phenocrysts shows us clearly that an alkaline magma has burst through a partially consolidated doleritic mass, mixed with it and to a degree assimilated it.

It seems that the trachy-andesite magma could very well have originated in the same way. The trachy-andesites and melanocratic trachytes and phonolites frequently contain corroded olivines, augites, etc., which have a xenogenic appearance.

The corundum basalt (Billy King's Creek, W.40) referred to above may itself be formed from a basalt-magma by assimilation. In the field this rock rapidly changes into a more or less typical olivine basalt with pilotaxitic fabric, and exhibits great variations.

Mixture or assimilation has therefore probably played an important part in the production of the Warrumbungle rocks. The question therefore arises how the trachy-andesite magma could have originated by the aid of these processes.

The lateral flow of alkaline rocks from oceanic basins to continental areas during which the primitive alkaline precipitates were changed to a foyaitic magma would have commenced in this part of the world in the Carboniferous. During the late Palæozoic sedimentation of New England, alkaline magmas were thus forced aside and accumulated in the shear-zone of adjacent continental areas. This movement would actively continue through the Mesozoic era when the New England district was influenced by rise of isogeotherms. Sedimentation would probably also tend to force in a lateral direction some underlying basic magmas, and more or less mixing might take place. The alkaline magmas belonging to a higher plane in the zone of shear would, on the fracturing and collapse of a continent, be the first to be expelled (fig.8).

If we now assume first that no mixture with basic rock has taken place in the process of lateral squeezing we will in the cataclysmal period have first acid alkaline eruptions forming mamelons, laccolites and breccia-cones, and next, after a pause in activity, basaltic eruptions. This seems to have occurred in the Glass House Mountain region, where the melanocratic facies of alkaline lava is practically absent.

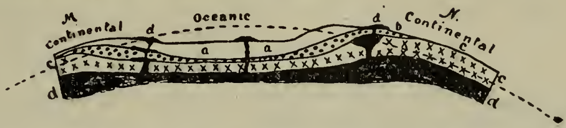

Fig. 8.—Diagram showing the effect of sedimentation in squeezing the alkaline rocks into Continental areas.

Broken line = spheroid of earth's curvature—*a*. Zone of sedimentary rock—*b*. Zone of alkaline rocks and Archæan schists—*c*. Zone of acid igneous rock—*d*. Zone of basic igneous rock.

If in the process of lateral squeezing a mixture with basic rock has occurred, the initial eruptions in the fracture-period will be of the leucocratic trachyte-type, and melanocratic trachytes will follow. Trachy-dolerites will also come in before the basalts are extruded. This type of sequence obtains in the Warrumbungles and Canoblas.

Now in the Nandewars we have an indication that the first intrusions consisted of an essexitic magma. In such a case if we imagine a part of a plateau (i.) drawn down by secular contraction (ii.), folding will take place in the outer zone which cannot accommodate itself to the lessened space (iii.); and the alkaline magma will be forced into the anticlines as laccolites by the subsiding segment being squeezed between the stable segments M and N (fig. 9).

But before the compression of the subsiding segment commences it will have fractured, and basic magmas may rise along the fractures and intrude themselves into the alkaline zone. Here they will assimilate alkali and also help to bring about the refusion of the whole alkaline zone. The formation of a vent may lead to the expulsion of this mixed magma first, the alkaline magma next, then mixed magma again and lastly calcic basic magma.

It will be remembered that the Nandewars appear to form a gentle anticline of Post-Triassic age which was subsequently greatly faulted. The Mt. Flinders area near Ipswich is an analogous instance.

If a basic rock-mass (B) be intruded into an alkaline one (fig.9, iv.) and remelts the alkaline body (A) and thereby loses its heat and solidifies, the alkaline lavas expelled will contain inclusions of the basic rock. This might account for the basic xenoliths in The Spire orthoclase basalt (W.67) and in the Dingo Creek (Nandewar) lamprophyric monchiquite, and the common occurrence of basic inclusions in alkaline rocks as observed in Brazil, Portugal and elsewhere.

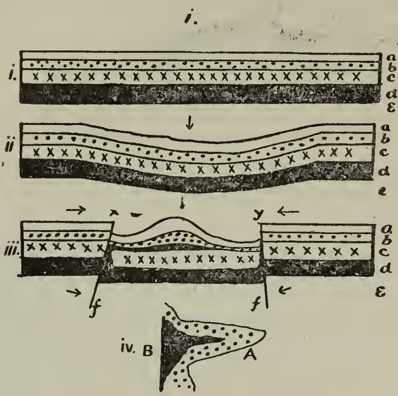

Fig.9 (i. ii. iii. iv.).—Diagramatic representation of the formation of mixed magmas by the development of a subsidence-area (rift valley) in a plateau undergoing secular contraction.

a. Zone of sedimentary rocks—*b*. Zone of alkaline rocks and Archæan schists—*c*. Zone of acid igneous rocks—*d*. Zone of basic igneous rocks—*e*. Nucleus—*x* and *y*. Points of eruptions of alkaline, mixed and basic magmas—A. Alkaline rock—B. Basic rock.

On these hypotheses the succession can easily be explained and understood.

The volcanic succession observed in the Nandewars, the Fassifern district, Mittagong, etc., is exceedingly common in alkaline areas. It occurs at Kerguelen Island and in many Antarctic islands, also in Bourbon. "Observations by R. von Drasche," says Geikie* "have shown that at Bourbon (Réunion) during the early submarine eruptions of that volcano crystalline rocks (gabbros) were erupted, that these were succeeded by andesitic and trachytic lavas, but that when the vent rose above the sea-level basalts were poured out." A similar sequence has been shown to exist in the islands of Palma and St. Paul.†

* Text-Book of Geology, 3rd Ed., p.253.
† Tschermak's Min. Mitth. 1876, pp.42 and 157.

Before dismissing the question of the origin of the alkaline rocks it is interesting to note the chemical composition of some cherty inclusions of metamorphic rock which are abundant in the arfvedsonite trachyte of Timor Rock in the Warrumbungle Mountains. These are referred to in my paper.* These inclusions are rounded or subangular with rounded edges. The trachyte gets more and more fine-grained as the inclusions are approached and at the same time gets richer in blue soda amphibole. In the following table the compositions of the host-rock and of the inclusions are given, and it will be readily noticeable that the difference between them is exceedingly slight, chiefly noticeable in the MgO. It is not only possible but extremely likely that the arfvedsonite trachyte actually represents this sedimentary metamorphic rock (chert, adinole or halleflinta) refused by some deep-seated process.

	Inclusion.	Timor Trachyte.	
SiO_2	66·90	65·90	
Al_2O_3	15·75	16·74	
Fe_2O_3	4·42	1·72	3·91
FeO		1·99	
MgO	1·04	0·06	
CaO	0·48	0·09	
Na_2O	4·57	6·35	
K_2O	5·18	5·77	
H_2O-	1·04	0·27	0·70
H_2O+		0·43	
TiO_2	0·62	0·25	
ZrO_2	—	0 29	
	100·00	100·09	

The differentiation of the Warrumbungle and Nandewar rocks has already been discussed in my papers dealing with those regions. It need only be mentioned that the parent-magmas of the two regions are very closely related chemically.

It might be objected to this 'refusion and assimilation theory' which I suggest to explain the origin of alkaline rocks

* Proc. Linn. Soc. N.S. Wales, 1907, Vol.xxxii. pp. 560 and 595.

that it is unnecessary, as differentiation alone is capable of explaining all facts. I do not think so. A powerful argument against the assumption that foyaitic and calcic rocks are derived from one parent-magma and have then been further differentiated into acid and basic varieties of each is found in the infrequency of passage-types and the distinctive dyke-series which accompanies each of these two main magmas. Another is the occurrence in alkaline rocks of so many minerals which are characteristic of metamorphic rocks.

Queensland.—Proceeding to Queensland, we first meet with allied alkaline rocks at Mt. Flinders near Ipswich; these are fully described in a subsequent chapter.

At Spring Bluff, between Helidon and Toowoomba, trachytes underlie basalts, but not having examined sections of them I cannot say if they are very alkaline or not. They support a flora similar to that occurring on the ceratophyres of Byron Creek, grass-tree playing an important rôle.

On the North Coast Line, between Brisbane and Gympie, we come upon the alkaline areas of the Glass House Mountains. In the Glass House proper the alkaline series is not very complete. The leucocratic rocks are the most abundant and comprise comendites, pantellarites, arfvedsonite and ægirine trachytes, and occasional ceratophyre dykes.

Some of the more southerly mountains are composed of a porphyritic bostonite. The melanocratic alkaline rocks include dark, very fine-grained ægirine trachytes and dacites. The subsequent basalts are calcic.

The order of eruption was :—1. Acid alkaline lavas. 2. Dacitic lavas. 3. Basalts.

The basalts, however, were not erupted in the same district, but to the north of the main trachyte-area The original vents seem to have been effectually plugged up by the pasty trachytes, and the basalts were compelled to find an outlet by fissures in the area to the north. The great Blackall Range basalt-sheet does, however, overlie trachytes and ceratophyres in many places,* and to the north of the main basaltic area we again come upon a group of alkaline lava-masses extending from Nambour to Cooroy, and from the Mary River to the sea. As I have shown in my paper on this area (*loc. cit.*) the alkaline series is more complete here than in the Glass House Mountains proper. Volcanic activity commenced with the intrusion of huge sills and laccolites of porphyrite and quartz-diorite (andose) and monzonite (dacase) at Point Arkwright, Noosa Head, Mount Cooroy, and elsewhere, and the simultaneous eruption of andesitic and dacitic lavas in the Eumundi district. All these eruptions were of an alkaline nature, as my analyses show. From the larger masses were differentiated dykes of a beautiful graphic granophyre, and a curious characteristic of all the hypabyssal and volcanic rocks of this series is the almost universal occurrence of intergrowths of minerals, graphic, micrographic, and cryptographic. Even allotriomorphic phenocrysts having roughly the contour of felspar and consisting of a micrographic intergrowth of quartz and felspar occur. This shows that cooling proceeded in the magmatic reservoir until a number of phenocrysts had separated, and only a eutectic mixture of quartz and felspar was left. Then the magmas were expelled and cooling continued where the masses occur at present. Felspar being greatly in excess of quartz in the mixture, and the original conditions having been disturbed, the felspar molecule seems to have reacquired a tendency to crystallise, hence we get the remarkable appearance of micrographic phenocrysts in a micrographic to granular base.

The next lavas to be expelled after a period of erosion were acid and very alkaline rhyolites and trachytes, with arfvedsonite, riebeckite, and cossyrite. Then followed alkaline andesites with ægirine-augite and acmite; next dacites; last alkaline to normal basalts.

Now the whole volcanic series from Mt. Byron to Cooran lies on a long earth-fracture preserving a general north and south

* "Geology of the East Moreton and Wide Bay Districts." Proc. Linn. Soc. N.S. Wales, 1906, Part 1.

direction. From this fracture a number of east and west cross-fractures originated, and volcanic activity was displaced from west to east along them, just as the modern volcanoes of Fonseca Bay are displaced from east to west. The explanation which, in my paper on this district, I advance to account for the dip of the Trias-Jura fails if Suess' theories are correct. The easterly dip of the Trias-Jura in the monocline of the N. D'Aguilar and Blackall Ranges can be explained just as well by assuming, as probably Suess would do, that the early Tertiary push was exercised in the same sense as that of the Palæozoic folding, viz., from west to east. Then the long fault along which the lavas were extruded borders a portion of the subsided Vorland. The monocline is then due just to a bending of the strata before subsidence. The Woondoom Tableland to the north of Cooran is undoubtedly, as I have shown in my paper, a horst bordered by faults.

The main fracture (the volcanic line) has always Palæozoic rocks near it to the west, and has universally Trias-Jura strata to the east. It is therefore situated along the margin of Mesozoic sedimentation, and it was probably formed in early Tertiary time by the subsidence of the Trias-Jura area which was probably land in the late Cretaceous. The horizontality of most of the Trias-Jura beds everywhere except in the mountain-range shows that they can only have been subjected to vertical movements.

Much of the Mesozoic strait which connected the Ipswich and Burrum Coal Measures is now resubmerged under the waters of Moreton Bay. After all, the nature of the Ipswich and Burrum Beds shows that the Trias-Jura sea was only what Suess would term a mere "transgression." The islands in and around Moreton Bay are to my mind the product of subaërial erosion in late Cretaceous times, prior to the early Tertiary downthrow. The present tendency in Moreton Bay is distinctly towards elevation.

The volcanic line in the ocean about 100 miles east of Brisbane, which runs parallel with the Glass Mountain fracture, may mark the eastern rim of the Triassic sea. If the Bowen Coal Measures occur under the Trias-Jura here, the analogy of the situation of the Glass Mountains and New South Wales alkaline rocks would be very close.

We have seen that the Glass House Mountains are situated on the fractured border of a Palæozoic land-mass, that the Mesozoic sediments east of them are the product of the Trias-Jura transgression, that although the folding of Trias-Jura sediments has occurred to a limited extent, faulting and fracturing have played a more important part in shaping this area in Post-Triassic times. In all respects we find the correspondence with other Australian alkaline areas very great.

In discussing the Warrumbungles and Nandewars I did not make any reference to the existence of cross-fractures.

An examination of my special papers on these regions shows that in the Warrumbungles the main fracture runs N.N.E., and there seems to be a tendency for cross-fractures to develop at right-angles to this line.

In the Nandewars the main fracture runs N.N.W., and a number of minor fractures originate in it and run at right-angles to it. Here the displacement of activity seems to have been from east to west, that is from the land-side towards the inland sea.

Further north in Queensland, continuing along the margin of the Burrum Beds, we have syenitic masses of Post-Triassic age, such as Mt. Boppy, examined by Mr. B. Dunstan, F.G.S.

Mr L. C. Ball informs me that to the west of Gladstone there are more trachytes essentially similar in character and mode of occurrence to the Glass House. Further north, at Yeppoon, we have another group, a specimen of which in my collection does not possess the alkaline facies. All these Queensland trachytes take the form of steep-sided cones or monoliths of columnar rock, which represent plugs in tuff-cones now removed by denudation, and mamelons.

More trachytic knobs occur in the Clermont district. These, like the Yeppoon ones, have never been geologically examined, so all that can be said is that they too stand on the rim of Mesozoic basins.

Mr. A. Gibb Maitland has also described trachyte tuffs in the Upper Cretaceous west of Mackay.*

All along the Queensland coast the trachytes have in general an older appearance than inland in New South Wales. The reasons are obvious. All recent sediments, all soft tuffs, and many of the more decomposable lavas have been totally removed by the rapid erosion due to a moist tropical climate. In some places, as at Mt. Cooran, the trachytes intrude very ancient granites, and if it were not the case that other neighbouring masses very definitely intrude the Trias-Jura, we might mistake these masses to be extremely ancient.

As I have mentioned elsewhere, the removal of about 400 feet of Trias-Jura strata in the Glass House Mountains proper would probably leave all the masses surrounded by very ancient rocks, and no one would be able to say that they were later than Palæozoic.

Ch. v.

We have now seen that alkaline rocks everywhere in Australia exhibit many characteristics in common.

The succession is in general from the more acid to the more basic. In some cases a more basic intrusion has in Post-Triassic times preceded the acid series, as the Dingo Creek dolerites in the Nandewars, N.S.W., and the Point Arkwright porphyrites in the Maroochy district, Queensland.

In every case the alkaline rocks occur along the borders of the Mesozoic transgressions and faulted continental masses, and they always belong to the Eocene, a period of great earth-movements.

The existence of cross-cracks, not unlike radial and tangential cracks, as at Fonseca Bay, has been demonstrated, so that at this time the volcanic portions of Australia were probably being subjected to changes similar to those going on to-day in the environs of the Gulf of Mexico. The alkaline volcanic areas seem in general to be situated on subsiding portions of a Vorland

* "Geological Features and Mineral Resources of the Mackay District," by A. Gibb Maitland. By Authority, Brisbane, 1889.

or continent undergoing destruction by trough-faulting. In every case Palæozoic or Archæan rocks occur not far from the alkaline extrusions, and at no great depth under them.

As regards the law of succession, we see that the one observed by Richthofen in the Andes, and accepted as general by most geologists, does not hold for alkaline areas.

In the Dunedin district, as Marshall has shown, the succession is very complex, and a magmatic mixture has taken place in several cases. I have given evidence for a similar mixture of magmas in the Warrumbungles and Nandewars.

In the Cambewarra-Kiama flows a mixture of magmas has also interfered with the normal succession. But in most cases the succession can be accounted for best by imagining—

(1) Earth-movements and faulting accompanied by basic intrusions which may or may not have reached the surface and laccolites in between old sedimentary or metamorphic strata at a great depth.

(2) Fusion of alkaline Archæan schists and similar rocks of sedimentary origin by the immense friction accompanying earth-movements, and by the heat from basic intrusions, so as to form alkaline magmas.

(3) Fracturing and expulsion of the alkaline magmas in part.

(4) Mixing of alkaline magmas with basic ones, and expulsion of mixed products.

(5) Differentiation of the mixed magmas, and expulsion of differentiation-products.

Brögger in his second volume of "Die Eruptivgesteine des Kristiania Gebiets" compares the sequence observed at Christiania with that observed in Tyrol.

I contend that if we imagine stoping and assimilation to have taken place here in a magmatic reservoir at a great depth, and differentiation to have taken place chiefly in the reservoirs now exposed by denudation, almost all the features which have been observed in nature can be explained on the theory outlined above.

Brögger shows clearly enough that neither in Tyrol nor in the Christiania Gebiet, nor in the Highwood Mountains, Montana, has assimilation of the rocks surrounding the exposed masses taken place. Undoubtedly his contention is correct. We can, nevertheless, imagine assimilation to have proceeded in a more deep-seated reservoir, and differentiation to have taken place in the various bathylitic masses ejected from the reservoir, and we can fall back upon the evidence afforded by Daley's Okanagan bathyliths, by Bayley's eruptive rocks of Pigeon Point, by Hogböm's nepheline syenites of Alnö, by Andrews' New England bathyliths, and many other occurrences to verify that alkaline rocks can be produced by assimilation. The work of Jaquet, Card, Harper, Mingaye, and White on the Kiama-Jamberoo rocks is also much to the point.

Again, the association of alkaline rocks with extremely calcic rocks so often observed as in the Nandewar Mountains, and especially the sudden break from extremely basic gabbroic rocks and peridotites which sometimes commence the cycle to extremely acid alkaline rocks can hardly be explained by natural differentiation processes. The later gradual passage from alkaline acid to calcic basic rocks can well be explained on the differentiation-hypothesis.

The existence of fragments of peridotite in alkaline rocks, as shown by Süssmilch for the monchiquite of Bumbo Quarry, Kiama, by myself for the lamprophyric monchiquite of the Nandewars, by Derby in the Brazilian nepheline syenites, and by Kraatzlan and Hackmann in those of Serra de Monchique is best explained as I have done in dealing with the Warrumbungles.

The general occurrence of the porphyritic habit and the universal occurrence of great resorption and corrosion of phenocrysts in alkaline rocks show that crystallisation commenced in a deep-seated reservoir, and on relief of pressure in rising to higher zones the crystals were attacked by the ground-mass.

The occurrence of graphic structure and sometimes micrographic phenocrysts shows that eutectic conditions were first reached in a deep-seated reservoir, then disturbed on the ascension of the magmas, and finally reached again on cooling at the higher level.

The evidence which all our alkaline trachytes so strongly afford of pneumatolytic action displayed in the cryptovesicular structure of the ground-mass, the micrographic intergrowths of quartz and felspar in the base, the occurrence of minerals produced by pneumatolysis such as riebeckite, arfvedsonite, etc., and titanium, zirconium, and fluorine minerals, and the occurrence of chloride and sulphate minerals in the phonolites are all strong arguments for believing that old hydrous, sulphate- and chlorine-rich sediments have been remelted or assimilated to produce the magma.

The rare minerals which occur so commonly, though it be in small amount, in alkaline rocks are in every instance minerals which do not typically belong to pure plutonic magmas. They are best developed in regions of contact-metamorphosis and in pegmatite-veins. Such is the case with scapolite, vesuvianite, guarinite, analcite (*vide antea*), arfvedsonite, etc. The peculiar dendritic (paisanitic) or mossy (poikilitic) structure of the alkaline amphiboles, and the corroded nature of any stray phenocrysts of them which one may meet with, and their frequent alteration to hæmatite or ferrite, show that crystals of these minerals can only form under very peculiar circumstances, and are again destroyed on immersion in a moving fluid or pasty magma.

The occurrence of spinels, garnets with kelyphitic borders and similar minerals in alkaline trachytes and tinguaites is also a feature pointing to the assimilation-theory.

The foregoing features observed in Australian alkaline rocks are equally well observed elsewhere in other parts of the world.

Of all the alkaline areas outlined in this exposition only some of the following are definitely known to be older than the Triassic:

Australia—The Kiama-Jamberoo alkaline basalts (shonkinose and monzonose).

Europe—None are known to be Pre-Triassic, but the Monchique, Laurvig, Kola, and Miask areas may be.

Asia—A Palæozoic leucite rock has been described from Tunguska, Siberia, by K. von Chrustchoff,* and the same author has

* See Min. Mag. x.

described a nosean-felspar rock from Taimyr River, N. Siberia, supposed to be of the same age.*

Africa—None.

America—The Montreal ali-syenites appear to be Palæozoic. The alkaline rocks of Pigeon Point, New Jersey, Lake Champlain, and many other places in the North-eastern States are still more indefinite as regards age. Those of Brazil are supposed to be Permo-Carboniferous. In no single instance have we definite proof except when they are known to be Post-Cretaceous.

In the vast majority of instances the alkaline rocks belong to the period of Tertiary convulsions, but there is no reason why a similar period of disturbance should have produced alkaline magmas in the Palæozoic.

In no single case in any continent do the alkaline rocks occur in a range of intensely folded Mesozoic and Tertiary sediments, such as might have constituted a deep sea throughout the late Palæozoic and Mesozoic periods. The Mesozoic sediments represented in their vicinity are relics of mere transgressions or epicontinental seas spreading over subsiding portions of continents.

The alkaline rocks are always on or near portions of continental masses which have been fractured by faults and developed trough-faults.

Evidence has been given for all these generalisations which may be considered tentatively proved.

Further, it appears that alkaline rocks are seldom erupted in a subsiding Rückland, almost always in a subsiding Vorland.

BRIEF SUMMARY OF CONCLUSIONS.

1. Alkaline rocks are practically confined to the flanks of old plateaux (continental areas) which have escaped heavy sedimentation in late Palæozoic and Mesozoic times.

2. They occur on fissure-lines along which great crustal movements took place that led to the dismemberment of the plateaux.

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*Bull. Acad. Imp. Sci. St. Pet. New Series, iii. p.421.

3. They occur only in regions where the dominant displacements were vertical, that is where folding played little part.

4. Very old rocks, often the Archæan complex, occur in or very near every alkaline province.

5. Almost all the great alkaline eruptions of all parts of the earth took place in the Eocene period.

6. It is suggested that alkaline rocks are only exceptionally produced by differentiation from a normal magma. They are in

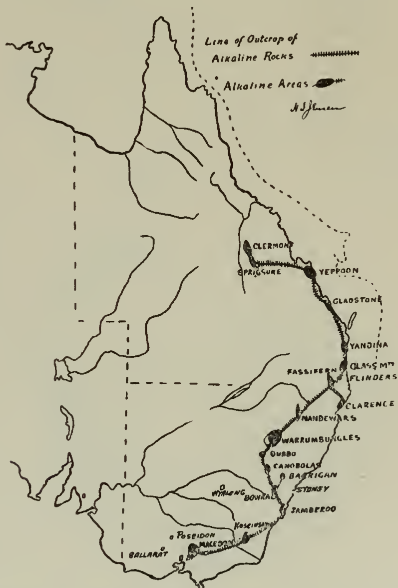

Fig. 10.—The Australian Trachyte Line, or Line of Outcrop of Alkaline Rocks.

general produced from an alkaline magma, and such a magma is not formed in the same way as a normal magma.

7. For reasons given the theory is advanced that alkaline rocks are derived from, in the first place, Archæan saline beds which, by chemical attacks on the adjacent sediments, have given rise to an alkaline magma in the process of metamorphosis. This magma has been squeezed laterally into the continental areas,

and has undergone differentiation, or it has mixed with other magmas, chiefly basic, and then been differentiated.

8. The age and mode of occurrence of alkaline rocks lend support to the Laplacian (Gaseo-Molten) hypothesis of Cosmogony, and seem difficult to explain on the planetesimal hypothesis.

9. It is also suggested that great basic intrusions frequently aided in the refusion and extrusion of alkaline schists and

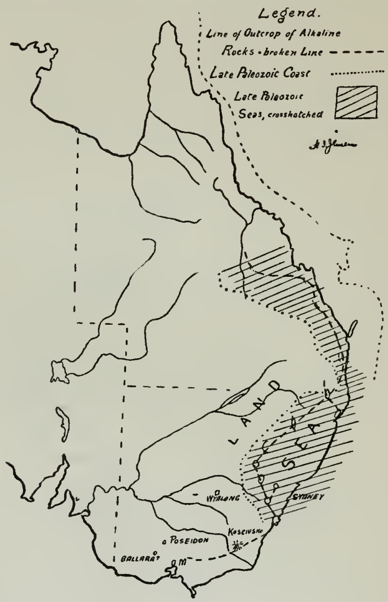

Fig. 11.—Relation of the Line of Outcrop of Alkaline Rocks to the approximate Coast-line in late Palæozioc time (Devonian, Carboniferous, and Permian).

magmas. The crushing of subsiding earth-blocks between passive segments also aided the expulsion.

10. Durocher's view of two principal magmas and Prior's division of lavas into those of the Atlantic and those of the 'Pacific' type have been discussed and have been shown to be favourable to the hypothesis advanced.

11. A review of each alkaline province is given, that of Eastern Australia being given special consideration.

12. Finally it may be stated that the hypothesis suggested, though in the present state of our science incapable of proof, is based on scientific principles and scientific evidence; hence it should be worthy of the consideration of other workers whose aid is solicited in getting further evidence for or against it.

If I have not succeeded in convincing readers of the probability of my suggestions as to the origin of the foyaitic magma, I believe

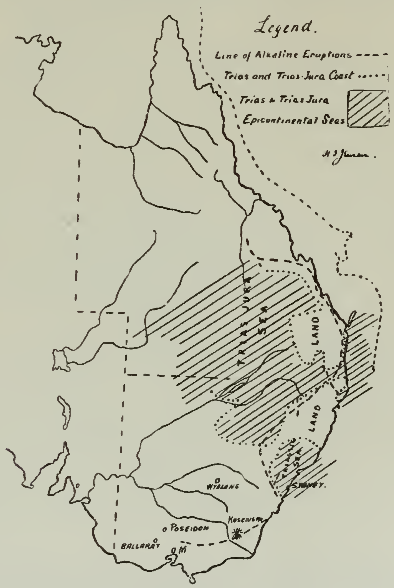

Fig. 12.—Relation of the Direction of Outcrop of Alkaline Rocks to the Triassic and Trias-Jura Coast-line.

that I have in this paper summarised all the main facts of interest and importance to students of alkaline rocks, and pointed out some problems which demand their investigation.

Maps are supplied (figs.10-13) showing the relationship of the trachyte-line to the shore-lines of the Triassic (and Trias-Jura) and Cretaceous seas are appended (figs.12-13), and I have also (in fig. 11) given a sketch showing the distribution of land and sea in Palæozoic times. These maps make it clear that our Australian alkaline rocks occupy, roughly speaking, a position which has been a coast-line or near a coast-line for many geological periods. This line appears to have been a hinge in all the earth-movements since the Palæozoic, and alternately the blocks on the one side or the other of it have been slowly uplifted or depressed.

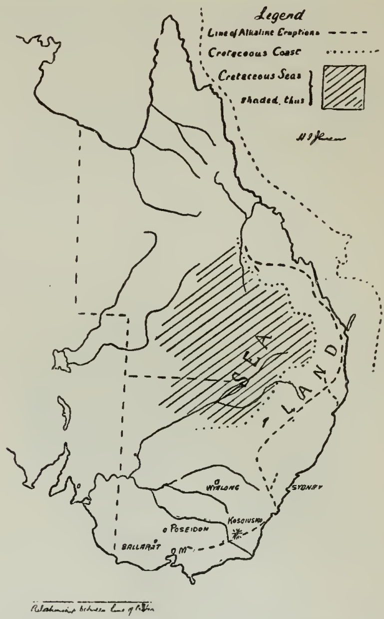

Fig. 13.—Relation of Line of Outcrop of Alkaline Rocks to Cretaceous Coast-line.

It has not been heavily sedimented, but it has been greatly faulted, in the Tertiary periods particularly.

This line is therefore one of the grandest structural features of Australia, and probably contains the key to the solution of many problems in Australian geology.

The text-figures also show that the trachyte-line follows with more exactness, as far as we can tell, the Triassic and Trias-Jura coast-lines than the Cretaceous coast.

THE ALKALINE PETROGRAPHICAL PROVINCE OF EASTERN AUSTRALIA.

By H. I. Jensen, D.Sc., late Linnean Macleay Fellow of the Society in Geology.

In several papers already published* I have discussed the characteristics of the rocks of a number of alkaline areas in Australia. The evidence given in these papers shows that each of the areas constitutes an alkaline province. In the following notes I propose to summarise the features which the alkaline rocks of all these areas have in common, with the view of showing that the whole of Eastern Australia may be looked upon as having constituted an alkaline province in the early Tertiary period.

In addition to rocks with a very high percentage of alkali, I include under the heading of alkaline rocks any intermediate and basic rocks in which the composition of the magma has been such as to allow minerals like nepheline, leucite, sodalite, ægirite, and allied minerals to crystallise out. Such rocks are looked upon as the more basic differentiation-products of an alkaline magma.

The principle that rocks of a given region may be genetically related, as formulated by Judd, has already been accepted by most modern petrologists. It has been applied by Pirsson to the rocks of Central Montana,† and with great success by Washington in his recent work on "The Roman Comagmatic Region."‡

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* These Proceedings, 1905, 1906, 1907.

† Pirsson, L. V., "The Petrological Province of Central Montana." American Journal of Science, Vol.xx. July, 1905.

‡ Carnegie Institution, 1906.

Likewise Lacroix* has pointed out the relationship which exists between the alkaline rocks of Eastern Africa, all the way from Madagascar to the Highlands of Abyssinia.

The tests which are applied to determine consanguinity comprise—(1) Similarity in texture; (2) similarity in mineral composition; and (3) similarity in chemical composition.

Eastern Australia is a large area, and contains a great diversity of igneous rocks of most varied ages of intrusion. It is therefore impossible to apply the term petrographical province to it without qualification. This term can, however, be applied within its strictest sense to a number of areas within Eastern Australia. Thus, the Warrumbungle Mountains described by myself† form a well marked petrographical province; so do the Glass House Mountains, Q., the Nandewar Mountains, and to a smaller extent the Mittagong area, the Macedon area, the Yandina area (E. Moreton and Wide Bay), and the Canoblas (under investigation); I say, in thesecases to a smaller extent, because in addition to comagmatic lavas of alkaline nature, we have basic and acid rocks of totally different ages, and in no wise, as far as can be seen, related to the alkaline rocks.

However, as far as alkaline rocks are concerned, Eastern Australia undoubtedly forms a comagmatic region. The foyaitic rocks throughout the whole extent are related in a number of ways, comprised under the following heads:—(1) They all date from approximately the same period of geological history; (2) they exhibit close textural affinities; (3) they contain the same, or allied minerals; (4) they are very similar in chemical composition.

In other petrological features the eastern side of the Continent also presents a less marked, yet quite noticeable, homogeneity. For example, most of our granites, especially those of Permo-Carboniferous age, are very rich in titanic acid (TiO_2); this feature is not at all confined to our granites, but it characterises

* "Roches alcalines de Prov. Petrograph. d'Ampaindava. Nouv. Arch. du Muséum" 4me. Sér. Vols. i. and v. 1902, 1903.

† Proc. Linn. Soc. N. S. Wales, 1907.

also our basic rocks and the alkaline rocks; analcite and nepheline basalts are by no means rare, and they are in our region generally rich in titanium (*e.g.*, the analcite basalts of the Sydney Basin). An analcite dolerite, very closely related to the Prospect rock, has been recently collected by me near Mumbilla, Q., where it occurs over a considerable area. Further, graphic and micrographic porphyries (diorite-monzonite-porphyries) of late Mesozoic, probably Cretaceous age—in hand-specimen easily taken for granite—occur abundantly in South-east Queensland, and extend, according to Mr. Andrews, into New England. They are commonly called granite.

Another feature which might well be considered petrologically is that sands rich in titanium, zircons, monazite, tin, with various proportions of precious metals, occur all along our coasts, and can be mined with profit. The tin-bearing granites and eurites from Mt. Bischoff in Tasmania right up to Herberton, North Queensland, also are wonderfully alike.

These points will serve to show that the eastern coast of Australia has a totally different origin and geological history from the rest of the Continent, and that it has again and again been affected in its entirety by great processes.

The alkaline rocks are those which are of immediate importance to this paper. Accordingly the following remarks apply specially to them.

A. Distribution of Alkaline Rocks in Eastern Australia.

The localities where these rocks occur and their mode of occurrence has already been described. A summary of localities may be here given with advantage. The more isolated masses of alkaline basalt are omitted.

1. In Tasmania : Regatta Point.

2. In Victoria : Mount Macedon.

2. In New South Wales: The Kiama-Jamberoo area—The Canoblas—The Dubbo group—The Warrumbungles—The Nandewars—And certain alkaline trachyte dykes in the Richmond-Tweed district, referred to by Mr. Carne—Also the Barrigan

tinguaite-laccolites; and the Kosciusko nepheline-ægirine phonolite described by David, Guthrie, and Woolnough.

4. In Queensland : The Little Liverpool Range and Fassifern trachyte lavas—The Mt. Flinders mass—The Glass House Mountains and the Yandina-Coolum area—The Yeppoon Ranges.

It has already been pointed out how all these rocks lie in a definite but somewhat sinuous belt, which only ramifies to a minor extent; and it has been suggested that this belt occupies the position of a long line of fractures. I would further here suggest that these fractures owe their origin to differential movement of uplift and subsidence in adjoining areas, such as gave rise to the elevation of the Blue Mountains (east of the Mittagong-Canoblas-Dubbo line), New England (east of the New England), the Darling Downs (west of the Little Liverpool Range), and the Woodford peneplain (west of the Glass House group).

B. Age of Intrusion.

With the exception of the Regatta Point and Kiama-Jamberoo areas all the alkaline intrusions investigated so far have been shown to belong to the late Cretaceous or early Tertiary eras. Definite fossil evidence fixes the Warrumbungle mass as early Tertiary. In the other districts no such definite evidence has been discovered as yet, but the alkaline rocks have been proved later than Trias or Trias-Jura, as the case may be, and strong probabilities exist that they belong to the same era as the Warrumbungle mass.

C. Textural Evidence of Consanguinity.

(*a*) In most of the areas mentioned an abundant rock-type is a rather acid, very fine-grained, grey, alkaline lava, often exhibiting fine columnar structure. This rock is sometimes orthophyric, sometimes micrograuitic in fabric, and belongs to the Rosenbusch families of comendite and pantellarite. Dyke-varieties of the same rock have been described by me under the same names as the lavas, although I should, strictly speaking, have applied

Osann's name, paisanite, to them. These rocks have a wonderful resemblance from all the localities mentioned. The felspar phenocrysts may be prismatic, but are usually nephilinitoid; the base is microcrystalline to cryptocrystalline, and consists of idiomorphic felspar, mossy (dendritic) aggregates of soda-amphibole, sometimes riebeckite, more often arfvedsonite, and rarely cossyrite, similar feathery aggregates of ægirine and interstitial quartz and chalcedony which frequently form pseudo-spherulitic or star-shaped (strahlenkörnig) aggregates. A micrographic intergrowth of quartz and felspar is frequently seen in the base, and very often little parallel quartz strands in optical continuity exist within the felspar phenocrysts. This feature is very characteristic, and phenocrysts of this type I have occasionally referred to in my papers as micrographic phenocrysts. Intergrowths of albite and orthoclase are also frequent in the phenocrysts, and often the intergrowth becomes so pronounced that a microcline-microperthite is formed, as in many rocks from the Warrumbungles, Nandewars, the Canoblas, and Mount Flinders.

The mossy, dendritic, and feathery aggregates of amphibole and pyroxene, forming what is termed poecilitic (poikilitic) structure, the microperthitic phenocrysts of felspar, and the micrographic and micropoecilitic phenocrysts of felspar are very characteristic features.

(*b*) Next we have the light grey, rather fine-grained trachytes associated with the more acid types mentioned above. These rocks exhibit trachytic fabric, more rarely pilotaxitic fabric. Fluxion-structure is often well marked. The average grain-size is usually coarser than in the more acid types. The phenocrysts consist usually of felspar of the same kinds as mentioned above in the acid types, but phenocrysts of soda-amphibole and other minerals occasionally occur as well. Ægirine or ægirine-augite is usually an abundant constituent, and occurs as small idiomorphic phenocrysts in stunted rods, and as fine acicular microlites. The base is trachytic and contains little or no quartz. Soda-amphibole when present occurs as minute rods and grains, or more rarely as poecilitic (feathery) aggregates.

Such rocks occur in the Glass House Mountains (Beerwah type), the Warrumbungles (Timor Rock type), Mt. Flinders (summit type), &c., &c.

(*c*) Then we have the andesitic and phonolitic types of trachyte. These are of a dark colour, microcrystalline, and aphanitic. Phenocrysts are usually, but not always, present, and may consist of either microperthitic felspar, anorthoclase, pseudoleucite, nosean, biotite (rare), magnetite or pseudobrookite (rare). The groundmass is holocrystalline, but very fine-grained, and has usually a trachytic texture with well marked flow-structure. The common minerals in it are idiomorphic magnetite grains, idiomorphic or hypidiomorphic ægirine or ægirine-augite (as rods or needles), idiomorphic felspar laths and needles, and allotriomorphic interstitial felspar, also allotriomorphic felspathoid (rare). Feathery ægirine aggregates do not often occur, but may sometimes. This rock-type is particularly abundant in the Warrumbungles, but occurs also associated with other types in all the other regions mentioned.

(*d*) *Basic alkaline lavas.*—These rocks do not universally accompany the trachytes, nor do they exhibit very constant textural characters. In the Glass House Mountains proper no basic rocks exist, and those of the Blackall Range adjoining are not distinctly alkaline. In the Mittagong district no definite relationship exists between the basalts and trachytes, and in the Nandewars the affinity is not nearly so marked as in the Warrumbungles. In the last-mentioned region the trachydolerites and more basic rocks are characterised by porphyritic structure, inclusions of coarse dolerite lumps in a finer base, richness in iron and titanium minerals, and a typical pilotaxitic fabric in the base, with often a tendency to ophitic structure.

D. Mineralogical Evidence of Consanguinity.

There are certain minerals which almost invariably occur in the acid and intermediate members of these rocks.

1. One of them is anorthoclase, which may or may not be accompanied by microcline-microperthite. The anorthoclase phenocrysts

in the most acid rocks frequently contain a micropegmatitic intergrowth of quartz. Intergrowths of different minerals in phenocrysts, whether it be quartz in anorthoclase, or albite or orthoclase in anorthoclase, are very characteristic of alkaline rocks. The intergrowth may be either micropegmatitic, micropoikilitic, graphic, or microperthitic. The anorthoclase usually has the glassy clearness and cross-cracks of sanidine, but not infrequently exhibits a shadowy extinction due to ultramicroscopic twinning. This mineral is equally dominant in the comendites (where it has the equant, nephilinitoid habit), the pantellarites (equant, or tabular, or prismatic), the trachytes (tabular and lath-formed), the trachyandesites (tabular and lath-shaped), phonolites (lath-shaped), and trachydolerites (tabular and lath-shaped). It occurs both as phenocrysts and groundmass.

2. Next in importance is ægirine-augite. This mineral occurs as idiomorphic stunted prisms or very fine acicular rods. It is of a greenish colour, but its composition and pleochroism may vary within certain limits. The mineral in some rocks is an ægirine intensely pleochroic in colours varying from bluish-green to bright sea-green, to brownish-green or greenish-yellow. In other rocks it is a feebly pleochroic ægirine-augite which changes from light grass-green to various tones of greenish-yellow or greenish-brown. The extinction angles of the different species differ accordingly.

The ægirine of the Jellore trachyte has been isolated and analysed by Mr. D. Mawson, and has given the following interesting result:—

SiO_2	... 49·49%	MnO	... 0·60%	K_2O	... 0·18%
Al_2O_3	... tr.	CaO	... 3·28	Li_2O	... nil.
Fe_2O_3	... 27·76	MgO	... 0·30	TiO_2	... 1·80
FeO	... 4·71	Na_2O	... 10·10	ZrO_2	... 0·89

3. The acid alkaline rocks usually contain, in addition to ægirine, an alkaline hornblende. Usually this is an arfvedsonite, sometimes by relatively greater abundance of CaO and MgO it passes into barkevicite, and occasionally by the displacement of ferrous iron by ferric it passes into riebeckite. It has already been remarked how the soda-amphibole usually tends to form

patches which have been variously termed poecilitic, ophitic, feathery, mossy, or dendritic.

An analysis of the Bowral arfvedsonite has been made by Mr. D. Mawson, and this type of soda-amphibole appears the most abundant in all the alkaline areas which I have studied.

Perfect crystals are rarely met with; those described by Mr. Mawson in the Gib syenite-pegmatite or bowralite are unique instances.

When barkevicite (the more calcic species) becomes dominant there is a stronger tendency to idiomorphism.

4. Certain minerals of the group rich in rare earths are usually present. The exact species is not always the same. The commonest is laavenite, but wöhlerite, eudialite, rinkite (?), mosandrite (?), &c., also occur. These minerals are frequently very rich in TiO_2, a substance which must also be present in the femic minerals.

5. As other important and frequent accessories one might mention zircon, magnetite, ilmenite, and rutile (occasionally pseudobrookite). Apatite is rarely present.

6. In the more basic rocks plagioclase felspars occur with the anorthoclase, and occasionally felspathoid minerals enter into the composition, such as pseudoleucite, nosean, sodalite, nepheline, &c.

On the whole the character of the felspar of our alkaline rocks is the most constant feature. Everything considered, there can be no doubt that a close genetic resemblance exists between the mineral contents of all the groups of alkaline rocks in Eastern Australia.

E. Order of Consolidation.

In all the Australian alkaline rocks which I have so far investigated, the same order of consolidation of minerals is maintained for each rock-type. The sequence is generally one of decreasing basicity.

In the trachytes, magnetite, when present, was the first mineral to form, and it has always been strongly corroded and resorbed at the edges. It appears as if the magma commenced to crystallise at such depths that the temperature and pressure conditions necessitated the separation of magnetite. On rising to the surface the diminished pressure allowed the chemical affinity of the excess of Na_2O for iron oxides to assert itself, hence the magnetite was strongly attacked and ægirine formed instead.

Shortly after magnetite commenced to form, the phenocrysts of felspar and ægirine-augite commenced to separate, and they continued to grow long after the magnetite had finished crystallising out. Felspar probably commenced to separate so early because of mass-action; the magma consisting essentially of the constituents of felspar, it contained throughout an abundant food-supply for nuclei of this substance; for this reason, too, the felspar crystals grew rapidly. The felspar originally consisted of a soda-rich orthoclase, containing about equal molecular proportions of soda and potash. This mineral is stable under high pressure such as obtains at great depths, but on diminution of pressure it tends to split up into soda-orthoclase and albite. As the magma rose to higher levels this change took place in the felspars, and the diminution in pressure further caused a pause in crystallisation during which the phenocrysts tended to become corroded and resorbed, especially on the edges. In this way arose the break between the period of the formation of phenocrysts and that of the consolidation of the base. This break is generally, but not always, well marked, the rocks being occasionally serial-porphyritic. The change which the felspars underwent on rising to higher levels led to the formation of microcline microperthite, microcline cryptoperthite, moirée microcline, and anorthoclase (in which multiple twinning is only hinted at by the shadowy extinction). These soda-felspars are almost universally dominant in the generation of phenocrysts.

The formation of ægirine and ægirine-augite phenocrysts commenced early, shortly after the commencement of the separation of felspar. They grew less rapidly than the felspar. The presence of nuclei of common augite in the magma, or rubbing against augite rocks in the walls of the magmatic reservoir probably induced the isomorphous form ægirine to commence to separate at an early period. The ægirine phenocrysts are much more perfect than those of felspar, and are seldom corroded to any marked extent. This is because the mineral combination within them did not tend to become unstable on diminution of pressure.

The curious feature about the soda-pyroxenes and soda-amphibole of these rocks is that they commenced to form early, but they continued to separate out right up to the very last phase in consolidation. Hence the last products of solidification are the curious feathery and mossy poikilitic aggregates of felspar with ægirine-augite or arfvedsonite.

The simultaneous formation of felspar and ægirine is probably due to the presence of nuclei and crystals of these minerals formed for the reasons already given. Their presence would prevent overcooling, and lead to the continuous separation of these two minerals as long as the necessary chemical constituents existed in the magma. As the felspar, by virtue of mass-action, consolidated more rapidly than the ægirine, there was a tendency for the magma to become enriched in the pyroxenic constituent, and for a eutectic mixture of these minerals to form in the last phase of consolidation. Their presence as phenocrysts prevented overcooling of the eutectic so that finally, when the temperature fell low enough, they both crystallised out together as a crystalline intergrowth. These points, too, explain the rarity of glass in the alkaline trachytes. Glasses only occur where the lava is suddenly cooled and greatly mixed up with breccias. Interstitial glasses are also comparatively rare, and represent the suddenly cooled eutectic mixture of ægirine and felspar, the final aggregates of which are usually wanting in hypocrystalline lavas.

The presence of water and of mineralisers like HF, HCl, ZrO_2 and TiO_2 probably also assisted in maintaining a kind of eutectic relationship between the felspar and the ægirine.

When nosean and pseudoleucite are present, they commenced to form in the interval between the formation of the phenocrysts and the consolidation of the base. In some of the rocks of a less felspathic and more basic type-nosean continued to cool up to the last. Both these minerals are, however, usually idiomorphic in the alkaline trachytes and are generally represented by pseudomorphs.

Many of these rocks show evidences of having originally contained idiomorphic nepheline which has been resorbed. Katapleiite and, less frequently, cancrinite are met with in some melanocratic trachytes. Nepheline probably exists in very minute amount in the groundmass of many.

At great depths (in the magmatic reservoirs), it seems probable, the magma tended to consolidate into magnetite, microcline microperthite, nepheline, ægirine ($SiO_2 = 49 \cdot 5\,\%$). On rising to higher levels new combinations tended to form; the nepheline became albite in part, and the magnetite went to form arfvedsonite or an ægirine-augite equivalent to arfvedsonite (SiO_2 44·0 %) with the rest of the nepheline molecule.

The addition of the SiO_2 and Na_2O necessary for this transformation is best ascribed to the agency of mineralising vapours, especially HF, which brought SiO_2 and Na_2O from portions of the magma, where they were abundant, to places where they were deficient, as by the following equation :—

$$2\,NaF + 5\,SiF_4 + 11\,H_2O + \underset{\text{magnetite}}{FeO.Fe_2O_3} = 22\,HF + \underset{\text{riebeckite}}{Na_2O.Fe_2O_3.4\,SiO_2.FeO.SiO_2}$$

These vapours would likewise account for nepheline being changed into albite; thus—

$$\underset{\text{nepheline}}{Na_2O.Al_2O_3.4\,SiO_2} + 2\,SiF_4 + 4\,H_2O = 8\,HF + \underset{\text{albite}}{Na_2O.Al_2O_3.6\,SiO_2}$$

The vapours would play an important function as silica-carriers between the magma and the enclosing rock, and in that way tend to increase its acidity as it rose from deep-seated reservoirs to the surface.

Biotite was also an original constituent of many alkaline trachytes. It is occasionally seen included in the felspar phenocrysts. If not protected in this way, it has generally been resorbed.

The importance of mineralisers in giving to the alkaline trachytes and comendites their special characters cannot be overlooked. To them it is largely due that the whole ground-mass has been enabled to crystallise out; they, too, have filled interstices and miarolitic cavities with opal and chalcedony. Pneumatolytic minerals are of frequent occurrence, filling interstices, such as fluorspar, topaz, wöhlerite, laavenite, etc.; and in this connection it must be remembered that arfvedsonite and riebeckite themselves are of pneumatolytic origin, Murgogi considering HF essential for their production. Perhaps the best evidence of the action of pneumatolytic agents is seen in some hæmatite trachytes and comendites, which consolidated as alkali-amphibole rocks, but circulating vapours immediately after consolidation broke up the arfvedsonite (or riebeckite) molecule, oxidising its FeO to Fe_2O_3 and removing its Na_2O and SiO_2 to other parts of the rock, where, with magnetite, they formed ægirine, and, with titanite, they gave wöhlerite.

In some cases the same mineralising agents have restored some of the soda and silica to the hæmatite, forming round it a rim of ægirine and riebeckite. Instances of these occurrences have been given by me in former papers.

In all these cases the hæmatite is distinctly pseudomorphous after alkali-hornblende, and this fact, in conjunction with the freshness of the rock in the cases specially described, shows that the occurrence is due to pneumatolysis just after consolidation, and not to weathering.

The other facts concerning the consolidation of the alkaline rocks of Australia are essentially the same as those which obtain in other igneous rocks; and, being well known, they need not be specially discussed here.

The frequent parallel lamellæ of crystalline quartz in anorthoclase phenocrysts of comendites (micrographic phenocrysts) may also have been formed by these mineralising vapours acting along solution-planes.

F. Chemical Evidences of Genetic Relationship.

I have, in previous papers, given analyses of trachytic rocks from the various alkaline areas of Australia. A comparison of these analyses and of those of their basic associates is invited.

The points of affinity which are most apparent in the chemical constitution of all the Australian alkaline rocks may be summarised as follows :—

1. They are invariably very rich in alkali.

2. Soda and potash occur in about equal molecular proportions, sometimes one, sometimes the other slightly preponderating in amount. The effect of nearly equal proportions of these two radicals is to produce anorthoclase, with the slight excess of soda going into the ægirine.

3. Lime and magnesia are very deficient, particularly the latter. This applies to the acid, intermediate, and basic rocks alike. In the more basic rock-types lime, of course, increases in amount, but is low for the silica-percentage, and magnesia is still lower proportionately. This statement, however, does not apply to lamprophyric (monchiquite) dyke-rocks.

4. The iron oxides vary inversely with the basicity, and our alkaline rocks are all characterised by a high iron-percentage for their basicity. The ferrous and ferric oxides occur in nearly equal proportions in most cases, the higher oxide preponderating in the ægirine rocks.

5. Titanium dioxide is rather high in all varieties, increasing in amount with increase of basicity of the rock. Phosphoric anhydride is correspondingly low. Zirconia is very frequently present.

6. Increase of CaO affects the character of the pyroxene only, unless the rock be moderately or very rich in CaO.

7. Al_2O_3 is high, as is to be expected from the abundance of felspar.

8. In the Queensland areas there is a distinct tendency for Fe_2O_3 to greatly exceed FeO in amount. This is ascribed to—(1) Riebeckite and ægirine primarily dominating over arfvedsonite. (2) Fe_2O_3 has separated as hæmatite and limonite by

the decomposition of the Alferric minerals, decomposition having penetrated more deeply than in the dry and arid west.

The facts above summarised tend to show that the alkaline areas of Eastern Australia have great resemblance to one another, and probably the same origin.

Rocks Associated with the Alkaline Rocks.

(a) Dacites, dacitic tuffs and breccias occur in the following areas—The Glass House Mountains, Yandina, Mt. Flinders, Mt. Macedon.

(b) Basalts occur universally near to or capping the trachytes, and they are of later age.

(c) Andesites occur at Yandina, The Canoblas, Mt. Macedon, and the Nandewars.

(d) Trachy-andesites are abundant in the Warrumbungle and Fassifern alkaline areas, and rare in the Nandewars and East Moreton-Wide Bay. This rock-type is purely a differentiation-product of the same magma.

(e) Earlier basic rocks occur as—i. Essexite at Mittagong and in the Nandewars; ii. analcite-dolerite (or gabbro) in the Fassifern; iii. monzonitic porphyrite in the Wide Bay district.

The rocks mentioned in (a), (b), (c), and (e) are only sometimes differentiation-products of the alkaline magma.

The foregoing notes, I think, fairly conclusively prove that Eastern Australia forms an alkaline petrological province, and in addition a titanium-rich province.

SOME SYDNEY DESMIDS.

By G. I. Playfair.

(Plates xi.-xiii.)

With one or two exceptions the Desmids described in this paper were obtained from the suburbs of Sydney. Of those mentioned, five are believed to be new species, and thirty-six distinct varieties or new forms of others. Since my last notes were published, several papers have come into my possession which I had previously only been able to glance over. A thorough perusal of these has necessitated some rearrangement of forms previously named; this has been attended to in the text. The numbers found in most cases against the localities refer to samples of gatherings preserved in the National Herbarium, Botanic Gardens, Sydney.

The locality referred to as Coogee is noteworthy as being a small tract of Sphagnum bog, the only one that has come under my notice as yet. As these bogs generally have a distinctive Desmid-flora of their own, a list of the species commonly associated there may perhaps be interesting to workers in other lands. One of the most abundant is *Cos. glyptodermum* West & West, known hitherto only from East and Central Africa, and with it are generally *Cos. turgidum*, *Cos. amplum*, *Cos. Boeckii* vars., *Cos. quadrifarium* f. *hexasticha*, *Cos. reniforme* β *compressum*, *Cos. validius*, *Pl. crenulatum*, *Pl. ovatum*, *Pen. australe*, *Pen. libellula*, *Pen. digitus*, *Pen. spirostriolatum*, *Eu. dideltoides*, *Eu. sinuosum* vars., *Micr. truncata* vars., *Micr. papillifera* vars., *Micr. euastroides* β *indivisa*, *Cl. Delpontei* vars., *Cl. nematodes* var., *Cl. Dianæ*, *St. submonticulosum* vars., *St. alternans.* In the late autumn, April and May, a large assortment of these may be found in quantities, sometimes even forming a pure gelatinous crust on the surface of the water. More spasmodic in their appearance are *Tetm. laevis*, *Tetm. Brebissonii*, *Xan. Coogeanum*, *Cl. striolatum*, *Cl. Cynthia*, *Cl. lunula*, *Cl. praelongum* var., *Spiro. obscura*, *Sp. condensata*, *Pl. nodosum*, *Pen. cucurbita*, *Pen. navicula*, *Cos. tinctum*, *Cos. orthopunctulatum*, *Cos. pseudo-pyramidatum* vars., *Cos. mesoleium*, *Cos. amoenum* vars., *Cos. subspeciosum*, and *Hyal. hians*.

Genus Closterium Nitzsch.

Cl. lanceolatum Kütz. β coloratum (Klebs). (Pl.xi., fig.1).

Cl. lunula β coloratum Klebs, ex parte, Desm. Ostpreuss. T.i., f.1c,d.

Forma, a fronte visa, ventre omnino plana, apicibus subtruncatis interdum paullulo reflexis. A latere late-fusiformis, apicibus subtruncatis; ex obliquo ut a cl. Ralfs, T.28, f.1b, delineata sed apicibus subtruncatis. Endochroma in laminas longitudinales circ. 10-12 ordinata, nucleis amylaceis 5-6 in quâque semicellula in seriem unicam dispositis. Membrana achroa vel luteola.

Long. 162-270; lat. 25-45; crass. ad 44μ.

Coogee, Centennial Park (71).

If the amylaceous nuclei are allowed to have any weight at all in determining the species, this form should be arranged under *Cl. lanceolatum* rather than with *Cl. lunula*. Klebs, *l.c.* p.6, has evidently mixed up *a typicum* and *β coloratum* in the dimensions. According to his notes, those with one series of nuclei range from 145 × 20 to 286 × 41, and those with several series from 256 × 44 to 555 × 88, in each case the usual doubling in size. Nordstedt records this form from New Zealand at about the higher figure. The three specimens I have seen at different times also give a range in size approximating to that of Klebs for *β coloratum*. Ends subtruncate, not pointed. Cells fusiform in side-view, and in three-quarter face exactly the shape of *Cl. lanceolatum* as figured by Ralfs in Brit. Desm. T.28, f.1b, but with subtruncate tips.

Cl. lunula Ehr. β giganteum (Bernard). (Plate xi., fig.2).

Cl. giganteum Bernard, Protococc. et Desm., Pl. iii., fig.71,

Forma maxima, *ab omni latere visa* fusiformis. Semicellulæ conicæ, sensim sensimque a sutura attenuatæ lateribus levissime convexis fere rectis, apicibus obtusis rotundato-truncatis. Membrana achroa glabra. Endochroma in laminas longitudinales 18 (visis 9-10) ordinata, zona mediana pellucida instructa et vesiculis terminalibus, nucleis amylaceis permultis diffusis.

Long. 650-1040; lat. 115-145μ.

Auburn (10, 21).

Gathered out of some heads of weed from a small pool at Auburn in great quantity. The shape is as if two fool's caps had been joined together at the rims. The dimensions have the same range as those given by Nordstedt for New Zealand specimens of *a typicum*. Judging by the figures of Ralfs, Klebs, and Cooke, our forms of *Cl. lunula* differ a little from European specimens in always having the extreme ends subtruncate and not pointed. Before seeing Bernard's work I had this form arranged as β *fusiforme* of *Cl. lunula,* to which species I would certainly refer his *Cl. giganteum.*

Cl. praelongum var strigosum (Bréb.)(?). (Plate xi., fig.3).

Cl. angustum, elongatum, leniter curvatum, dorso modice convexo, ventre subrecto, sciagraphiâ ad *Cl. lineatum* accedente. Semicellulæ gradatim attenuatæ, ad polos versus rapide angustatæ et leviter dejectæ, apicibus truncatis subacutis, nonnunquam levissime reflexis. Membrana glabra, aequaliter dilute rufescens, striis nullis, suturis evidentibus nonnunquam 2-3. Endochroma in laminas longitudinales 6 disposita, nucleis amylaceis 15-16 in quâque semicellula, vesiculo centrali circulari, terminalibus minimis.

Long. 375-516; lat. 16-24; lat. apic. circ. 6; alt. ad dors. 42μ.

Auburn (10, 16), Coogee (4, 13).

I have not access to Brébisson's work, but the shape and size answer very well to those given by Delponte (p.205, T.18, f.3) for

Cl. strigosum. I give, above, a description of this form which is about the same size as *Cl. lineatum*, and somewhat resembles it in shape. This is not striate, however, and only faintly rufescent. More mature forms are more evenly attenuated and curve more regularly towards the tips which are then very slightly reflexed. A semicell of one in Mount No.16,B., measures 396μ, giving a possible length for the mature cell of nearly 800μ. These forms are probably identical with Nordstedt's *Cl. praelongum* f. *brevior*, Frw. Alg. N.Z., T.3, f.22-24, some specimens of which, he says, approach *Cl. strigosum* in shape (*l.c.* p.68). It is possible therefore that *Cl. strigosum* is a young form of *Cl. praelongum.*

Cl. Delpontei Wolle, Bull. Torr. Bot. Club, xii. 1885, p.2.

Cl. crassum Delp., Desm. subalp. T.18, f.22-30; = *Cl. lineatum* β *Sandvichense* Nord., Alg. et Char. Sandv. T.1, f.10-12.

Forma typica :—crassa, plerumque dorso arcuata. Zygospora globosa glabra.

Long. 420-696; lat. 39-48; lat. apic. 9, zygo. diam. 70-80μ.

Botany (51); Centennial Park (71); Coogee. (4, 13); Auburn (16); Guildford.

Var. rectum, mihi; = *Cl. lineatum* Ehr., forma, Börgesen, Desm. Braz. Cent. T.2, f.4.

Forma angustior, plerumque in medio recta, ad var. *elongatum* West & West (Frw. Alg. Ceylon, T.18, f.20), valde accedens sed diametro duplo major.

Long. 450-756; lat. 22-34; lat. apic. 5½-9μ.

Cum priori rarius (4, 15, 16); solum, Duck Creek, Auburn (74).

Raciborski (Desm. Ciast. p.9) gives 420 × 22, lat. subap. 7, as the size of a Sydney specimen; and Börgesen, *l.c.* p.934, has 650 × 29. I have found specimens of f. *typica* and var. *rectum* at Auburn with an almost colourless membrane but still finely striate. Mount No.16.

Var. elongatum West & West, *l.c.* forma. (Plate xi., fig.4).

Forma in sciagraphiæ simillima, sed striis nullis, membrana interdum sparse scrobiculata, apicibus paullulo dilatatis et incrassatis. Endochroma tantum non ad summos apices patet.

Long. 198-420; lat. 13-18; lat. apic. $3\frac{1}{2}$-5μ.

Botany (17), Centennial Park (6), Coogee (4, 13).

These three forms are quite distinct. The last is not uncommon in localities where the type is found, but on no specimen have I ever seen the slightest trace of striæ. It is not too much like West & West's figure, which more resembles var. *rectum*, but I do not see what else it can be.

Genus Penium, Bréb.

Pen. spirostriolatum Barker. (Plate xi., fig.5).

Pen. margaritaceum γ punctata Ralfs, p.149; = *Pen. margaritaceum β elongatum* Klebs, ex parte, Desm. Ostpreuss. T.2,f.18a,b; = *Pen. gracillimum* Playf. (Proc. Linn. Soc. N. S. Wales, 1907, p.168) sec. G. S. West in Nord., Index Desm. app. p.64.

Endochroma semper in partes 4 transverse divisa, in laminas longitudinales angustissimas 8-10 (visis 5-6) disposita, nucleis amylaceis 6 in quâque semicellula.

Long. 90-190; lat. $12\frac{1}{2}$-18μ.

Coogee (4,13), Botany.

This desmid is fairly common here, but none that I have seen have had the striæ arranged spirally. It would appear, however, that they rarely are. They seem to be rows of scrobiculæ or excavations close together upon the inner surface of the membrane, or coalesced together to form a groove. I am supplying another figure, that (as *Pen. gracillimum*) given before not being typical. The marginal denticulations are not always present. The semicell is divided up very often by a number of sutures, and the denticulations sometimes present are caused by incrassation of the cell-wall at one or more of these. The membrane is only rufescent when old, and then very slightly. However many sutures or pyrenoids there may be, the endochrome is always interrupted in the middle of the semicell, though not generally so plainly as in Klebs' figure. This fact is mentioned by Ralfs, *l.c.*, but his statement that the endochrome has no longitudinal fillets is not correct.

Genus Micrasterias Agardh.

MICR. TRUNCATA (Corda) Bréb., var. AUSTRALICA, n.var. (Plate xi. fig.6).

Forma lobulis lateralibus truncatis non inciso-dentatis, dentibus ubique nondum perfecte evolutis, lobis apicalibus primo utrinque dentibus singulis, tum bidentatis.

Long. 140-144; lat. 126-135; crass. 44μ.

Coogee.

Cf. Wolle, T.38, f 6; Delponte, T. 5, f.10; Ralfs, T.10, f 5b; and Borge, Alg. Regnell. T.5, f.18.

Var. DECEMDENTATA (?= *Micr. decemdentata* Näg., Gatt. Einz. Alg. T.6, f.2).

Long. 88-120; lat. 90-126; crass. 40μ.

Auburn (12), Collector, Botany, Coogee (4, 13).

Var. LATICIPIFORMIS, n.var. (Plate xi., figs.8-9).

Forma ad *Micr. laticipem* Nord., (Desm. Braz. Cent. T.2, f.14) valde accedens.

Long. 102-108; lat. 108-115; crass. 40μ.

Collector, Fairfield (84).

Var. *laticipiformis* and var. *decemdentata* are both stages of growth. I do not feel certain whether the latter should be considered as identical with *Micr. decemdentata* Näg. Nägeli gives diam. 40, Delponte and Lundell 50, ours are 90-126μ. Wolle indeed quotes American forms at diam. 83-110, but the illustrations he gives, T.33, f.5-6, show that his specimens belong to *Micr. truncata* var. *decemdentata* mihi, and not to Nägeli's plant, unless they are one and the same. An excellent specimen of β *Upsaliensis* Cleve (Lund. T.1, f.7), which I have figured in my notes, measures 88 × 110, but Lundell gives 52 × 52μ.

Genus Euastrum Ehr.

EU. QUADRATUM Nord., Desm Braz. Cent. T.2, f.10; subsp. INERMIUS Nord., var. PERORNATUM, n.var. (Plate xii., fig.1).

Forma major, paullo profundius incisa, lobis intermediis multo (lobo apicali paribus) productis, spinis marginalibus acutioribus, tumore supra isthmum majore, verrucis circ. 24 (15, 8, 1) ornato. Lobi basales verrucis magnis quadratis verticaliter 2, 3, 2 (horizontaliter etiam) juxta tumorem dispositis, et granulis minoribus, ornati. Membrana ipsa glabra.

Long. 70-74; lat. 70-73; lat. lob. pol. 21-24; crass, 39μ.

Sydney Water-supply (22).

Cf. Nordstedt, De Algis et Charac. T.1.

I have found some difficulty in placing this form, which is evidently fully developed. In general outline it is certainly nearest to *Eu. verrucosum* β *Wallichianum* Turn., Alg. E. Ind. T.11, f.9, but it is ruled out of any connection with *Eu. verrucosum* by its smooth membrane. In comparing Nordstedt's figures, *l.c.* T.1, it seems apparent that f.17 (*inermius*) much more resembles f.15 (*Eu. quadratum* β *javanicum*) than it does f.16, or *Eu. spinulosum* Delp. The shape of the polar lobes is quite different, and the general character of the markings much coarser than in Delponte's plant or in subsp. *africanum.* There is nothing in the size or the end-view to prevent *inermius* from being regarded as a subsp. of *Eu. quadratum* β *javanicum*, and this is made more probable by the fact that both are Javanese plants from the same gathering—"Java, in *Utricularia flexuosa* (herb. Blume)" in each case, *l.c.* p.9-10.

Since writing the above, in a sample from the same source I have come across a single clean semicell belonging to this species, and intermediate in character between β *javanicum* and subsp. *inermius.* This I will name

Eu. quadratum Nord. var. intermedium, n.var.

Semicellulæ profunde ut in subsp. *inermius* incisæ, lobis autem in sciagraphiâ β *javanico* congruentibus.

Long. *semicell* 42; lat. 72; lat. lob. pol. 28; crass. 42μ; basis lob. pol. 25μ supra isthmum; lat. ad constrict. supra lob. basal. 45μ.

The life-history of this interesting plant seems to run thus:—(1) *Eu. quadratum* Nord.; (2) β *javanicum* Nord.; (3) var. *intermedium* mihi; (4) subsp. *inermius* (Nord.); (5) var. *ornatum*

(Borge) mihi (= *Eu. spinulosum* var. *ornatum* Borge, in Bail. Bot. Bull. xv. T.13, f.13; (6) var. *perornatum* mihi, the fully developed form. *Cf.* also *Eu. divergens* Josh , Burm. Desm. T.23, f.8,9.

EU. TURGIDUM Wall. var. MOEBII mihi.

Eu. verrucosum forma, Möbius, Austral. Süssw. ii. T.2, f.21; = *Micr. Möbii* West & West., Desm. Singapore, p.162; = *Eu. verrucosum* Ehr., var. *Möbii* Borge, Austral. Süss. Chlor. T.2, f.18, 19.

Endochroma in laminas parietales 4 ordinata. Nuclei amylacei 8 in quâque semicellula ad bases processuum positi.

Long. 110-150; lat. 108-120; lat. lob. pol. 72-102; lat. coll. 60-72; lat. isth. 40-48; crass. 66-84μ.

Auburn (56, 59, 67), Guildford, Fairfield.

In 'Desmids from Singapore,' 1894, West & G. S. West described and figured a plant to which they gave the name *Micr. Möbii* var. *Ridleyi*, considering it a variation of *Micr. Möbii* West & West (= *Eu. verrucosum* Möb., *supra*). It seems to me certain that, whether a Micrasterias or a Euastrum, their plant is specifically identical with *Eu. turgidum* Wall., in Turn. Alg. E. Ind. T.10, f.28; and with *Eu. turgidum* (*verrucosum*) var. *crux australis* Rac., in Desm. Ciast. T.2, f.26. This connection, the following considerations will, I think, show. Compare West & West, f.2b, with Turner, f.28c, and Rac. f.26c, right figure; and West & West, f.2c, with Turner, f.28b.

The slight dissimilarity in front-view is not sufficient to make up for the decided agreement in end-view. It is true that Turner's figures would perhaps make *Eu. turgidum* verrucose, but the difference between verrucose and scrobiculate membranes has not always been noticed. Raciborski's figures also are not above reproach, both front-views being evidently tilted; but the likeness to *Eu. turgidum* is quite recognisable, and is indeed commented on in the text. Without doubt his plant and that from Singapore should at least be *Eu. turgidum* Wall., var. *crux australis* (Rac.) and *Eu. turgidum* Wall , var. *Ridleyi* (West & West), respectively, even if var. *Ridleyi* be not regarded as a form of *crux australis*. In size they tally fairly well also, and the agreement of West & West's figures with those given by Raciborski is marked: Turner—long. 120-135; lat. 80-97; crass. 44-50; lat. apic. 50-56. Raciborski—long. 120-130; lat. 105-125; crass. 55-65; lat. apic. 57-77. West & West—long. 135; lat. 102; crass. 57; lat. apic. 76.

I cannot see any particular reason for placing Möbius' plant or any of these forms under *Micrasterias*. Generally speaking, the membrane in that genus is delicate, and at most puncto-granulate or slightly scrobiculate. It is in *Euastrum* and *Cosmarium* that we meet with the strongly verrucose or scrobiculate membranes and tumours. The rugged character of the membrane, and the scrobiculate or verrucose tumour in these desmids should, I think, create a presupposition in favour of their being Euastra. Other points are the great thickness of the cell in end-view, and the disposal of the endochrome in four parietal plates, which link them to such forms as *Cos. amplum*, *Cos. magnificum*, *Cos. tholiforme*, etc.

Var. Auburnense, n.var. (Plate xii., fig.2).

Forma paullo major, sinu apertiore, lobo polari truncato, angulis granulatis, sinu inter lobos apertiore acutangulato, supra isthmum tumore magno scrobiculato, scrobiculis plus minus in quincuncem dispositis ornato. Lobi laterales angustiores extrorsum attenuati, apicibus bifidis sed minime incisis, margines versus granulati, tumoribus minimis geminatis binis (et tumore unico introrsum) instructis. A vertice semicellulæ ellipticæ in medio latæ, utrinque tumore scrobiculato instructæ, polos versus acuminatæ, apicibus obtusis, prope apices tumoribus minimis binis utrinque projicientibus. Lobus polaris angustissimus, apicibus non bifidis. A latere semicellulæ pyriformes, a tumoribus ad apices rapide attenuatæ, apicibus obtusis.

Long. 132-168; lat. 116-144; lat. lob. pol. 96-108; lat. coll. 70-84; lat. isth. 40-48; crass. 72-76μ.

Auburn (47).

This form has the polar lobe undeveloped, compared with the rest of the cell. I consider it an *occasional* variation, intermediate in character between var. *Grunovii* and var. *crux australis*.

Var. CRUX AUSTRALIS (Rac.) mihi. (Plate xii., fig.4).

Eu. verrucosum var. *crux australis* Rac., Desm. Ciast. T.2, f.26, fig. sinistr.

Membrana, ut semper in *Eu. turgido*, grosse scrobiculata. Endochroma in laminas 4 disposita.

Long. 138-174; lat. 111-138; crass. 78-96; lat. isth. 42-48; lat. lob. pol. 73-114; crass. lob. pol. 36; lat. coll. 72-96μ.

Auburn (7, 10, 21, 68), Guildford (78).

Var. GRUNOVII Turn. formæ. (Plate xii., fig.3).

Lobi polares a vertice visi non bifidi. Endochroma atque nuclei amylacei ut in var. *Möbii* supra.

Long. 120-142; lat. 102-126; lat. lob. pol. 69-90; lat. coll. 58-72; lat. isth. 42-48; crass. 78μ.

Auburn (68), Fairfield (79).

Grunow's figure in Desm. Insel Banka, T.2, f.22, works out at long. 140, lat. 108, lat. lob. pol. 72, lat. coll. 52μ.

Var. SIMPLEX, n.var.

Forma ad *Eu. verrucosum* var. *simplex* Josh (in Turn., Alg. E. Ind. T.11, f.9*) accedens sed sinu aperto; lateribus late-rotundatis granulis paucis ornatis; lobo polari plano, indiviso, minime producto; tumore basali minore.

Long. *semicell.* 54; lat. 102; lat. lob. pol. 54; lat. isth. 42μ.

Guildford (78).

The life-history of *Eu. turgidum* Wall., as known here, runs as follows :—

(1) Var. *simplex* mihi; (2) var. *Auburnense* mihi; (3) var. *crux australis* (Rac.); (4) var. *Ridleyi* West & West (intermediate lobes undivided); (5) var. *crux australis* f. *evoluta* (Rac.) or *Eu. turgidum* Wall., as in Turn. *l.c* T.10, f.28 (intermediate lobes bifid); (6) var. *Möbii* mihi, vide Bail. Bot. Bull. xv. T.13, f.12.

Genus Cosmarium Corda.

Cos. submammilliferum West & West β quadrigemme mihi.

Cos. quadrigemme n.sp., in Proc. Linn. Soc. N. S. Wales, 1907, p.193.

Compare West & West, Journ Bot. xxxv. T.368, f.8.

This species is only known besides from South Africa.

Cos. rectangulare Grun. var. nodulatum, n.var. (Plate xii., fig.5).

Major quam forma typica. Semicellulæ lateribus e basi rectis paullo divergentibus; angulis basalibus fere rectis interdum acuminatis et subdentatis; angulis lateralibus obtusis, apicalibus in tumores parvos, glabros, humiles, rotundatos, singulos productis. A vertice semicellulæ latissime-ellipticæ, apicibus acuminatis rotundatis. A latere semicellulæ subcirculares latiores quam longæ, sursum tumoribus singulis projicientibus. Membrana achroa glabra, grosse punctata, ad angulos basales incrassata ut videtur. Nuclei amylacei bini.

Long. 54-62; lat. 40-44; crass. 30-36μ.

Auburn, Guildford (23, 45, 60), cum forma typica.

The tumours are on the midline of the apex; there are therefore only two to each semicell. With this form compare *Cos. repandum* Nord., Frw. Alg. N. Z. T.6, f.14; *Cos. pseudoprotuberans* Kirch., in Wille, Norges Fersk. T.1, f.18, and β *angustius* Nord., *l.c.* T.6, f.15,16; also *Cos. rectangulare* Grun.(= *Cos. Gothlandicum* Wittr., Gotlands Sötv. T.4, f.14).

Var. Boldtii mihi.

Cos. rectangulare, forma, Boldt., Desm. Grönl. T.1, f.18.

Semicellulæ a vertice visæ late-ovales, apicibus latissime rotundatis, utrinque in medio levissime angulatæ.

Long. 44; lat. 36; crass. 24μ.

This form undoubtedly belongs here, and not to *Cos. subrectangulare* Gutw., Fl. ok. Tarn. T.3, f.23.

Var. QUADRIGEMINATUM, n.var.

Paullo minus quam var. *nodulatum*. Semicellulæ angulis basalibus minus acuminatis minus incrassatis, apicibus paullo productis, nodulis prominentibus. A latere visæ subglobosæ, apicibus paullo productis, nodulis binis.

Long. 45; lat. 34-36; crass. 25; lat. apic., a fronte 15, a latere 14μ.

Guildford (60), cum priori.

The fully developed form certainly has only two nodules to the semicell; var. *quadrigeminatum* seems to be a variation occasionally produced, as I have noted, at division. The opposite nodules (in side-view) coalesce later, and the produced apex disappears. This shows that a desmid is not limited to one plan of development.

Cos. DIFFICILLIMUM, n.sp. (Plate xiii., fig.5).

Cos. parvum, oblongum, medio sinu lineari profunde constrictum. Semicellulæ subquadratæ vel subhexagonæ latissimæ infra apices, angulis omnibus rotundatis; lateribus e basi levissime divergentibus, apicibus late-arcuatis plus minus truncatis, foveis apicalibus singulis instructis; seriebus 3 punctorum ornatæ:—punctis apicalibus 4, exterioribus in cytioderma; medianis in centro 4 et utrinque 2 paullo superne, exterioribus in cytioderma; basalibus 4, utrinque ad isthmum 1, juxta margines 1. A latere semicellulæ oblongæ, lateribus parallelis, apicibus rotundatis, punctis apicalibus 3, medianis 3 in triangulum ordinatis (nonnunquam 5 divergentibus visis), basalibus 2, ornatæ. A vertice late-ellipticæ, apicibus late-rotundatis, in medio foveis incrassatis 2 et punctis 6 concentrice ordinatis, ad polos punctis singulis. Membrana achroa, glabra, crassa.

Long. 33-36; lat. 21; crass. 13μ.

Auburn (26), Botany (37).

This species is a member of a small group of four characterised by puncta variously arranged. In size it agrees with *Cos. difficile* Lütk., Desm Oberösterr. T.8, f.4, but differs so much from it in front-, side- and end-views, as well as in the number and arrangement of the puncta, that I have not felt able to place it under that species. *Cf.* also *Cos. binerve* Lund., Desm. Suec. T.3,f. 19; and *Cos. zonatum* Lund., *l.c.* T.3, f.18. The puncta are all exceedingly faint. In young forms the semicells are all simply oblong, and the puncta sometimes wanting. As the plant matures, the apex broadens and the ends tend to become angular.

Cos. PUNCTULATUM Bréb.

Long. 22-28; lat. 20-24. Nuclei amylacei singuli.

Botany (17), Guildford (23), Centennial Park (11).

Cos. MESOLEIUM (Rac.) mihi. (Plate xiii., fig.1).

Cos. punctulatum Bréb., subsp. *mesoleium* Rac., Desm. Nowe, p.15, T.1, f.27.

Forma ADULTA, n.f.

Paullo major. Semicellulæ medio non laeves, ubique irregulariter granulatæ, granulis parvis, lateribus granulis 8-10, dorso 4-5, supra basin serie granulorum nulla. A vertice visæ ellipticæ, levissime tumidæ. Cetera ut in forma typica. Nuclei amylacei bini.

Long. 40-56; lat. 30-45; crass. 22-24μ.

Auburn, Botany (37), Collector, Centennial Park, Coogee (13)

Forma ASPERRIMA, n.f. (Plate xiii., fig.2).

Forma granulis incrassatis, marginibus lateralibus 6-10 instructis, cetera ut in forma *adulta*. Nuclei amylacei bini.

Long. 40-42; lat. 34-36μ.

Botany (37), Centennial Park.

Var. RHOMBOIDEUM Rac., *l.c.* T.1, f.28, forma AUSTRALIS, n.f. (Plate xiii., fig.3).

Semicellulæ lateribus granulis 10, dorso glabro, granulis parvis in lineas diagonales 5-6 trans angulos basales dispositis, lineis granulorum brevibus 5-6 radiantibus intra margines apicales, in medio et supra isthmum granulis nullis. A vertice semicellulæ granulis in lineas transversales dispositis, in medio nudæ.

Long. 50; lat. 40; crass. 24μ.

Rose's Lagoon, Collector.

Var. ARCUATUM, n.var. (Plate xiii., fig.4).

Forma sinu cuneato constricta. Semicellulæ basi concava, angulis basalibus late-rotundatis, dorso alte-convexo regulariter arcuato, angulis superioribus nullis, granulis in lineas 7-8 trans angulos dispositis, area mediana nuda, etiam apicali. A vertice, semicellulæ ellipticæ tumidæ, granulis in lineas transversales dispositis, in medio nudæ.

Long. 45; lat. 39; crass. 22μ.

Collector.

Cos. mesoleium forma *adulta* is widespread in this country, and the size constant, from 40 × 30 in young, to 50 × 40 or so in mature specimens. All its forms are larger and longer in proportion than *Cos. punctulatum* Bréb., which, roughly, runs from 20 × 20 to 30 × 30, is simply elliptical in end-view and with single pyrenoids. *Cos. mesoleium* is inflated in end-view, and has double pyrenoids. To this species belong, as Raciborski has noted, Lewin's two forms (Span. Süssw. T.1, f.14, 15), f. *malagensis* 45 × 36, and f. *circularis* 47-48 × 41-42, crass. 23-24, and Turner's forma *rotundata* Klebs (Alg. E. Ind. p.54) 40 × 34.

Cos. BOECKII Wille, var. TRIFOLIATUM, n.var. (Plate xiii., fig.7).

Forma paullo major, basi latiore, angulis basalibus acutioribus, lateribus minus convexis, 3-crenatis, trans latera seriebus 3 granulorum obscurorum 5-6, granulis singulis (binis ?) infra margines, infra apicem granulis 4, paullo supra centrum papillis 3 in triangulum ordinatis. A vertice semicellulæ oblongo-ellipticæ non tumidæ, utrinque medio tumore plano humillimo instructæ, apicibus late-rotundatis, granulis in seriebus transversalibus. Membrana grosse punctata.

Long. 34; lat. 32; crass. 18μ.

Botany (37), Broughton Island (31), common; (Dr. E. Stokes).

Cf. *Cos. fluviatile* Playf., Proc. Linn. Soc. N. S. Wales, 1907, T.5, f.18, and *Cos. Boeckii* var. *imperfectum* below. The principal difference is in the end-view, and the two conspicuous granules above the isthmus are replaced by three low papillæ above the middle of the semicell, which show in the end-view as a very low flat elevation. The produced apex is caused by ten granules which appear in end-view as an oblong, four in front, four behind, and an intermediate one on each side to complete the rectangle.

Var. IMPERFECTUM, n.var.

Forma paullo longior quam forma typica, angulis basalibus fere rectis, lateribus magis convexis, infra apicem granulis obscuris 4, infra margines laterales serie una tantum granulorum, supra isthmum granulis nullis. A vertice semicellulæ ellipticæ utrinque medio scrobiculatione, apicibus rotundatis leviter angulatis, granulis in seriebus transversalibus.

Long. 32; lat. 27; crass 16μ

Guildford (23).

This probably develops into var. *trifoliatum*, the scrobiculation at each side in end-view being an indication of the papillæ about to be formed. With the above compare *Cos. Boeckii* Wille, Norges Fersk. T.1, f.10; *Cos. didymochondrum* Nord. & Wittr., Desm. Ital. T.12, f.11; and *Cos. aphanichondrum* Nord & Wittr., *l.c.* T.12, f.12, which belong to the same group of desmids. In *Cos. fluviatile* Playf., the sides are not crenate, and the papillæ are conspicuous (*cf.* subsp. *bipapillatum* West, Frw. Alg. W. Irel. p.157) whereas in *Cos. Boeckii* they are very low and obscure, and hardly noticeable in end-view.

COS. ULIGINOSUM, n.sp. (Plate xiii., fig.6).

Cos. mediocre, oblongum, dimidio diametro longius, medio sinu brevi acuto constrictum. Semicellulæ subcirculares, angulis basalibus fere rectis, crenis marginalibus circ. 15, granulis magnis irregulariter (vel plus minus in quincuncem) dispositis, ornatæ, inter granulos binos punctis singulis. A vertice ellipticæ. Nuclei amylacei bini.

Long. 51-56; lat. 36-39μ.

Coogee.

The nearest to the above species is *Cos. bacciferum* Turn., Alg. E. Ind. T.10, f.8, which is larger, and has the granules arranged differently. Compare also *Cos. tetrophthalmum* Kütz., in Ralfs, T.17, f.11, which is quite double the size, with a linear sinus also.

Cos. SUBBINALE (Nord.) Lager. var. EUASTROIDEUM, n var. (Plate xiii., fig.8).

Cos. parvum, duplo diametro longius, medio sinu lineari constrictum. Semicellulæ subpyriformes, angulis basalibus laterotundatis, lateribus e basi tumidis, e medio levissime retusis, ad apices convergentibus, apicibus truncatis medio indentatis foveis singulis instructis, angulis superioribus acute-rotundatis. A latere semicellulæ oblongæ, lateribus parallelis, apicibus rotundatis. Membrana glabra, ad partem inferiorem laterum et ad apices (ut videtur), incrassata.

Long. 40; lat. 22; crass. 12μ.

Botany (37).

Probably the fully developed form of *Cos. subbinale.* The incrassations at the side and end seem to be only apparent, not real, as they were not visible in side-view. In this it differs from *Eu. subincisum* Rein., Cape, f.12, to which it has a slight general resemblance. Others somewhat similar are *Cos. doliforme* West & West, N. Am. Desm. T.15, f.16, which is retuse near the base; and *Eu. cosmarioides* W. & W., Alg. Madag. T.6, f.23, which is inflated above the isthmus.

Cos. STENONOTUM (Nord.) var. SPIRALE, n.var. (Plate xiii., fig.20).

Semicellulæ pyramidatæ, angulis basalibus subacutis, lateribus levissime convexis paullo supra medium angulatis, apicibus obtusis quam levissime truncatis, foveis singulis instructis. A latere et a vertice semicellulæ semper spiraliter tortæ, lateribus parallelis, apicibus rotundatis. Membrana grosse scrobiculata, paullo supra centrum scrobiculato-reticulata.

Long. 83-96; lat. 45-53; crass. 20μ.

Rose's Lagoon, Collector.

Cos. genuosum Nord., Frw. Alg. N. Z T.6, f.4; *Cos. umbonulatum* Nord., *l.c.* T.6, f 2; and *Cos. variolatum* Lund. β *extensum* Nord., *l.c.* T.6, f.3, have something in common with this form. From them all it differs in its larger size, especially the greater diameter, in its honeycombed membrane and spirally twisted side- and end-views. Raciborski's forma *minor*, Desm. Ciast. T.1, f.32, is *Cos. subbinale* (Nord.) Lager.

Cos. GLYPTODERMUM West & West, Frw. Alg. Madag. T.7, f.23.

Semicellulæ semper globosæ, a vertice semper circulares. Endochroma interdum in taenias parietales circ. 9, interdum in laminas parietales 4-6 disposita.

Long. 112-132; lat. 66-78μ.

Coogee (1, 4, 13, 24, 58).

Common at Coogee, but not found elsewhere. In the Auburn-Guildford district its place is taken by *Cos. tholiforme* Cohn, Desm. Bongo. f.9.

Genus XANTHIDIUM Ehr.

XAN. INCHOATUM Nord. β MAMMILLATUM, n.var. (Plate xii., fig.6).

Paullo majus quam forma typica. Semicellulæ hexagonæ, basi plana, ad foramen sinus parva verruca praedita, apice lato truncato, basi latitudine pari, angulis apicalibus aculeis singulis fere verticalibus munitis; lateribus mammillatis, rectangularibus, parte inferiore levissime retusa, angulis lateralibus rotundatis. A vertice visæ semicellulæ ellipticæ (*Cos. obsoleto* simillimæ sed angustiores), apicibus acuminatis obtuse-rotundatis, utrinque in medio membrana introrsum incrassata. A latere subcirculares, utrinque incrassatæ, aculeo sursum praeditæ. Membrana achroa, glabra, in centro semicellularum incrassata.

Long.c.ac. 54-63, s.ac. 41-45; lat. 42-45; crass. 22-23μ.

Guildford (23, 45).

Cf. *Xan. inchoatum* Nord., Frw. Alg. N.Z. T.6, f.30; and *Xan.* (*Eu.*) *exile* Josh., Burm. Desm. T.23, f.16.

XAN. OCTONARIUM Nord. var. CORNUTUM, n.var. (Plate xii., fig 7).

Forma dimidio longius diametro (sine cornibus). Semicellulæ regulariter subreniformes, tres quadrantes circuli efficientes, apicibus planis; lateribus cornibus geminatis 3 munitis, cornibus rectis, conicis, validis, acuminatis, radiantibus. A vertice semicellulæ latissime ellipticæ vel ovales, apicibus late-rotundatis. Membrana achroa, glabra, subtiliter punctata, nullo tumore nec incrassatione. Unam tantum cellulam vidi.

Long. c. corn. 96, s. corn. 84; lat. c. corn. 84, s. corn. 58; crass. 40: long. corn. ad 15μ.

Botany.

This is probably a young form of *Xan. octonarium* Nord. I have it from Botany, whence all my specimens of that species have come. The number of spines is very irregular, *vide* my notes in these Proceedings, 1907, p.178, where a specimen with six spines on one side and seven on the other is given as $82 \times 58 \times 37\mu$, agreeing very well with that here figured. The characteristics of var. *cornutum* are the stout conical aculei, and the absence of the central incrassation.

XAN. GLORIOSUM G S. West, in Hardy, Frw. Alg. of Victoria, Vict. Nat. xxiii. p.19.

Xan. pulcherrimum Playf., *l.c.* p 180, according to a figure kindly supplied by Mr. Hardy.

XAN. SIMPLICIUS Nord., Frw. Alg. N.Z. T.4, f.26.

Long. c.ac. 36, s.ac. 24; lat. c.ac. 30, s.ac 24; lat. isth. 6; long. ac. 4-5μ.

Botany (2).

Var. BOTANICUM mihi (*X. Botanicum* Playf., *l.c.* p.182). (Plate xi., fig.10).

Figura l.c. data non typica. Semicellulæ lateribus valde retusis, apicibus etiam atque ad basin plus minus parallelis. Angulis in aculeos productis, superioribus leviter incurvis, basalibus patentibus.

Long. c.ac. 36-42, s.ac. 26-30; lat. c.ac. 42, s.ac. 24-30; lat. isth. 6; long. ac. 6-9μ.

Botany (2).

Var. INTERMEDIUM, n.var.

Semicellulæ, apicibus minus retusis, angulis apicalibus aculeis minoribus binis munitis. Cetera ut in var. *Botanicum.*

Long. c.ac. 36-42, s.ac. 24-28; lat. c.ac. 36-38, s.ac. 24-26; lat. isth. 6; long. ac. 5-7μ.

Botany (2).

Genus ARTHRODESMUS Ehr.

AR. GIBBERULUS Josh., in West & West, Frw. Alg. Ceylon, T.22, f.22.

Ar. ellipticus Playf., *l.c.* T.4, f.5.

Var. ELLIPTICUS mihi, Proc. Linn. Soc. N. S.Wales, 1907, T.4, f.4.

Genus STAURASTRUM Meyen.

ST. PSEUDOSEBALDI Wille, var. PECTINATUM, n.var. (Plate xiii., fig.9).

Forma paullo gracilior quam forma typica, radiis longioribus, spinis apicalibus non bifurcatis.

Long. c.sp. 54, s. sp. 48; lat. 80μ.

Botany (15).

This form seems to suit the description and size of Wille's plant, Norges Fersk. p.45, and is not unlike the figure in T.2, f. 30, considered as more or less diagrammatic.

Var. PLANKTONICUM, n.var.

Forma a fronte visa spinis nullis, marginibus denticulatis; a vertice spinis nullis, marginibus corporis verrucis parvis ornatis.

Long. 42-48; lat. 68-73μ.

Sydney Water-supply (22).

In front-view var. *planktonicum* somewhat resembles *St. pseudosebaldi* tonsum* Nord., Frw. Alg. N. Z. T.4, f.4, but is triradiate in end-view, not biradiate. It also bears a striking resemblance to another plankton-form, viz., *St. Manfeldtii* var. *annulatum*, West & West, Frw. Alg. N. Irel. T.1, f.30, 31, with which it also agrees in size, but differs in the verrucose margins in end-view

St. ARMATUM, n.sp. (Plate xiii., fig.10).

St. mediocre, sinu brevi acutangulato constrictum. Semicellulæ basi inflata angustissima, apice plano, parte superiore corporis utrinque in radium horizontaliter producta, radiis annulis 5-6 granulorum ornatis, apicibus 4-fidis, infra marginem apicalem granulis (ut videtur) geminatis 2 et utrinque granulis solis 2, in serie horizontaliter arcuatim ordinatis, basi inflata annulo granulorum instructa. A vertice semicellulæ fusiformes, in medio non inflatæ, vix isthmo latiores, utrinque aculeis parvis 6 (granulis a fronte visis) munitis.

Long. 30-36; lat. 48-60; crass. s.ac. 12; lat. isth. 9μ.

Botany (2, 17), Sydney Water-supply (22).

St. armatum is nearest in front-view to *St. pseudosebaldi***tonsum* Nord., for which it may easily be mistaken. It is, however, smaller (mature at 36 × 60 × 12) leaving off, in size, where *tonsum* begins, the apex is slightly arched, not flat, and there are granules in rings on the rays. In end-view also *tonsum* is inflated and smooth at the sides. *Cf.* also *St. angolense* West & West, Welw. Afr. Alg. T.368, f.22; *St. brachioprominens* Börg., Braz. Cent. T 5, f.52; and *St bicorne* Hauptfl., in Börges. Bornholm, f.9.

St. PATENS Turn., var. PLANKTONICUM G. S. West, in Hardy, Frw. Alg. of Vict., Vict. Nat. xxii., p.73

Forma AUSTRALICA mihi, (= *St. patens* Turn., forma *australica* Playf., in Proc. Linn. Soc. N. S. Wales, 1907, p.189).

Verba "area centrali granulis geminatis in seriebus 3 concentrice ordinatis" ut loc. cit. reportavi, potius "area centrali granulis 6 concentrice ordinatis" legenda sunt.

Forma *australica* agrees entirely with var. *planktonicum* except that it has two series of faint apical granules.

St. patens Turn., var. coronatum, n.var. (Plate xiii., fig.11).

Semicellulæ processibus brevibus glabris bifidis 6 in apicibus concentrice ordinatis, cetera ut in forma *australica*.

Long.c.proc. 36-56, s.proc. 24-48; long. proc. 6-8; lat. c.ac. 54-57, s.ac. 31-37μ.

Botany (2, 37), Sydney Water-supply.

Forma obesa, n.f. (Plate xiii., fig.12).

Semicellulæ longiores, sursum tumidæ, dorso convexæ, processibus lateralibus latioribus, horizontaliter dispositis, aculeis brevioribus.

Botany (7).

The six faint granules arranged concentrically in end-view of forma *australica* have here developed into six short, smooth, bifid processes, the double granules nearer the angles remaining unchanged. The same rule of development obtains in many other desmids, perhaps in all those furnished with short, smooth processes such as *St. armigerum*, etc. First a granule or denticulation, then a delicate spine, finally a smooth, bifid or trifid process, is the order. It may be observed also in *St. orbiculare* var. *germinosum* mihi, and *St. submonticulosum* Roy & Bissett. *St. patens*, as found here, has two shapes in front-view—the one with flat apex and narrow constricted processes turned up well from the horizontal; the other (forma *obesa* mihi) inflated above, with broader, less constricted processes pointed horizontally. The long spines, I find, are two or three in number quite indifferently. Hardy says of var. *planktonicum* (*l.c.* p.73)—"This variety differs chiefly in the three large spines at each angle instead of the two possessed by the Indian forms." As the spines vary, it would perhaps be safer to rely on the end-view, which, with its almost straight sides and produced angles, is quite different from Turner's figure or description.

St. Sebaldi Rein. β altum (Boldt) West & West, N. Amer. Desm. p.267, forma pusilla, n.f. (Plate xiii., fig.13).

Forma dimidio minor quam β *altum*, dorso minus convexo, verrucis apicalibus minus prominentibus.

Long. 36; lat. 38; lat. corp. infra proc. 21; lat. isth. 12μ.

Guildford (23).

Cf. Boldt, Sibir. Chlor. T.6, f.34. Forma *pusilla* is just about one-half the size given by Boldt and West & West, *l.c.* The only measurement of β *altum* that I have for New South Wales is long. 54, lat. 48, lat. corp. infra proc. 22, lat. isth. 15; the end-view and verrucation are the same. The diameter of the body and isthmus seem to point to the specific identity of these forms. The specimens of *St. Sebaldi* and β *altum* that I have seen mature all had the marginal spines in end-view, one for each apical verruca. Compare Reinsch, Mittelfr. T.11, f.1b.

St. approximatum West & West var. centenniale, n.var. (Plate xiii., fig.14).

Semicellulæ inferne cylindricaceæ, serie papillarum 3 supra isthmum, superne cuneatæ, apicibus planis, angulis superioribus in radios breves, graciles, leviter curvatos, assurgentes, singulos productis; radiis 5-6 denticulatis, apicibus 3-fidis. A vertice semicellulæ triangulares, angulis in radios graciles singulos productis, granulis singulis ad bases radiorum, atque ad medium latus intra marginem minoribus, ornatis.

Long. 23-30; lat. 29-36; lat. isth. 5-6μ.

Centennial Park, Sydney; cum forma typica.

The type is figured by West & West, in Frw. Alg. Ceylon, T.22, f.5. Var. *centenniale* recalls *St. elongatum* Barker, in Wolle, T.46, f.11, 12; and *St. comptum* Wolle, T.42, f.43-46, but both are much larger, and the latter 6-radiate. *Cf.* also *St. parvulum* West & West, N. Amer. Desm. T.17, f.1, and *St. genuflexum*, *l.c.* T.17, f.2.

St. aureolatum, n.sp. (Plate xiii., fig.15).

St. parvum, corpore oblongo, medio leviter constrictum sed sinu nullo. Semicellulæ subglobosæ, apicibus rotundatis; utrinque infra apices radiis glabris, ellipticis, singulis instructæ, apicibus radiorum obtusis non fissis. A vertice semicellulæ corpore globoso, radiis glabris, ellipticis 4, paullo intra marginem orientibus, cruciatim dispositis, ornatæ. Membrana glabra.

Long. c.proc. 27, s proc. 19; lat. c.proc. 27-38; lat. corp. 22. lat. isth. 18μ.

Botany (17).

With this species compare *St. nudibrachiatum* Borge, Alg. Regnell. T.4, f.20, which is very much larger and seven-rayed, the rays bifid. Of that, a var. *Victoriense* G. S. West, 10-radiate, is reported from Victoria by Hardy in his Frw. Alg. of Vict. (Vict. Nat. xxii. p.72). Another somewhat similar form is *St. sublaevispinum* West & West, Desm. U.S. T.18, f.20-22, with less prominent body and narrower isthmus.

St. brachiatum Ralfs.

Long. c.proc. 21-26, s.proc. 15; lat. c.proc 25-30; lat. isth. 7μ.

Botany (17).

The essential difference between this species and *St. aureolatum* supra, is that the latter has a well-defined globose body into which the rays are, so to speak, inserted. In this form the rays are prolongations of the sides of the semicell which has no distinct body. On the other hand *St. laevispinum* Bissett (Journ. R. Micr. Soc. iv. T.5, f.5) has apparently no distinct rays but only attenuations of the body. Compare *St. sublaevispinum* West & West, Desm. U.S. T.18, f.20-22, which is very probably a young form of *St. brachiatum*. *St. laevispinum* forma *Sydneyensis* Rac., Desm. Ciast. T.2, f.10, is identical with *St. brachiatum* var. *longipedum* Rac., Desm. Tapakoom. f.20.

St. orbiculare (Ehr.) Meneg. var. germinosum, n.var. (Plate xii., fig.9).

Forma medio sinu lineari extrorsum ampliato profunde constricta. Semicellulæ subtriangulares; angulis basalibus laterotundatis; lateribus ad apices convergentibus, plus minus convexis; apicibus late-rotundatis; lateribus processibus glabris, brevibus, bifidis instructis, ad angulos basales singulis, infra apices binis, ad media latera binis. A vertice semicellulæ triangulares, angulis inflatis rotundatis, processibus singulis munitis, lateribus levissime convexis, prope latera processibus 6 concentrice ordinatis, ad angulos versus processibus binis. Membrana subtiliter punctata.

Long. 55; lat. c.proc. 57μ, s.proc. 48.

Centennial Park, Sydney Water-supply (22, 42).

Forma SPINOSA, n.f.

Forma paullo minor, spiculis tenuibus ubique in vicem processuum instructis.

Lat. corp. circ. 42μ.

Cum priori.

ST. CORNICULATUM Lund, var. PSEUDOCONNATUM. (Plate xiii., fig. 17).

Forma medio constricta sed sinu vero nullo. Semicellulæ latiores paullo depressæ, dorso planæ, angulis apicalibus rotundatis non mammillatis, aculeis singulis validis munitis, lateribus in medio vix retusis. A vertice semicellulæ triangulares, angulis inflatis acuminatis, lateribus sinuatis non (ut in β *variabile*) in medio rectis vel convexis.

Long. c.ac. 33-42, s.ac. 27-35; lat. isth. 11-13; lat. c.ac. 42-55, s.ac 30-40; long. ac. 6μ.

Botany (17), Coogee.

This form is liable to be mistaken for *St. connatum* (Lund.) Roy & Biss. β *Spencerianum* (Mask.) Nord., Frw. Alg. N.Z. T.4, f.18 (var. *rectangulum* Roy & Biss., Jap. Desm. f.12) which it very much resembles. It is distinguished by its larger size, stouter build, and by the diameter of the isthmus which in *St. connatum* is 6-8μ, in *St. corniculatum* β *variabile* 12-18μ (16μ Nord.), and in var. *pseudoconnatum* from 11 upwards. Maskell seems to have confounded these species. Nordstedt, *l.c.* p.40, remarks :—"The breadth of the isthmus seems much to vary, to judge from the figures in Maskell, 18-8μ; according to the text 16-17μ." Those with isthmus about 8μ belong to *St. connatum*, the rest to *St. corniculatum*. The life-history of *St. corniculatum*, as found here, runs as follows :—

(1) Var. *australis* Rac., Desm. Ciast. T.2, f.15, the youngest; (2) β *variabile* Nord , Frw. Alg N. Z. T.4, f.17, angles slightly mammillate and pointed; (3) a form of β *variabile* observed by me, with angles strongly inflated and produced, spines 3μ long; and (4) var. *pseudoconnatum* mihi, the fully developed form.

St. FONTENSE, n.sp. (Plate xiii., fig.18).

St. minimum, corpore minuto clepsydriforme, vix constricto. Semicellulæ minutæ, crateriformes vel subglobosæ, sursum utrinque in radios glabros, tenuissimos, minute 4-fidos, singulos horizontaliter productæ; radiis cylindratis, sursum leviter curvatis. A vertice corpus globosum, radiis tenuissimis 4 (ut videtur) cruciatim dispositis—semicellulis vero decussatim ordinatis.

Long. c.rad. 19, s rad. 10; lat. corp. 5; lat. c.rad. 39; lat. rad. circ. 2μ.

Sydney Water-supply (22).

St. fontense naturally falls into line with *St. tetracerum* Ralfs, T.23, f.7; and *St. volans* West & West, Alg. Madag. T.9, f.10, 11, but is plainly distinct from both, even if the semicells were not arranged crosswise.

St. LONGISPINUM (Bail.) Arch. β DEPRESSUM, n.var. (Plates xii., fig.8, and xiii., fig.19).

Forma brevior, paullo magis constricta. Semicellulæ latiores, depressæ, dorso planiores, lateribus magis convexis, aculeis horizontaliter dispositis.

Long. 59; lat. s ac. 64, c.ac. 90μ.

Botany (37).

EXPLANATION OF PLATES XI.-XIII.

Plate xi.

Fig. 1.—*Cl. lanceolatum* Kütz. β *coloratum* (Klebs) mihi (×528).
Fig. 2.—*Cl. lunula* Ehr. β *giganteum* Bernard (×147).
Fig. 3.—*Cl. praelongum* var. *strigosum* Bréb. (?) (×264).
Fig. 4.—*Cl. Delpontei* Wolle var. *elongatum* West & West, f. (×264).
Fig. 5.—*Pen. spirostriolatum* Barker (×528).

Fig. 6.—*Micr. truncata* (Corda) Bréb. var. *australica*, n.var.(× 264).
Fig. 7.— ,, ,, ,, ,, var. *decemdentata*, n.var.(× 264).
Fig. 8.— ,, ,, ,, ,, var. *laticipiformis*, n.var.(× 264).
Fig. 9.— ,, ,, ,, ,, ,, forma(× 264).
Fig. 10.—*Xan. simplicius* Nord. var. *Botanicum* mihi(× 528).

Plate xii.

Fig. 1.—*Eu. quadratum* subsp. *inermius* Nord. var. *perornatum*, n.var.(× 528)
Fig. 2.—*Eu. turgidum* Wall. var. *Auburnense*, n.var.(× 264).
Fig. 3.— ,, ,, ,, var. *Grunovii* Turn. formæ(× 264).
Fig. 4.— ,, ,, ,, var. *crux australis* (Rac.) mihi (× 264).
Fig. 5.—*Cos. rectangulare* Grun. var. *nodulatum*, n.var.(× 528).
Fig. 6.—*Xan. inchoatum* Nord. β *mammillatum*, n.var.(× 528).
Fig. 7.—*Xan. octonarium* Nord. var. *cornutum*, n var.(× 528).
Fig. 8.—*St. longispinum* (Bail.) Arch. β *depressum*, n.var.(× 528).
Fig. 9.—*St. orbiculare* (Ehr.) Meneg. var. *germinosum*, n.var.(× 528).

Plate xiii.

Fig. 1.—*Cos. mesoleium* (Rac.) mihi f. *adulta*, n.f.(× 528).
Fig. 2.— ,, ,, ,, ,, f. *asperrima*, n.f.(× 528).
Fig. 3.— ,, ,, var. *rhomboideum* Rac., f. *australis*, n.f.(× 528).
Fig. 4.— ,, ,, var. *arcuatum*, n.var.(× 528).
Fig. 5.—*Cos. difficillimum*, n.sp.(× 528).
Fig. 6.—*Cos. uliginosum*, n.sp.(× 528).
Fig. 7.—*Cos. Boeckii* Wille, var. *trifoliatum*, n.var.(× 528).
Fig. 8.—*Cos. subbinale* (Nord.) Lager. var. *euastroideum*, n.var.(× 528).
Fig. 9.—*St. pseudosebaldi* Wille, var. *pectinatum*, n.var.(× 528).
Fig. 10.—*St. armatum*, n.sp.(× 528).
Fig. 11.—*St. patens* Turn. var. *coronatum*, n.var. × (528).
Fig. 12.— ,, ,, ,, ,, ,, f. *obesa*, n.f.(528).
Fig 13.—*St. Sebaldi* Rein. β *altum* (Boldt) W. & W., f. *pusilla*, n.f.(× 528).
Fig. 14.—*St. approximatum* West & West, var. *centenniale*, n.var.(× 528).
Fig. 15.—*St. aureolatum*, n.sp.(× 528).
Fig. 16.—*St. brachiatum* Ralfs(× 528).
Fig. 17.—*St. corniculatum* Lund, var. *pseudoconnatum*, n.var.(× 528).
Fig. 18.—*St. fontense*, n.sp.(× 528).
Fig. 19.—*St. longispinum* (Bail.) Arch. β *depressum*, n.var., end(× 264).
Fig 20.—*Cos. stenonotum* (Nord.) var. *spirale*, n.var.(× 264).

NOTES AND EXHIBITS.

Mr. Tillyard exhibited a beautiful series of dragonflies with coloured wings, belonging to the genera *Rhyothemis* and *Neurothemis*, family *Libellulidæ*. These interesting insects are tropical in their distribution. Of the six Australian species the smallest, *R. resplendens*, is also the most brilliant, the wings showing wonderful metallic blue reflections *R. princeps* has wings quite black, and *R. Alcestis*, a very rare species, has them half black and half hyaline. *R. Chloë* has beautiful black and orange markings, while *R. graphiptera*, which extends into New South Wales, appears to have wings written over with mystic characters in dark brown. Both sexes of *Neurothemis stigmatizans* were also shown, the male being dark brown, with so intricate a venation that the cells of a single wing number 2600, while the female is paler, spotted with brown, and has an open venation containing only a tenth of the number of cells found in the male.

Dr. Greig-Smith exhibited a specimen of condensed milk which had become "jellified." This change is caused by a micrococcus, in proof of which a number of test flasks were shown. These contained portions of condensed milk; some had, after infection with pure cultures of the micrococcus, become "jellified," while uninoculated flasks, under identical conditions, had remained normal.

Mr. Lucas exhibited branches of a number of Wattles flowering in his garden at Gordon.

DISCUSSION.

The President invited discussion upon the general question of the welfare of the indigenous fauna and flora, and the best means of safeguarding it.

The Secretary gave a brief summary of the various attempts to preserve faunas and floras from extermination in other countries and States by means (*a*) of protected National Parks and Reserves, with or without the co-operation of contiguous private estate-owners; (*b*) of restrictive legislation enacting the permanent protection of animals, &c., for specified periods, or during close seasons, preventing undesirable introductions and exports, etc.; and (*c*) of educational or other organisations for the enlightenment of those in need of it, in order to prevent or minimise the wanton destruction of animals and plants.

Mr. A. J. North, of the Australian Museum, contributed a short paper on "Bird-Protection and Bird-Destruction in New South Wales," in which he pointed out certain weak points in the original Acts in force in the State, and outlined the efforts which had been made to remedy them. It was impossible to afford full protection to many species unless absolute protection was given, because of irregularities in breeding habits. Vast destruction of birds was due, directly or indirectly, to the introduction of undesirable aliens, particularly rabbits and foxes, and to the efforts made to keep these in check. He advocated the reprinting of the Acts in force, together with the additions that had been subsequently made, in the newspapers so that the widest publicity might be given to them. Gould Societies might very advantageously be inaugurated throughout the State, to take up work on the lines so successfully followed by the Audubon Societies of the United States; and to bring about the observance of "Bird Day" in the schools. But there could be no doubt that perhaps the most urgent need at present was better administration of the legislation provided in the existing Acts.*

Mr. Frank Farnell, Chairman of the National Park Trust, spoke of an unsuccessful movement, largely for the protection of the native flora and fauna, which he had initiated in 1905. The Premier at the time, Mr. (now Sir) Hector Carruthers, warmly supported the movement; but the Bill necessary to provide for its effectiveness was not carried; and the effort failed. Still more recently he had been instrumental in getting a proposed Bill drafted, to provide for the introduction, acclimatisation and preservation of animals and birds which are or may be deemed

* See also "The Destruction of Native Birds in New South Wales," by A. J. North. Rec. Aust. Mus. Vol. iv. p.17(1902).

to be of economic value to New South Wales, and for other purposes consequent thereon or incidental thereto, to be known as the "Birds and Native Animals Protection and Acclimatisation Act, 1906"; but until the Cabinet made it a Government measure, its chance of coming into operation was remote. With reference to the National Park, the speaker said that the Trustees fully recognised that it was, first and last, the People's Park; that they were keenly alive to the desirability of preserving the native plants and animals throughout the area of 60 square miles under their jurisdiction; that they had reason to be gratified not only with the way in which the Park was fulfilling its purpose as a sanctuary for bird and other life, but with the more appreciative attitude, on the part of those who visited the Park, to the main objects of the Reserve, as well as to what the Trust was trying to make it. He concluded an interesting address by offering the Society his hearty support.

Mr. F. J. W. Harrison, Secretary to the Kuring-Gai Chase Trust, spoke of the magnificent possibilities of the Chase, as a national park and preserve, though these were not being fully realised quite so rapidly as the members of the Trust wished to see, partly because of the natural obstacles in the way of affording adequate protection to the fauna and flora with the resources at their disposal; and partly because marauders were apt to take advantage of this deficiency. They had a large area, about 35,300 acres to deal with; at present only 3,500 acres were enclosed; much of it was very difficult to patrol adequately on account of the physical configuration of the area; and so much of it was at present unfenced. Still the Trustees were sanguine as to the future of the Chase; because they were hopeful of improving the existing conditions by degrees, as well as of seeing a steadily growing intelligent appreciation of the right way to treat a People's Park on the part of those who had access to it.

Mr. F. Montague Rothery, Secretary of the Animals' Protection Society of New South Wales, spoke of the interest of the Society which he represented, in the subject before the Meeting; and of the steps which it had already taken, or proposed to take, to advance matters, among others by arranging for a deputation to wait upon the Colonial Secretary. Personally he advocated the repeal of the Birds' Protection Act of 1901, because it was cumbersome and misleading, in favour of a simple Act which should provide for the protection of all birds and their eggs, with the exception of those birds regarded as pests, to be specified in a separate schedule.

Mr. J. H. Maiden, representing the Royal Society of New South Wales, communicated a letter which had been received from the Royal Society for the Protection of Birds, in London, upon the subject of the treatment which is now being meted out to Birds of Paradise in New Guinea since the recission of the Proclamation made in 1904 for the protection of these birds; and asking for the support of the Society in obtaining a renewal of the Proclamation. The Royal Society of New South Wales had accordingly approached the Commonwealth Government through the kind offices of the Premier of New South Wales. Copies of the correspondence were communicated to the Meeting. The speaker then addressed himself more particularly to the difficult question of the best means of securing the protection of native plants. As the representative of the Zoological Society of New South Wales also, Mr. Maiden communicated a message from the Hon. Secretary to the effect that the Society was arranging for a deputation to the Premier.

Mr. R. Etheridge, junr., Curator of the Australian Museum, spoke in favour of the retention of most of the clauses of the Act of 1901, provided the Act was properly put into operation. For example, the present Act provided that mere possession of a scheduled bird was sufficient to constitute liability; this was a wise provision and should be retained. The existing schedules, however, were defective and confusing. The suggestion that the birds that might be shot should be specified, and all others protected, was an excellent one. The urgent need for reform in the administration of the Act was evidenced by the enormous amount of trapping of native birds, including scheduled birds such as the lyre-bird, for commercial purposes, and by the openly conducted sale of scheduled birds, such as seagulls, in Sydney.

Mr. Deane specially referred to the very serious complications which the rabbit-destruction question created, so long as the laying of open poisoned baits and the poisoning of waterholes were resorted to on a large scale.

Mr. R. T. Baker entered a plea for provision for the reservation of future national parks in the Dorrigo, on the Richmond River, in the Pillaga Scrub, and elsewhere, before it was too late. In time to come such reserves would be important additions to the national assets of the State and of Australia, as well as of great importauce from a botanical standpoint.

Mr. H. J. Carter and Mr. E. Cheel offered observations on special phases of the question; and the President summarised the suggestions which had been put forward.

It was thereupon resolved :

(1) That the hearty congratulations of the Meeting be tendered to Professor Baldwin Spencer, of Melbourne University, the leader of the influential deputation which waited upon the Prime Minister of the Commonwealth on 5th August, upon its favourable reception, with promising results. The object of the deputation was to urge (*a*) That the exportation of the skins and plumes of certain Australian birds should be prohibited; (*b*) That Lord Avebury's Bill in the British Parliament be supported; and (*c*) That the Federal power be used as far as practicable for the preservation of the bird-life of Australia and Papua.

(2) That a subcommittee consisting of Messrs. R. T. Baker, W. W. Froggatt, A. G. Hamilton, J. H. Maiden, A. J. North, and the *ex officio* Members, be appointed to confer with the other Societies which are contemplating an appeal to the Government, so as to promote co-operation in this and other respects.

WEDNESDAY, SEPTEMBER 30TH, 1908.

The Ordinary Monthly Meeting of the Society was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, September 30th, 1908.

Mr. T. Steel, F.L.S., F.C.S., Vice-President, in the Chair.

Mr. John George Hunter, Junior Demonstrator in Biology, University of Sydney, was elected an Ordinary Member of the Society.

The Chairman gave notice of a Special General Meeting to be held on Wednesday, 28th October, at 8 o'clock, before the appointed Ordinary Monthly Meeting on the same date. *Business*: to consider the desirability of amending Rules xlv., xlvi., and lix., so as to allow of the annual audit of the Society's accounts being carried out by a Public Accountant, not a Member of the Society, actively practising his profession.

A letter from Dr. Alfred Russel Wallace, Broadstone, England, thanking the Society for its congratulations on the occasion of the fiftieth anniversary of the Meeting of the Linnean Society of London at which the papers by Darwin and Wallace, setting forth the main outlines of the Theory of Natural Selection, were presented, was read from the Chair.

The Donations and Exchanges received since the previous Monthly Meeting, amounting to 12 Vols, 83 Parts or Nos., 46 Bulletins, 8 Reports, and 24 Pamphlets, received from 62 Societies, &c., were laid upon the table.

NOTES AND EXHIBITS.

The Secretary communicated a letter from Dr. J. B. Cleland, President of the West Australian Natural History Society, Perth, in which the writer showed that the needs of West Australia in respect of proper reservations for national parks, and satisfactory administration of the Game Acts for the preservation of marsupials and birds, were perhaps rather more urgent than those of any other State. Dr. Cleland also forwarded a copy of a resolution passed at the last meeting of the Society, expressing approval of the efforts now being made to arouse attention in the matter of the protection of the indigenous flora and fauna ; and offering cordial support.

Mr. Froggatt exhibited an interesting series of biting and blood-sucking Diptera from the Soudan, Africa, received from Mr. Harold H. King, and including examples of the Tsetse-Fly (*Glossina morsitans* Westw.) so destructive to stock in South Africa, and the allied species, *Glossina palpalis* Desv., which transmits the organism causing "sleeping sickness"; a biting house-fly (*Stomoxys* sp.); the Camel Louse Fly *Hippobosca camelina* Leech; and six common biting horse-flies (*Tabanidæ*) found in the Soudan.

Acting-Professor Woolnough exhibited a collection of Graptolites from a northern extension of the locality on the Shoalhaven recently noted by Mr. Carne. The Ordovician rocks occur in the form of a narrow band extending from near Tolwong Creek, northwards past the great bend of the Shoalhaven, through the Razorback and Ballanya Trig. Station to a point about one mile south of the Great Southern Railway Line between Tallong and Marulan. Silurian and Devonian rocks are developed in the neighbourhood. This is the nearest point to Sydney at which fossiliferous Ordivician strata have been met with.

Mr. Hedley exhibited a copy of Klincksieck & Valette's "Code des Couleurs à l'usage des Naturalistes," etc. (1908) and also of Scopoli's "Introductio ad Historiam Naturalem sistens Genera Lapidum, Plantarum, et Animalium hactenus detecta," etc. (Pragæ, 1777).

Mr. North exhibited eight eggs of the Great Bower-bird, *Chlamydodera nuchalis* Jardine & Selby, to show the variation in colour, and in the character of their markings.

Mr. Fred. Turner exhibited and offered some observations on *Hordeum* (*Critho*) *œgiceras* Royle, the curious Nepal Barley, grown in the Brisbane Botanic Gardens in 1878, where the grain ripened in about nine weeks from the time of sowing the seed. From numerous inquiries made he could hear of no previous record of this economic plant being cultivated in Australia.

ON SOME REMARKABLE AUSTRALIAN *LIBELLULINÆ*.

By R. J. Tillyard, M.A., F.E.S.

Part ii. Descriptions of new Species.

(Plate xiv.)

The numerous *Libellulinæ* which are found in the tropical regions of Queensland afford a most interesting study to the naturalist. Many of them, of course, are forms found also in New Guinea or in the other islands lying northwards from Australia, but we also find some remarkable exceptions which are distinct from the island forms, yet very closely allied to them. One may safely say, however, that the time that has elapsed since the tropical oceanic *Libellulinæ* invaded northern Australia and settled there has scarcely yet been sufficient for the formation of many new species. Variation has taken place along unexpected lines, and the result has been rather to upset some of the current ideas of the true value of certain venational characters to which European authors had given undoubted generic value. The general tendency of the *Libellulinæ* of northern Australia appears to be one of gradual simplification, which can be noticed as taking place in the following ways :—

1. *Abolition of superfluous nervures*, shown by change from a once or twice-crossed triangle to a free triangle, or a reduction in the number of rows of discoidal cells following the triangle. Probably the same tendency operated in the formation of the heteromorphic females of *Neurothemis*; and it is interesting to

note that of the two species of that genus inhabiting Australia, one (*N. stigmatizans* Fabr.) possesses the heteromorphic or simplified female only, while in the other (*N. oligoneura* Brauer) the change has extended to both sexes, so that the original intricate venation is entirely lost.

2. *Loss of pruinescence*, exemplified by specimens of the genera *Zyxomma* and *Orthetrum* taken in Australia.

3. *Decrease in size*; many examples of this might be given; see *Zyxomma obtusum*, below.

4. *Simplification of colour-pattern*; see *Agrionoptera regalis* below.

5. *Contraction and intensification of dark pigmentation on the wings*. *Neurothemis oligoneura* Br., affords a striking example of this; see also *Camacinia Othello*, below.

The interesting problems connected with these peculiar tendencies cannot be discussed in this paper, but the particular facts relating to each species described in it will be noted in their proper places. Seven species are now added to the Australian list, of which five are new to science, while the hitherto unknown male of *Rhyothemis Alcestis* Tillyard, is also described.

1. Zyxomma obtusum Albarda.

A single male taken by Mr. E. Allen, at Cairns, exhibits remarkable differences from the type-form. It has absolutely no pruinescence, and is considerably smaller than the type. It is easily distinguished from *Z. petiolatum* Rambur (the only other species of the genus found in Australia) by the shape of the abdomen, which is short and rather thick, with segment 3 pinched.

2. Rhyothemis Alcestis Tillyard. (Plate xiv., fig 2).

♂. *Wings* very similar to those of the female, already described.* *Head* and *thorax* as in ♀. *Abdomen* slightly longer and less

* These Proceedings, 1906, xxxi., p.482.

cylindrical, segment 3 scarcely narrower than the rest. Appendages: *superior* 1·7 mm, narrow wavy sublanceolate, slightly thickened towards the tips, which are pointed; deep black. *Inferior* 1·2 mm., subtriangular, black, tip curved upwards.

In the living insect the black basal half of the wings possesses a rich purplish-brown sheen, and is considerably deeper than in the female. One very mature specimen in my collection has a very large portion of the outer half of the wings slightly clouded with dull brown.

Hab.—Kuranda, N.Q. (Mr. E. Allen and Mr. F. P. Dodd). Rare; January.

3. CAMACINIA OTHELLO, n.sp. (Plate xiv., fig.1).

♂. Unique. Total length 52 mm.; abdomen 32·5 mm.; forewing 45·5 mm.; hindwing 44 mm.

Wings: *neuration* close, black; basal half of all four wings, as far as nodus, of a deep opaque black colour; the boundary between the black and hyaline portions crossing the wing slantwise, ending on the forewings about 7 mm. beyond apex of triangle, and on hindwings at about the termination of the sectors of the triangle; rest of wings hyaline except tips, which are just touched with smoky-black; hindwings broad at bases; *pterostigma* 6 mm., black; *membranule*, fore 2·5 mm, very narrow, hind 3·5 mm., broader, dull dirty grey; *triangle of forewings* very narrow, 6-7-celled, followed by very irregular rows of cells in the discoidal area, first 7, then 7 or 8 placed rather irregularly, then several irregular curved rows of 5 or 6; the discoidal area is then divided into two by a short auxiliary sector, curving up to meet the short sector 6 cells from the margin of the wing; *triangle of hindwings* long and narrow, 4- or 5-celled; *short sector* broken for 2 cells where it meets the auxiliary sector; *sectors of arculus* separated at bases in forewings, *just touching* at bases in hindwings; *nodal sector* distinctly waved just beyond middle; *basilar spaces* of all wings free; *submedian space* of forewings containing one cross-nervule before level of arculus and three rather close together beyond arculus, that of hindwing carrying one cross-nervule near its middle, another nearer the arculus, and a third arising from base of arculus so as to form a small subtriangle; *hypertrigonal space* with 3-4 cells in forewing, 1-2 in hindwing. *Nodal Indicator*

25-26	16-17
15-16	18-19

Head: all parts shining jet black, except *labium* dark brown; front and *clypeus* hairy; *vertex* a large bifid tubercle, hairy, standing up high and carrying two conspicuous spikes or horns; front *ocellus* pale, transparent; other two smaller, brownish; *antennæ* 4 mm., slender, black. Thorax deep black all over, some brown hairs on breast. *Legs* black with short spines. Abdomen rather short and stout, 4 slightly narrower than 2-3, 2-4 rounded, 5-9 triangular in section, 8-10 narrower than the rest: colour jet black: 2-3 with supplementary carina. Appendages: *superior* 2mm., separated at bases, undulating sublanceolate, hairy, pointed, black; *inferior* 1·3 mm., broad subtriangular, slightly hollowed out above, very dark brown.

Hab.—Cooktown, N.Q. A single male in magnificent condition taken on a billabong near the Annan River on Dec. 29th, 1907. Its flight is slow and majestic, and it is fond of settling on prominent twigs or branches overhanging the water.

This magnificent insect is closely allied to *C. gigantea* Br., from which it can be at once distinguished as follows:—

(a) The opaque portion of the wings in *C. gigantea* extends considerably *beyond* the nodus.

(b) The colouration of *C. gigantea*, both on body and wings, is rich brown. Mr. Laidlaw, who has seen this insect in the Malay Peninsula at Kwala Aring, says:—"It haunts the same localities as *Neurothemis stigmatizans*, which resembles it very closely in colour, though, of course, much smaller."

It is quite possible that *C. Othello* arose as a differentiation from the parent stock *C. gigantea*, which does not occur in Australia. Note the intensification and contraction of the opaque pigment of the wings. This tendency carried to its fullest extent can best be seen by comparing *Neurothemis stigmatizans* with *N. oligoneura*. Compare with these two species *C. gigantea* and *C. Othello*, and one feels that the same tendency is at work here, though the differentiation has not proceeded nearly as far as in *N. oligoneura*.

♀. Unknown. It would be most interesting to find the female and compare its neuration with that of the male.

4. ORTHETRUM PRUINOSUM Burmeister.

A single male of this species taken by me at Cairns in December, 1907, exhibits considerable difference from the type, being of smaller size, and lacking pruinescence on the abdomen. Typical *O. pruinosum* is found in Java, and the species is represented in India and Ceylon by the race *neglectum* Fabr., and in the Celebes and Borneo by the race *clelia* Selys. I cannot do better than quote the remarks of my friend, Dr. Ris of Switzerland, the expert in *Libellulinæ*, on the specimen from Cairns, which I sent him to examine:—"Your specimen extends the limits of the concern (*O. pruinosum*) to Queensland in a form that is certainly not of the *clelia* type but of the true *pruinosum* type, and thus must suggest its origin from the Sunda region, and its way to Australia probably has been across Timor. Your specimen is distinct from *O. pruinosum* typical, by the darker colour of the thorax, the absence of pruinosity from the abdomen, the larger and lighter pterostigma, and many reddish nervules on the costal and basal part of the wings—otherwise very similar to the Javanese typical form. The differences are very probably racial, certainly not specific."

The specimen is chiefly of interest as affording direct evidence of a stream of immigration to the Cape York Peninsula independent of that across Torres Straits from New Guinea.

5. AGRIONOPTERA ALLOGENES, n.sp.

This species was described by me under the name *A. insignis* Rambur(?) in these Proceedings for 1906 (p.485). Since that description was published, I have sent specimens of my type-series to Dr. Ris, and he tells me that they are distinct from the type *A. insignis* Ramb., of Java. The most remarkable character which differentiates them, and one that is quite constant, is that in the typical *A. insignis* the triangle of the forewing has a cross-nervure, while in the Australian *A. allogenes* this triangle is always *free.* This character actually demands either that a new genus should be instituted for *A. allogenes* (the cross-nervule of the forewing triangle being included in the original definition of the genus *Agrionoptera*) or else that the definition of the genus should be extended to include *A. allogenes.* Dr. Ris' opinion is that in spite of the remarkable difference in the triangles, the two forms must be placed in the same genus, and are probably not even more than subspecies or geographical races of one widely diffused and variable species. In *Agrionoptera*, as in *Nannodythemis* (which I have already dealt with in Part i. of this paper) lack of sufficient material from many localities has caused the genus to be founded, partly at least, on an important character which was accepted as constant and of generic value, whereas the discovery of this new Australian form, so closely allied to the type *A. insignis* Ramb., shows us the necessity for revising our classification of the group and eliminating from the generic definition a character which is not shared in common by all its members.

In the markings of thorax and abdomen, the four species *A. insignis* Ramb., *A. quatuornotata* Br., *A. similis* Selys, and *A. allogenes* are extremely similar, and the individual variation of specimens is sufficient to prevent us from drawing a hard and fast distinction between them; *A. similis* and *A. allogenes*, however, differ from *A. insignis* and *A. quatuornotata* by having *only one submedian cross-vein instead of two.*

Note.—In the description of this species formerly made by me, and referred to above, I compared this beautiful insect with the larger *Lathrecista festa*, an insect of similar form and habits. At that time I possessed only three immature examples of the latter of an orange-brown colour; and this led me into the error of saying that *A. allogenes* "is far more brilliantly coloured than *L. festa.*" On my recent visit to Cooktown, however, I took a fine series of *L. festa* (♂) and also some *A. allogenes* (♂), both mature; and I can now correct my statement, and say that of all the brilliant red dragonflies I have seen in Australia, *L. festa* is perhaps the most brilliant, outrivalling even such vivid insects as *Erythemis rufa* and *Orthetrum villosovittatum* in the pure vermilion of its abdomen. *A. allogenes* has a narrower and duller abdomen with the last three segments black, while *L. festa* is brilliant red throughout. It, however, lacks the brilliant metallic frontal spots possessed by *A. allogenes.*

This insect occurs at Cairns and Cooktown both in winter and summer.

6. Agrionoptera regalis, n.sp. (Plate xiv., fig.3).

♂. Total length 48 mm.; abdomen 33 mm.; forewing 41 mm.; hindwing 40 mm.

Wings: *neuration* black, *pterostigma* black, 5 mm.; *membranule* very small, brownish; *triangle of forewings* with one cross-nervule, followed by one row of three cells and then five rows of two cells in the discoidal area, increasing afterwards to three again; *triangle of hindwings* free. *Nodal Indicator* | 14 13-14 | 14 13-15 | Head: *occipital triangle* very small, black; *eyes* dark brown; *vertex* small, much tubercled, bifid, bright metallic blue, the three *ocelli* arranged round it in a triangle; the central ocellus large and conspicuous, and all three transparent, pale yellowish; *front* wide above, low in front, somewhat cleft medially, brilliant metallic blue, a dull yellowish-grey area low down on each side; *postclypeus* pale yellow with a flap or fold on each side overhanging the anteclypeus and carrying a small point; *anteclypeus* and *labrum* pale yellow; *labium* and *genæ* large, pale rich brown; a large black central mark with a semicircular bar on labium; *mouth* broadly edged with black. Thorax: *Prothorax* hairy, very dark brown. *Meso-* and *metathorax* hairy in front, very dark brown or almost black above, downy; a short double yellowish line on dorsal ridge and a pair of indistinct yellowish marks inside interalar ridge; sides greyish-black, crossed by a broad *longitudinal* band of dull yellow, nearly in line with the abdomen, somewhat irregular, and enclosing the conspicuous meso-spiracle; *notum* black, scuta and scutella yellowish. *Legs* black, procoxæ and part of underside of profemora pale yellow, tibiæ with conspicuous stiff hairs or spines. Abdomen: 1-2 very short, slightly enlarged; 3 with transverse carina one-fourth from base, 3-4 slightly narrowed in middle, 5-8 slightly enlarged again, 9-10 slightly narrower. Colour black; 1, a touch of pale yellow on dorsum, a yellow spot on each side; 2, a yellow dorsal mark, a small round spot on each side. These markings vary in shape and size with the specimens. No other markings. Appendages: *superior* 2·3 mm., sublanceolate, somewhat curved, bases separate, tips pointed and curving outwards; hairy, black. *Inferior* nearly as long, subtriangular, tip upcurved, blunt and rounded; black.

♀. Total length 49 mm.; abdomen 33 mm.; forewing 44 mm.; hindwing 42·5 mm. *Nodal Indicator* ‖ 16 15-16 | 16-17 15-16 | Head: *vertex* and *front* brilliant metallic green or greenish-blue; clypeus dull shiny yellowish-brown; *labrum* black, a brown spot on each side. Thorax as in ♂. Abdomen: 1-2 rather broad, narrowing to 4 then broadening to end. Colour black; 1, a yellow spot above, a pale yellow round spot on each side; 2, an elongated dorsal mark and a spot on each side, yellow; 3, a similar dorsal mark before the carina, a slight yellow line behind the carina, on each side a small yellow basal spot and a fine yellow line behind the carina; 4-6, a suspicion of a fine yellow dorsal line near bases. Size of markings varies with the specimens. Appendages short, 1·2 mm., very wide apart at bases, straight, pointed, black.

Hab.—Cooktown, Cairns and Kuranda, N.Q. Rare. November-February.

This remarkable insect has habits totally different from most of the tropical *Libellulinæ*, which are sun-loving insects inhabiting swamps and wide, open rivers. It is found only in the densest tropical forest, inhabiting small swiftly running mountain-creeks. It hawks about over the pools like an Aeschnid, but is also very fond of some particular twig or branch, to which it will continually return. It appears to shun sunlight, and is not difficult to capture.

It is closely allied to *A. longitudinalis* Selys (with which *A. biserialis* Selys and *A. Karschii* Förster are synonymous), but differs from it in its larger size, in lacking the yellow points on the dorsal region of the thorax, in not having the wings tipped with brown, and in the yellow markings of the abdomen being restricted to the first two or three segments, whereas *A. longitudinalis* is marked from 1 to 7. The expanse of *A. longitudinalis* is 75-78 mm., that of *A. regalis* 85-90 mm.

I possess ten specimens of *A. regalis* taken by myself at Cooktown, also a fine pair taken by Mr. Dodd at Kuranda, and one taken by Mr. Allen at Cairns. The species probably extends to Cape York, and specimens from that locality are much to be desired, as they may show intermediate variation between type *A. regalis* and the New Guinea *A. longitudinalis*. In spite of the great similarity between these two species, I am inclined to think that *A. regalis* is deserving of more than subspecific rank.

The species is peculiar in being an exception to the general rule that the Australian form is generally considerably smaller than the closely allied form from Papua or the Malay Archipelago.

7. Nannophlebia eludens, n.sp. (Plate xiv., fig.4).

♂. Total length 28 mm.; abdomen 20 mm ; forewing 20 mm.; hindwing 18·5 mm.

W i n g s : *neuration* thin, black; bases very faintly clouded with pale yellow up to or slightly beyond triangles; *pterostigma* short, 1·4 mm., broad, black; *membranule* minute; first postnodals of all wings not continuous. *Nodal Indicator* 6 4-5 / 5 4-5. H e a d : *vertex* small tubercled, brown; front *ocellus* large, transparent, pinkish; *eyes* brown; front slightly cleft medially, brown above, sides and face dull yellow or olive-green; *clypeus* dull yellowish; *labrum* yellowish edged with black; *labium* pale straw-colour. T h o r a x : *prothorax* brownish. *Meso-* and *metathorax* rich dark brown or black above, with a fine yellowish line on dorsal ridge; shoulders and sides yellowish or olive-green (the more mature the insect the more greenish the colouring) marked with a rather broad dark brown lateral band running from fore wing-join to mesocoxa, a narrower and more irregular band arising from the first one and proceeding to the lower metapleurum, continuing across the underside, and a short brown band arising under the hind wing-join and proceeding along the pleural suture for not more than 2 mm.; notum dark brown or black spotted with yellow or olive-green. *Legs* black, undersides of profemora and bases of undersides of meso- and metafemora pale straw-colour. Abdomen: 1-2 swollen, 3-6 very slender, 7-10 wider. Colour black, marked with yellow in the young, olive-green in the mature insect as follows:—1, sides yellowish; 2, a transverse basal band, and on each side a very large spot, extending down to the genital appendage, which is very prominent, dark brown; 3, a transverse basal band; 4-6, a transverse central ring, narrow on 4-5, broader on 6; 7-10 black. Appendages: *superior* 1 mm., separated at bases, curving inwards to meet at tips, rather slender and of uniform width, pale straw-colour, tips pointed and just touched with brown; *inferior* 0·8 mm., subtriangular, slightly upcurved, pale straw-colour.

♀. Similar to male, generally slightly larger and with a deeper shading of yellow on bases of wings. Abdomen: 1-3 swollen, 4-6 narrow, 7-10 wider; generally with a fine transverse central line on 7; other markings as in male. Appendages short, 0·5 mm., conical, pale straw-colour.

Another very distinct form of the female exists, which may be recognized as follows—size much larger than the usual type; total length 33 mm., abdomen 23 mm., forewing 25 mm., hindwing 23·5 mm. *Bases of wings* deeply suffused to level of arculus only; *vertex yellow, tibiæ pale brown; abdomen* marked as follows: 1, broad basal band; 2, basal band, lateral central spots nearly meeting on dorsum; 3, with broad transverse band often interrupted by brown lines on dorsum; 4 with *two* transverse narrow bands; 5-6 with a narrow band near base and a wider central one; 7 with a fine basal transverse line and a broad central band narrowest on dorsum; 8-10 black. *Pterostigma* 2 mm.

Hab.—Cairns and Kuranda, N.Q. Not uncommon; January-May.

The three species *Nannophlebia Lorquini* Selys, *N. imitans* Ris, and *N. eludens*, n.sp., are very closely related, but may be distinguished as follows :—

N. Lorquini has the base of its front in the male very largely, in the female somewhat more narrowly, metallic greenish-black. *N. imitans* has the front metallic greenish-black above. *N. eludens* has *no* metallic colour on front. *N. imitans* has no yellow on the dorsal ridge of thorax; *N. Lorquini* has a very fine yellow line; so has *N. eludens*.

N. imitans has the abdomen all black except a yellow ring on 2. *N. Lorquini* has the abdomen similar to *N. eludens* ♂.

It is very probable that these three species are only geographical subspecies of one widely distributed and exceedingly variable species. The Australian form is, however, sufficiently distinct and constant to merit a new name. I have named it *N. eludens* because of its peculiar elusive zigzag flight up into the air when disturbed from its usual rest on a favourite twig.

8. Tetrathemis cladophila, n.sp. (Plate xiv., fig.5).

♂. Total length 25 mm.; abdomen 16·5 mm.; forewing 21 mm.; hindwing 19·5 mm.

Wings: *neuration* fine, black; basal half to nodus slightly suffused with dull yellow; *pterostigma* 1·6 mm., rather broad, black; *membranule* nil; one cross-nervule in hypertrigonal spaces, 3-4 submedian nervules. *Nodal Indicator*

8	5
7	4-5

Head: *eyes* dark brown; *vertex* dark metallic green, front *ocellus* transparent, pink; *front* cleft medially, downy, orange-yellow; *clypeus* dirty glaucous-grey; *labrum* black; *labium* pale straw-colour; *mouth* edged with brown. Thorax: *prothorax* pale dirty brownish. *Meso-* and *metathorax* very dark steely metallic green above; on each side a subhumeral blotch of yellow placed very far forward, somewhat narrowed or pointed behind; sides greenish-yellow with a brown band in the pleural suture; interalar ridge, scuta and scutella yellowish or brownish. *Legs* black, tibiæ with long cilia. Abdomen short, cylindrical; 1-2 yellow, an anal transverse black band on 2 and base of 3; rest of basal half of 3 yellow, anal half black; 4-10 black, a transverse basal yellow band on 4; a basal yellow spot on each side of 5-6; basal half of 7 yellow. Appendages: *superior* 1 mm., slender, black, somewhat hooked; *inferior* 1 mm., subtriangular, blackish, tip upcurved.

♀. Similar to male, wings slightly longer; abdomen slightly shorter, 1-2 slightly enlarged. Bases of wings to nodus conspicuously suffused in mature specimens. *Labrum* black, with two round yellowish spots. Abdomen coloured as follows—1-2 yellow, 3 yellow, a basal black band and a longitudinal black band on dorsum; 3-4 with a black line showing on supplementary carina; 4-6 with a large yellow mark on each side; 7, basal two-thirds yellow; 8-10 black; 9-10 very short; 10 with a projecting tongue underneath, brownish. Appendages very short, wide apart, straight, pointed, black.

Hab.—Cooktown, N.Q. Rare; January, 1908.

I have named it *T. cladophila* because of its great fondness for returning again and again to the same twig, even after being frightened away with the net.

This quaint little dragonfly differs considerably from the *Tetrathemis* which I took at Cairns in 1905; the latter was determined by M. René Martin as identical with *T. flavescens* Kirby, from Borneo. The chief difference is that the vertex and thorax of *T. flavescens* are brown; the yellow shading of the wings only apparent at the bases and near the nodus, and *not throughout* the basal half of the wings. The markings of the abdomen and the shape of the appendages and tenth segment of the female also differ considerably. [For purposes of comparison, see pp 487-488, these Proceedings for 1906, "New Australian Species of the Family *Libellulidæ*."]

It is interesting to note that the vertex presents the same difference in *T. cladophila* and *T. flavescens* as it does in *Nannophlebia Lorquini* and *N. eludens*. But in the former two the difference has extended to the thorax also, which is metallic in *T. cladophila*.

In conclusion, I wish to acknowledge the kind and ready help of my friend, Dr. Ris of Rheinau, Switzerland, in supplying information on nearly allied species and in generously giving me the benefit of his experienced opinion on some of the more difficult forms described in this paper.

EXPLANATION OF PLATE XIV.

Fig. 1.—*Camacinia Othello*, n.sp., ♂ nat. size.
Fig. 2.—*Rhyothemis Alcestis* Tillyard, ♂ nat. size.
Fig. 3.—*Agrionoptera regalis*, n.sp., ♂ nat. size.
Fig. 4.—*Nannophlebia eludens*, n.sp., ♂ nat. size.
Fig. 5.—*Tetrathemis cladophila*, n.sp., ♂ nat. size.

THE LIFE-HISTORY OF *LORANTHUS EXOCARPI* Behr.

By C. C. Brittlebank.

(Communicated by A. G. Hamilton.)

(Plates xv.-xx.)

From the standpoint of economic forestry alone, owing to the rapid spread and great damage caused by the Loranths in parts of Victoria, the life-history of these plants is worthy of study. Twenty years ago these parasites were very scarce in this, the Myrniong district; but at the present time there is scarcely a tree free from them; some indeed support several dozen separate plants.

For several reasons, some of which are given below, I look upon the Loranths as recent introductions from the north into the south-eastern portion of Australia. They probably came south after the last cold period to which Victoria was subjected. This view is strengthened by there being no record of Loranthus in Tasmania. A bird, the Swallow Dicæum, which feeds upon the fleshy portion of the fruit of these parasites is not found to the south of Bass Strait. The seeds are fairly large and heavy, and quite incapable of being borne by wind to any considerable distance. We must therefore suppose that the parasites reached the southern shores of Victoria after Tasmania was cut off from the mainland.

The various host-plants on which *L. Exocarpi* has been observed in this district are *Acacia* sp., *A. decurrens*, *A. dealbata*, *A. implexa*, *A. melanoxylon*, *A. pycnantha*, *Bursaria spinosa*, *Casuarina* sp., *C. quadrivalvis*, *Exocarpus cupressiformis*, *Hymenanthera Banksii*, Native Hazel, *Loranthus pendulus*, *Prunus cerasus*, and *P. domestica*.

The fruit of *Loranthus Exocarpi* is of a bright orange-yellow, and somewhat transparent, changing to a dark madder-brown when overripe. A viscid and somewhat sweet pulp coats the seed, which on exposure to the air dries rapidly. Birds, chiefly honey-eaters, the Swallow Dicæum, *Strepera cuneicaudata*, and some introduced birds, carry the seeds from tree to tree. Although numbers of seeds pass through the alimentary canal of birds, a greater proportion are rejected after having their exterior coating removed. These, falling, may adhere to branches, and in a short time become firmly cemented on the upper surface and sides.

Seeds which have passed through the alimentary canal of birds are often found in strings of from three to six ; these germinate as readily as those which have fallen directly from the parent plant. The strings and single seeds dropped by the birds are seldom found on the under side of branches as in the European Mistletoe. This is accounted for by the smaller size of the Australian birds which feed upon the fruit of *L. Exocarpi*, and the less quantity of excreta, which is not semifluid and consequently does not flow down to the under surface, carrying the contained seeds with it, as is the case with the European *Viscum album*, described by Kerner and Oliver in "The Natural History of Plants."

A large bird, *Strepera cuneicaudata*, feeds upon the fruit, which it swallows whole, casting the seeds, as owls cast the bones, teeth, and hard indigestible parts of small animals eaten. These cast pellets, from their nature, never adhere to the branches, but occasionally lodge in forks, seldom if ever growing.

Numbers of seeds are deposited, or fall upon, branches which are covered with hard, stringy or corky bark, and, being unable to penetrate to the soft underlying cortex, perish. Nearly all the hosts on which the parasite has been observed, have the thicker limbs covered by dry, hard bark; and it is owing to this that we generally find the parasite start upon thin twigs or branches which have clean, tender, and sappy bark.

The seed, which is somewhat oval and about five-sixteenths of an inch long by three-sixteenths wide, is divided by five longitudinal furrows having at the upper end a short neck and apical pore (Plate xv.,figs.26-27). The embryo, which is clove-shaped, runs through the longer axis of the seed, and is completely surrounded by a store of plant-food, the whole of which, both embryo and food, is stained green by chlorophyll. In this respect it resembles the European Viscum described by Kerner and Oliver.

Germination usually takes place within one or two days after the seed has fallen, and even while the fruit is attached, but it may be delayed in some cases for a period of over fifty days. Germination having begun, the radicle emerges from the pore, which up to this moment it had filled, somewhat after the manner of a stopper in the neck of a flask. (Pl. xv., fig.26.)

In many instances the radicle tends downwards towards the branch, but in others it tends upwards and over the seed, reaching the branch behind (Pl.xv., figs.9-25).

As the axis of the embryo lengthens, it becomes covered by clavate processes. At the free extremity the radicle becomes enlarged, club-shaped, papillose, and of a pale yellowish colour (Pl.xv., figs.4-6).

This and the clavate processes exude a clear, glairy fluid, which plays a most important part in the life of the young plant. This sticky, oil-like fluid, coming in contact with the cortex of various plants, at once penetrates their structure, softening and partly dissolving the cellulose matter, and at the same time cementing the disc to the host. If a very thin piece of paper be inserted between the radicle and the branch, the fluid dissolves a passage for the radicle through which it reaches the underlying branch. If instead of paper a piece of mica or metal be placed in the same position, the radicle, after being in contact for a short period, moves forward and from side to side in search of a suitable place for attachment. If, however, this cannot be found, the plant continues to push forward until the tips of the cotyledons only remain within the seed (Pl.xv., figs.7-8).

The radicle, having reached the branch, becomes rapidly enlarged, spreading out into a hemispherical mass, which is formed of two flounce-like layers, one within the other. As the plant matures, branches arise from the outer layer, which thus takes the place of the bole or trunk of ordinary plants. The inner portion, or attachment disc, becomes at first firmly cemented, and in time grafted to the host (Pl.xx., figs.2-3). If the attachment-disc be removed after being in contact with the branch for a period of from ten to twenty days, it will be found to be somewhat concave, and have a cleft running three-fourths across the upper surface (Pl.xv., fig. 28). This cleft is formed by the sides of the disc, which are parallel to, and in contact with the branch, and which thicken and meet in the centre, forming a small chamber in the upper portion of the disc.

From the upper surface of this chamber a wedge-shaped process grows downward, corresponding to the sinker of *Loranthus Europæus.* This wedge passes through and is held in position by the lips of the cleft, which is always parallel to the longer axis of the branch (Pl.xvii., fig.2; Pl.xv., fig.29). Growth proceeding, the sinker passes through the bark, enters the sapwood, and if the branch be slender, passes completely through, appearing on lower side, where it becomes covered by its own bark. After passing the centre of the branch the invading process gradually increases in width, making a dove-tailed joint (Pl.xvi., figs.2-3). Or, the process having penetrated the bark, sapwood and that of the previous year's growth, invades the annular rings, and then splits the branch along the medullary rays, which it also invades, thus uniting the inner and outer layers of parasitic growth (Plates xvi.,fig.1, xvii.,fig.1, xviii., fig.4). In other instances the process, after penetrating to the centre of the branch, invades nearly all the medullary rays. Owing to the withdrawal of sap the branch beyond the parasite is retarded in growth, dies, and falls away. In this case the base of the parasite overgrows the entire end of the branch, which directly below the junction is much swollen and somewhat trumpet-shaped, the hemispherical base of the parasite making a junction more or less at right angles to the length of the branch. The excrescence is increased in bulk by thin sheets of the parasite growing outward from the central mass. These reaching the exterior of the swelling, become covered by bark. Excrescences have been observed with a diameter of six inches, though this is an exceptional size for this species.

In many instances, however, the portion of host-wood between the sheets of Loranth-tissue becomes submerged, owing to the cells of the parasite invading the cambium, and thus stopping further outward growth of the host. If the excrescence be cut through, portions of the parasite will be noticed, which have to all appearances grown from the exterior towards the centre. These vary in the depth to which they have penetrated, some just entering the sapwood, others with several annual rings of the host above their points. What really happens is that the Loranth cells invade the cambium, become lignified, and are built round by the annual growth of the host. Every annual ring buries the parasite deeper within the host; but, unlike the European species, it does not produce a root-system, like those mentioned by Kerner and Oliver, which invades the cambium cells of the host, either above or below the excrescence formed by the junction with the host. If the branch be cut off directly below the excrescence, new growth of the parasite will not occur. A transverse section through the base of the Loranth and Casuarina resembles a wheel, the spokes of which are represented by the host, the spaces between being occupied by the woody tissue of the parasite (Pl. xviii., fig. 4).

These nature-grafts differ one from the other in a marked degree, being influenced by the nature of the host and the size of the branch or twig on which the parasite first takes root.

When a plant starts on a branch from 1-1½ inches in diameter, the sinker penetrates the cortex and sapwood only (Pl. xix. fig. 1). The base of the attachment-disc becomes grafted to the surface of the branch, and by the constant thrust exerted by the outward growth of the base of the parasite, together with the irritation of the cells, spreads the branch at right angles to its length

(Pl.xix.,figs.2-6). The growth of the parasite being more rapid than that of the host, the bark of the latter is weakened or forced off, the space being occupied by Loranth cells. By this continued outward pressure and invasion, the base of the parasite completely surrounds the branch, which is forced off and falls away beyond the junction, and is then overgrown by the base of the parasite. The medullary rays are seldom, if ever, invaded in this type of graft (Pl.xix.,figs.5-6).

In microscopic sections taken from the base of the Loranth, the cells are found to be crammed with starch granules, as indeed is the whole of the parasite, even from the early stages of its growth. If the excrescence be sawn through, smoothed, and then placed in a bath of dilute iodine, the portion formed by the Loranth-tissue will become black, owing to the great quantity of contained starch. A clear, well-defined junction can then be observed (Pl.xviii.,figs.5-6).

Branches bearing parasitic growths when compared with others from the same tree, are lacking in starch to a marked degree. Observations are, however, being carried out to ascertain if the sap returned to the host from the Loranths is capable of supporting and building up the host. Trees, especially *Casuarina* and *Acacia melanoxylon*, perish when plants of *Loranthus Exocarpi* have been established on them for some years. The cause of death is not yet definitely known, but in this case it is probably owing to the great quantity of starch stored within the tissues of the Loranths, thus bringing about a slow starvation of the host.

During the year 1907, and on subsequent dates, small branches bearing Loranths, as well as others which were free, were ring-barked, the cambium being completely scraped away, as well as some of the sapwood. These branches were examined a month later, and in all cases the Loranths were still fresh, while the other branches were dead, or nearly so. On 4th April of the present year, similar experiments were carried out, and the Loranths were quite fresh on June 2nd following.

A seed with two embryos is represented in Plate xv., fig.30.

The production of two or more sinkers from the attachment-disc, which takes place when the inner portion of the disc becomes wedged in a forked branch, is represented in Plate xviii., fig. 7.

Young plants of *Loranthus Exocarpi* are at first erect, but, as the plant increases in size and weight, the branch is twisted, the Loranth becoming pendulous (Pl.xx., fig.4).

EXPLANATION OF PLATES XV.-XX.

Plate xv.

Figs.1-27.—Seeds of *Loranthus Exocarpi* Behr, in various stages of growth and sections of some.

Fig.28.—Attachment-disc and cleft through which the sinker reaches the branch of the host.

Fig.29.—Section through attachment-disc, parallel to the cleft, showing sinker.

Fig.30.—Seed producing two radicles.

Plate xvi.

Fig.1.—Young plant of *Loranthus Exocarpi* on *Casuarina quadrivalvis.* The sinker has penetrated the annual rings and medullary rays.

Figs.2-3.—Sinker through the centre of twigs.

Plate xvii.

Fig.1.—Same as fig. 1 of previous plate.

Fig.2.—Section through attachment-disc and portion of Prunus branch, sinker passing through and held in position by the lips of the cleft.

Plate xviii.

Figs.1, 2 and 4.—Various types of graft with *Casuarina quadrivalvis.*

Fig.3.—*Loranthus Exocarpi* on *Loranthus pendulus.*

Fig.5.—Microscopic section from base of *Loranthus Exocarpi.* Cells crammed with starch grains, iodine-stained.

Fig.6.—Micro. section of junction of Loranth and host-plant, showing starch, iodine-stained.

Fig.7.—Attachment-disc developing two sinkers.

Plate xix.

Figs.1-6.—*Acacia melanoxylon*, showing grafts not penetrating medullary rays and method of formation. [Fig.6 is erroneously lettered 7].

Plate xx.

Figs.1-4.—Life-history, from the germinating seed to one year old seedling.

GEOLOGICAL NOTES ON KOSCIUSKO, WITH SPECIAL REFERENCE TO EVIDENCES OF GLACIAL ACTION.

Part II. By T. W. Edgeworth David, B.A., F.R.S., etc

(Plate xxiii.)

i. Introductory.

An earlier paper dealing with this subject was contributed by Messrs. Richard Helms, E. F. Pittman, and the author.*

During subsequent examinations of the Kosciusko plateau, chiefly in January and February, 1906, and in January, 1907, additional information has been obtained which is now embodied in the present paper.

In January, 1906, the Kosciusko plateau was visited by me in company with Judge Docker, Mr. H. J. Carter, and Messrs. G. and E. Carter. On that occasion a coracle was constructed at the Blue Lake, and a set of soundings were obtained. In February of the same year the plateau was revisited, the party this time consisting of Mr. C. Hedley of the Australian Museum, Mr. G. A. Waterhouse of the Royal Mint, Sydney, and my wife and, myself. The coracle was refitted with a view to dredging, and with Mr. Hedley's help, numbers of hauls were made from the lake-bottom which enabled us to form some idea of the nature of its fauna. Some of the material thus obtained has been described by Professor Benham of Otago University, New Zealand.

During January, 1907, a third visit was paid to Kosciusko in company with a large party of University students, together with Mr. E. C. Andrews of the Geological Survey, N.S.W., Mr. C. A. Süssmilch of the Technical College, Sydney, and Mr. A. Mackie, Principal of the Training College, Sydney. On the occasion of this trip, thanks very largely to the experience of Mr. E. C. Andrews, important additional information was obtained as to the downward limits of the Kosciusko Pleistocene glaciation, and some means of estimating its duration in geological time.

* These Proceedings, 1901, xxvi., pp.26-74, pls.3-10.

During a brief visit in September, 1907, in company with Mr. Leo A. Cotton, Junior Demonstrator in the Geological Department of the University of Sydney, additional information was obtained which is now embodied in this paper.

A bibliography relating to Kosciusko has already been published in the paper already referred to.

ii. General Geological Features.

In travelling from Cooma to Kosciusko, a distance of about 35 miles has to be traversed before the Snowy River is reached at Jindabyne. The general nature of the section has already been described in the previous paper, but later information suggests the following additions or modifications.

The gneissic granite at Cooma has now been proved to pass in places into coarse mica schists with large dark pseudomorphs after andesite. These schists are not only veined with pegmatite containing large bunches of black and whitish-grey tourmaline, but are interleaved with granite, of the nature of partly reconstructed granite, to such an extent that one cannot say where the schist ends and the granite begins; in fact the schist itself seems to pass by insensible gradations into a reconstructed granite. This granite is strongly foliated and has large crystals here and there of adularia felspar which render it porphyritic. This belt of rocks extends from Cooma to Pine Valley, a distance of a little over 5 miles. The rocks are so unlike those of Kosciusko as to justify the supposition that they may belong to a distinctly older series. Lithologically they are not unlike the rocks of the Mitta Mitta massif in Victoria, which are assumed to be of Pre-Heathcotian age and probably Pre-Cambrian. Outwardly too they very much resemble the Pre-Cambrian series which stretches northwards from near the Murray Bridge in South Australia, forming the eastern foot-hills of the Mount Lofty and Flinders Ranges.

Provisionally then I would suggest that they may be classed as Pre-Cambrian.

A careful examination of the country in the neighbourhood of Barney's Ridge, overlooking Lake Coolamatong, has led me to the conclusion that the lake owes its origin probably to a down-throw fault to the east having a nearly meridional trend. It may be mentioned, too, that recently Mr. W. S. Dun, Palæontologist to the Geological Department, and University lecturer in Palæontology, has identified specimens of *Leptograptus* amongst the Graptolites found at about 2 miles westerly from Berridale. Near Kara Station, about 28 miles from Cooma, there are traces of large river-pebbles marking the former channel of an ancient river, a tributary of the Snowy, or possibly the Snowy River itself. It was pointed out by Mr. Andrews that at the top of the long hill bounding the Snowy valley on the east, at 32 miles from Cooma towards Jindabyne, the small hanging valley, which there descends through a rocky precipitous channel into the broad valley of the Snowy, possibly owes its origin to a strong fault throwing down westwards. Certainly the great width of the Snowy valley, between two and three miles at this spot, is a puzzling feature. Below Jindabyne the valley is narrowed in by rocky rounded foot-hills through which the Snowy River has cut a zigzag gorge with overlapping rocky spurs. The question suggests itself, is this wide flat valley with its rounded rocky foot-hills due to the glaciation accompanied by a Piedmont glacier supplied by cascades of ice formerly pouring over the edges of the Kosciusko plateau in their passage to the east? Or is this feature due simply to trough-faulting? Is the Snowy valley above Jindabyne on the side of a narrow senkungsfeld or trough-fault?

It appeared clear to Mr. Andrews and myself that there was a heavy fault bounding the Kosciusko plateau on the south-east, parallel to the channel of the Thredbo or Crackenback River. The throw of this fault appears to increase towards the north-east, lessening, however, and possibly dying out altogether in a south-westerly direction. We also obtained evidences of probably more than one cross-fault running almost at right angles to the direction of the main fault. One of the most noticeable of these is at Pretty Point, about 8 miles from the Thredbo crossing towards Kosciusko. The trend of this Pretty Point fault is about N. 20 W. and S. 20 E., the downthrow being towards E. 20 N. This fault is approximately parallel to the general trend of Digger's Creek on which the new Hospice is now being erected. The probable amount of downthrow of the Pretty Point fault is about 200 feet.

There is also probable evidence, though more doubtful, of a downthrow fault in the neighbourhood of the usual camping place on Sawpit Creek, at about 3 miles from the Thredbo crossing towards Kosciusko. This faulting is also in a similar direction to the preceding, so that there is distinct evidence in this part of Kosciusko plateau of its having been step-faulted in an E.N.E. direction towards the junction of the Snowy River with the Eucumbene.

Possibly this step-faulting, combined with the relief found by the earth's crust to the tension from upward warping which culminated in the Thredbo valley, may account for the remarkable direction taken by the Snowy River in the first part of its course. As is shown by the map, it flows first almost due north, inclining gradually to N.N.E., then bends sharply to the east at a spot about 5 miles westerly of the junction of the Thredbo and the Snowy. There can be little doubt that the Kosciusko plateau represents an ancient warped peneplain heavily faulted on its south-eastern margin.

On the whole we are inclined to believe that although the maximum glaciation of Kosciusko dates back probably 100,000 years from the present time, these fault-features may be still older.

iii. Evidences of Glacial Action.

These may be grouped as follows :—

(1) General smoothing of rock-surfaces.

(2) Roches moutonnées, and grooved and striated rock-surfaces.

(3) Erratics and perched blocks.

(4) Terminal and lateral moraines.

(5) Lakes and tarns of glacial origin, together with alluvial flats and swamps representing silted-up old lake-basins.

(6) U-shaped valleys.

(7) Hanging valleys.

As regards evidence (1), Professor Lendenfeld has recorded the fact* that the rocks at "Tom's Flat" (Thompson's Flat) are smoothed and hollowed-out in a manner very suggestive of glacial action (*op. cit.* p.10, and Plate v.).

Mr. Richard Helms, in his most valuable paper to this Society,† has argued that the evidences of glacial action of this kind can be traced as far down as Boggy Plains and the head of Wilkinson's Valley, that is almost to a level of 5000 feet above the sea.

During my earlier examinations of Kosciusko Plateau it appeared to me difficult to realise that areas such as, for example, the Porcupine Ridge and Wragge's Camp, with their huge tors and spines of granite, could possibly have been glaciated in recent geological time. It seemed hard, too, to understand how smoothed rock-surfaces, such as those studied by Lendenfeld and Helms at Thompson's Flat, could have been glaciated by ice, while within a few yards of the same smoothed rocks are granite tors and blocks of granite, many feet in diameter, lightly poised upon one another, the latter structure being obviously due to prolonged weathering under conditions free from ice. These apparent inconsistencies, it appears to me, are now explicable on two grounds, viz.:—

First, an obvious fact, which should have attracted my attention before in connection with the preservation of glacial evidences at Kosciusko, is this, that where the snow is most heavily drifted there the rock-surfaces are best protected from the action of the weather. The presence alone of snow-drifts

* Report on the Results of Recent Examination of the Central Part of the Australian Alps, by R. von Lendenfeld, pp.1-16, Pl.i.-vi., Govt. Printer, Sydney, January 21, 1885.

† "On the Recently Observed Evidences of an extensive Glacier Action at Mount Kosciusko Plateau," by Richard Helms. Proc. Linn. Soc. N. S. Wales, Series ii. Vol. vii. 1893, p.355 and Pl.18.

year after year for thousands of years at a particular spot, the drifts perhaps disappearing only for a few weeks in each year, may preserve very effectively a small surface of granite rock, glaciated it may be 50,000 years ago, while in the immediate vicinity former glaciated rock-surfaces, not so protected by snow-drift, may become considerably weathered so as to produce the tor structure already referred to. It is obvious that the strongly marked differential weathering one sees so frequently on the Kosciusko Plateau is to be correlated chiefly with differential thickness of snow-covering. Obviously, too, variations in thickness of once protecting covering of morainic material has also played an important part, though not so important it seems as the snow drifting, in protecting old glaciated surfaces from the destructive action of the weather.

In the second place, in my original observations I had vastly underrated the age of the glaciation. The maximum glaciation, for reasons which will be adduced presently, probably took place at a period of time removed from 100,000 to 200,000 years from the present.

It may be stated at once that while evidences such as those grouped under (2), (3), (4) and (5) are most conspicuous in connection with the latest phenomena of Pleistocene glacial action at Kosciusko, the phenomena of U-shaped valleys, hanging valleys, filled-up lake-basins, and smoothed rock-surfaces are now the chief evidences to be relied upon for the former extent of the maximum glaciation.

Of the kinds of glacial evidences which are preserved amongst recent glacial phenomena, special reference may be made to the beautiful glacial lake known as the Blue Lake. On the evidence of this lake, and the extensive moraines below, between Hedley Tarn and the valley of the Snowy, in Evidence Valley, it was asserted in our previous paper that the glaciers came down to within 5,800 feet of sea-level from the summit of Kosciusko, which according to the most recently reduced trignometrical observations is about 5,305 feet above sea-level. We are now, however, in a position to state that the ice came down probably at least 800 feet lower, and that the glaciers and ice-fields had a far greater extent than was at first supposed.

The chief notes, then, in this paper modify or add to our previous statements about the glacial evidences relating to the Blue Lake, and to the U-shaped valleys, hanging valleys, and filled-in lake-basins outside and below the higher region of where traces of glaciation are fresh and conspicuous.

The Blue Lake.—With the help of a coracle made of an outer skin of American cloth on a framework of gum-sticks and rabbit-proof wire-netting, a series of soundings was obtained of this lake, which proved its greatest depth to be about 75 feet. With the help of Messrs. H. J., G. and E. Carter, C. A. Süssmilch and H. S. Mort, a sketch-survey of this lake was plotted, and the cross-section proves that the lake is a true rock-hollowed basin. A photograph taken by Judge Docker exhibits a fine example of a hanging valley on the north side of the lake. This hung about 200 feet above the lake-level. The dredgings made by Mr. Hedley and myself have yielded the following freshwater Annelids (*Oligochæta*)—*Tubifex davidis* Benham,* *Branchiura pleurotheca* Benham, *Phreodriloides notabilis* Benham.*

With reference now to the evidence of U-shaped valleys as indicating glaciation, a very interesting section is afforded by the Snowy River Valley, just below the junction with it of the creek which forms an outlet to the Club Lake. The section is a short distance below the spot known as the Pile of Stones, just N.W. of Charlotte's Pass. There is an old filled-in lake just above the spot where this cross-section was taken. For this filled-in old glacial lake the name of Lake Andrews is suggested. If the observer looks down upon the small silt-plain, which at one time formed the floor of this lake, he will see evidences, in the U-shaped contour of the valley below, of the former existence of the rocky bar which led to the impounding of the Snowy River water, and so to the formation of the lake. The Snowy River has gradually cut down a V-shaped notch through this bar to a

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* Benham, Rec. Austr. Mus., 1907, vi. pp.251-264, pls.46-47.

depth of 60 feet in very hard granite. The work done in cutting out this notch represents probably the whole amount of erosion accomplished by the Snowy River since the recession of the ice from this part of the Snowy Valley. According to the experiments of Mr. C. C. Brittlebank in Victoria, it would take a river like the Snowy from 50,000 to 100,000 years to accomplish such a work. These data are obviously only very approximate, and this points not to the oldest but to the middle phase of the glaciation.

Having traced the course of the old Snowy glacier down to this spot, which is only 5,500 feet above sea-level, we explored the country along to the east of Charlotte's Pass in the upper portion of Spencer's Creek. There was clear evidence of the glacier-ice having crossed the valley of the Snowy, forced its way over the high ridge of Charlotte's Pass, and having streamed down into Spencer's Creek; as it cascaded over the Pass it gouged out deep lake-hollows; on the eastern side of the Pass, at least three such being distinctly visible. It is proposed to call these Lakes Lendenfeld, Mackie and Süssmilch.

On the south-east side of Spencer's Creek several excellent examples of hanging valleys were observed. Another beautiful and typical hanging valley is to be seen up the northern tributary of Spencer's Creek, to the south of the Perisher, about a mile above the site of the new Betts' Camp; this valley is hung about 150 feet above the main valley. Mr. Andrews was of opinion that the phenomenon of this hanging valley was due to the differential erosion of a heavy mass of ice coming across from the direction of Mt. Twynam over the ridge which separates the Snowy River from Spencer's Creek, then plunging downwards as it crossed the northern tributary of Spencer's Creek, and moved eastward to the north of Betts' Camp over the shallow depression of the plateau into the valley of the Thredbo River. Numerous large blocks of phyllite were found by us in Spencer's Creek valley, resting there on a granite surface. These phyllite blocks must have boen transported from the direction of the belt extending from Kosciusko to Mt. Twynam, a distance of 4 or 5 miles.

At a spot between Betts' Camp and Pretty Point, known as Taylor's Bog, about a mile N.E. of the Porcupine Ridge, there is a small but well-marked old moraine, 15 chains in width and about 20 feet in height. The altitude of this moraine is about 6000 feet above sea-level. Near this locality, too, a block of phyllite was observed showing obscure glacial striæ.

A re-examination of the smoothed granite surfaces at Thompson's Flat convinced me that they were of true glacial origin, and even as far down as Boggy Plains in the head of Wilkinson's Valley Mr. Andrews agreed with me that there was distinct evidence of glacial action, chiefly in the form of the smoothed rock-surfaces and the arrangement of the morainic material.

From the foregoing observations it may be concluded that the ice-sheet during the maximum glaciation extended to at least 12 miles N.E. from Mount Kosciusko, and that the ice-sheet moved in a general S.E. to E.S.E. direction from the main dividing range between the Snowy and Murray Rivers towards the valley of the Thredbo. By far the greater portion of the ice-sheet, or calotte, lay to the S.E. of the main divide, and spread to a distance of probably at least 7 miles at right angles to the former. At the same time there is evidence also of small glaciers descending to the west of the main divide, such as those which formed the glacial features of Lake Albina, of the Wilkinson Valley, and of Lake Cootapatamba.

The total area covered by the ice-calotte of Kosciusko during the maximum glaciation was probably about from 80 to 100 square miles. This does not take account of the high land to the south of Kosciusko on the south-east side of the Thredbo River. It is more than probable that this, too, during the maximum glaciations harboured glaciers.

The greater development of the ice-cap on the south-east side of the main divide as compared with the portion to the north-west is obviously due to the fact that the drifting of the snow on the Kosciusko Plateau is controlled chiefly by the anti-trade wind, which blows there during the greater part of the year from the N.N.W., consequently the north-west slopes are swept more or less free of snow, while the snow is banked deep on all the south-east slopes.

As regards the thickness of the ice-sheet during the maximum glaciation, there is conclusive evidence now that it was able to cross the Snowy Valley and over-ride Charlotte's Pass Valley, the whole of Spencer's Creek Valley, and plunged over the south-eastern edge of the Plateau into the Thredbo Valley. In order to do this, the ice in the Snowy Valley must have had a thickness of not less than 1000 feet. Thus, in view of this recent evidence, one is able to state that the Kosciusko ice-cap at the time of the maximum glaciation was fully twelve times as large as was formerly stated, and that the ice was at least double the thickness of the amount originally calculated.

If now a summary be given of the probable events which preceded, accompanied, and followed the Pleistocene Ice Age at Kosciusko, it may be provisionally grouped as follows:—

A late Tertiary peneplain, formed of granite, gneissic rocks, and schists, was uplifted to a general level of about 3000 feet above the sea. From Cooma towards Kosciusko a further upward warping took place which led to the peneplain acquiring an inclination towards the north and east; this gave the Snowy River its original northerly to N.N.E. trend near its source. As the warping progressed, and the earth's crust towards the S.E. of the Kosciusko Plateau was put in tension, shearing followed, resulting in the great fault along the Thredbo Valley. Cross-faults also developed at Pretty Point and along Digger's Creek, marked now by a strong feature as well as freshwater springs, and probably also at Sawpit Creek. Possibly another fault may have formed on the south-east side of the Snowy Valley, producing a long narrow trough; possibly a lake may have been produced at the bottom of this trough, and the remarkable gravel banks to be seen two miles to the south-east of the Accommodation House on the Thredbo may be of lacustrine origin and antedate the coming down of the rocky bar near the mill-race below Jindabyne. The fault with its easterly throw at Barney's Ridge, which may have given origin to Lake Coolamatong, may have formed about the same time.

Next, at a period of time many scores of thousands of years removed from the present, possibly 200,000 years ago, Kosciusko was gradually covered by great fields of névé and glacier-ice, and all but the very highest peaks of the Plateau, such as the Nunatakr of the Etheridge Range, were completely shrouded in the ice-cap. The snow-field moved chiefly in a S.E. direction, pouring its ice over what is now a precipitous escarpment leading down into the Thredbo Valley. It is not yet known whether there was sufficient ice to form a Piedmont glacier in the valley below. Further examination of this valley is much to be desired with a view to gaining information upon this interesting point. During this maximum glaciation even the flats at Boggy Plains and the upper part of Digger's Creek were occupied by ice. The ice-flood gouged out the glacial lakes near new Betts' Camp—Lakes Lendenfeld, Mackie, and Süssmilch.

There now followed a considerable recession of the ice-sheet; the glaciated surfaces near Lake Albina belong perhaps to this stage.

Next we find in far more recent geological time, perhaps removed by only 10,000 to 20,000 years from the present, evidence of a fresh and conspicuous glaciation. Lakes Cootapatamba, Albina, Club, the Blue Lake, and Hedley Tarn were formed during this epoch. Even this latest glacial epoch is divided into two, if not more stages. For instance, as shown in our previous paper, there is distinct evidence of a double series of terminal moraines on either side of the main dividing range. As remarked in the previous paper (p.63), the height of these moraine-embankments is from 80 feet up to over 200 feet, and their length, which is between a quarter and half a mile, proved that the pauses of the ice-front at the spots where the moraines became developed must have been of considerable duration. During the long time which elapsed between the recession of the great ice-sheet after it had retired as far up the Snowy Valley as Lake Andrews, and the epoch when the terminal moraines of Hedley Tarn were formed, erosion was taking place in the valley of the Snowy River and its tributaries. The old typical U-shaped valleys became slowly converted into V-shaped valleys; the V-shaped notch in the hard gneiss below Lake Andrews having required a period of time of probably from 50,000 to 100,000 years for its erosion. As stated in our previous paper, the amount of erosion that has taken place since the last and youngest of the Kosciusko glaciers disappeared may be estimated at from perhaps 10,000 to 20,000 years.

It may be suggested that in view of the above facts we may conclude that the snow-line at Kosciusko during the maximum glaciation was fully 300 feet below the present limit. This would involve a lowering of the mean temperature by about 10° Fah.

There is now great need for a more detailed examination of the glacial phenomena at Kosciusko as well as on the adjoining plateau to the south-east, above the right bank of the Thredbo. It is also very desirable that careful examination be made of the Snowy Valley above and below Jindabyne down towards Delegate, and of all the country between Jindabyne and Kiandra where there are traces now of small lakes or tarns.

The suggestion, too, may be made that the Dargo high plains of Victoria, including the high plateau of the Fainter, may be carefully examined. Mr. E. C. Andrews has recently explored the Bogong Range proper and found that it is more of the nature of a high ridge unsuited for forming the gathering ground of an ice-sheet of considerable dimensions. The plateau of the Fainter, however, is of far greater extent, and would probably have carried glaciers during the maximum glaciation of Mount Kosciusko. It will thus be seen that these recent observations tend to greatly increase scientific interest in the Alpine region of Australia.

EXPLANATION OF PLATE xxiii.

View of the Valley of the Murray, from Lake Albina. (From a photograph taken, and kindly lent, by Judge Docker).

OPSONISATION FROM A BACTERIAL POINT OF VIEW AND OPSONIC TECHNIQUE.

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

When this research with *Micrococcus aureus* was begun, about two years ago, the tendency of opsonic investigation had been chiefly in the direction of the opsonic content of serum, and little had been done from the point of view of the bacterium and its environment. It appeared that much might be gained by regarding opsonisation from this aspect, especially as bacteria are inferentially considered to form or secrete an opsonisable substance. Variations in the formation of this body should be shown in an increased or decreased opsonisation of the bacteria. The measure of the formation will be shown by the extent to which the bacteria are ingested by the phagocytes, and especially by the polymorphonuclear leucocytes of the blood after treatment with opsonin-containing serum. As the research proceeded, questions regarding the technique of the process arose, and the scope of the investigation broadened.

The virulence of young cultures.—In the action of opsonic serum upon bacteria, we might obtain an explanation for the virulence of young as compared with older cultures of bacteria, especially if we take into account the remaining feature of the total phenomenon of which opsonisation is the first and phagocytosis the second step. The ingestion of the bacteria, although undoubtedly a great advance towards their destruction, need not necessarily mean that they are rendered less virulent. Indeed phagocytosis might make bacteria more deadly by conveying them to distant and more vulnerable parts of the animal. If an increased opsonisation is going to enable us to understand the reason for the lessened virulence of older cultures, the increased phagocytosis must also be accompanied by an increase in the intracorpuscular digestion of the englobed bacteria.

The question of the intracorpuscular digestion of the bacteria was therefore bracketed with that of opsonisation.

Age of culture.	Cocci per leucocyte.	Stained and counted six weeks later.
1 day...................	25	19
2 days..................	35	23
3 days..................	28	19
4 days..................	22	15

We see from this experiment that the bacteria of the 24 hours' culture are more feebly opsonised than those of the 48 hours'; it is assumed, therefore, that they are more virulent. The counts made at the later date show that intracorpuscular digestion has occurred.

A confirmation of the greater digestibility of the englobed bacteria was made about eighteen months afterwards, but the experiment took a different form, as the table will show.

	Cocci per leucocyte.			
Time of incubation in minutes...	5	10	15	30
Age of culture—1 day............	3·6	6·5	8·5	9·5
,, 2 days............	5·6	8·5	10·8	13·4
,, 3 days............	5·1	7·3	9·0	11·4

Again we see the more feeble opsonisation of the bacteria of the 24 hours' as compared with those of the 48 hours' cultures. If the results are plotted in such a way as to make the ages of the cultures the abscissæ, and the phagocytic indices or cocci per leucocyte the ordinates, and the points are joined by straight lines, we get four angles, one for each time of incubation. On the paper which was used the angles measured approximately—

5 minutes' incubation............	120°
10 ,, ,, ...	102°
15 ,, ,, ...	90°
30 ,, ,, ...	73°

The diminishing angle is a measure of the lack of staining power, that is, of the intracorpuscular digestion. It is, however, but a method of showing what was most clearly seen in the films; the majority of the bacteria within the leucocytes were, in the case of the three days' culture, imperfectly stained, and were clearly in process of resolution.

One more point seen in both of the experiments is the lower phagocytic index of the bacteria in the three and four days' cultures as compared with those of the two days'. This is probably another illustration of the greater intracorpuscular digestion of the older cultures and not an evidence of the formation of anti-opsonins. An amplification of the last experiment was made in order to see how still older cultures behaved. The results were most irregular, and it appeared that ingestion and digestion were occurring simultaneously and irregularly.

Days ...	1	2	3	4	6	7	10	15
Cocci per leucocyte ...	2·8	3·4	3·0	3·8	2·7	3·5	4·2	2·3

The formation of auto-opsonins.—Old cultures of *M. aureus*, whether in bouillon or on agar, are more translucent than young cultures, and, as in the case of *B. pyocyaneus*, the translucence may be due to the production of autodigestive ferments. Auto-opsonins may also be secreted. To determine this point, an experiment was made in which normal saline was used in place of serum.

Age of culture.	Cocci per leucocyte.
1 day	0·5
2 days	0·7
18 days	0·6
22 days	1·7

The result shows that no auto-opsonins are formed.

The opsonic identity of races of M. AUREUS.—*M. aureus* has been used throughout this series of researches because it is a micro-organism that lends itself admirably to the purpose. Races were obtained at different times from pus, and, as the following shows, these races were opsonically identical.

	Cocci per leucocyte.
Race (OR) eight months after isolation	25
(NR) two weeks ,, ,,	26
(OR) ten months ,, ,,	31
(NR) ten weeks ,, ,,	31
(AR) one day ,, ,,	32

Experience has led us to know that the virulence of bacteria generally diminishes while they are maintained under the artificial conditions that obtain in growing them in the laboratory. The opsonic identity of these races is at variance with this idea regarding the loss of virulence unless it be that there is no relation between virulence and power of being opsonised.

Moist and dry growths of bacteria.—In the belief that the bacteria in the dry upper portions of an agar slope might produce an amount of opsonisable substance different from the bacteria in the moist lower portions, the following experiment was made:

	Cocci per leucocyte.
Moist lower portion of slope in normal saline	27
Dry upper portion of slope in normal saline	22
Washed cells of moist portion in normal saline	27
Washed cells of moist portion in its own condensed water, diluted 1 : 24 with normal saline	27

This result led to the following set of experiments, which were made at different times:—

	Cocci per leucocyte.							
	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.
Dry upper cells of agar slope	19	8	10	3	5	10	5	8
Moist lower cells of agar slope	22	9	8	3	5	10	4	7

It is evident from these that when moderately strong suspensions of bacteria are used, the cells of the moist growths are more completely opsonised than the bacteria of the dry cultures. When, however, the suspensions are not so opaque, the differences in the opsonisation are not evident.

Staphylococci which had grown on the surface of nutrient agar were then tested against washed cocci which had been grown in bouillon.

	Cocci per leucocyte.			
	i.	ii.	iii.	iv.
Bacteria grown on dry agar ...	8·1-8·6	3·1	3·8	10·6 (five days'
Bacteria grown in bouillon.....	6·8	3·2	3·6	6·1 culture.)

It is clear that there is something in the bouillon that prevents the relative ingestion of the bacteria grown in it. To see if experiment could throw any light upon the nature of this substance, the following modifications of meat-extract were made, and the phagocytic activities of the leucocytes upon the washed bacteria grown in them were noted.

	Cocci per leucocyte
Experiment i.	
Raw meat extract	6·2
The same with 0·5% sodium chloride	8·0
,, ,, 1% peptone	5·5
Neutral bouillon	4·8
Experiment ii.	
Raw meat extract charged with calcium phosphate ...	4·4
Raw meat extract	5·1
Neutral meat extract	7·7
Raw meat extract with 0·5% sodium chloride	6·2
The same neutralised	5·6
,, ,, + 1% peptone (=bouillon) ...	5·6
Experiment iii.	
Raw meat extract	3·7
,, ,, with 0·5% sodium chloride	8·6
Neutral meat extract	5·0
,, ,, with 0·5% sodium chloride ...	7·8
Experiment iv.	
Acid bouillon (natural acid=0·1% Na_2CO_3)	7·0
,, ,, with 0·1% Na_2CO_3	6·8
,, ,, ,, 0·2 ,, ...	5·5
,, ,, ,, 0·3 ,, ...	11·4
,, ,, ,, 0·4 ,, ...	8·1
,, ,, ,, 0·5 ,, ...	12·7
,, ,, ,, 0·6 ,, ...	10·5

From these experiments it is seen that the presence of calcium phosphate in the culture-fluid causes the bacteria to be less easily phagocytosed. Common salt on the other hand increases the production of the substances which react with the opsonin of the serum. The addition of alkali up to a certain point lessens the formation of these substances in the presence of sodium chloride, but increases the formation in its absence. In experiment iv. the greater ingestion with large amounts of alkali is due to the bacteria having been collected in groups of two, three and four cocci.

The addition of a sugar such as saccharose to neutral bouillon apparently favours the formation of larger quantities of the substance which hinders opsonisation, as will be seen from the experiment on page 694.

The presence of anti-opsonins in old bouillon cultures.—The low index of the washed cells of a 5 days' bouillon culture as compared with a 24 hours' agar culture indicated that they were either deficient in opsonisable substance or that the latter had been annulled by some antibody that had been formed in the bouillon. The low index could not be explained by intracorpuscular digestion. The phenomenon led to the testing of the action of the cell-free fluid from the 5 days' culture in promoting or hindering phagocytosis. The older method of measuring the suspensions was employed as it prevented the results being rendered less sharp by the presence of an excess of saline. The proportions were 3 : 3 : 1 : 1, the last part or eight being the cell-free bouillon diluted with saline.

—	Cocci per leucocyte.	
	5 days' culture.	6 days' culture.
Saline (check test)	4·3	7·3
Cell-free bouillon, neutralised, 3 fold dilution..	1·4	3·2
,, ,, ,, 8 ,, ,, ...	2·2	3·5
,, ,, ,, 16 ,, ,, ...	2·9	4·1
,, ,, not ,, 3 ,, ,, ..	—	3·6
,, ,, ,, ,, 16 ,, ,, ..	—	4·7

It is evident that the cell-free bouillon has a depressing influence which is so pronounced that even in a dilution of $\frac{1}{16}$, which is $\frac{1}{16} \times \frac{1}{8}$, or $\frac{1}{128}$ of the whole test, the phagocytic index is reduced from 4·3 to 2·9, and from 7·3 to 4·1 or 4·7. The depressing constituent may be an anti-opsonin, aggressin or anti-phagin.

The anti-opsonic substance is not influenced by heating at 60° for 15 minutes, indeed, the depressing action is slightly augmented, as the following shows :—

——	Cocci per leucocyte.	
	not heated.	heated.
Saline (check test)	4·6	—
Cell-free bouillon	1·7	1·6
,, ,, diluted 16-fold	2·8	2·2
,, ,, ,, 32-fold	3·3	2·7

By heating bacteria in normal saline at 60°, Bail and Kichuchi were able to extract an anti-bacteriolysin and Weil obtained an anti-agglutinin. Since both of these antibodies were extracted, it might be possible to obtain yet another, an anti-opsonin, by the same process. Accordingly, a 24 hours' agar culture of *M. aureus* was distributed in about 2 c.c. of normal saline and heated at 60° for an hour. The bacterial cells were eliminated by centrifugalising the suspension. To a portion of this cell-free extract an equal volume of bacterial suspension was added and as a control upon this the same bacterial suspension was added to an equal volume of normal saline. The tests, i. and ii., were made at different times, the extracts being obtained from agar cultures of similar age.

	Cocci per leucocyte.	
	i.	ii.
Normal saline...........................	6·2	5·3
Bacterial extract......................	4·2	3·4

It is clear that the saline extracted something of the nature of an anti-opsonin, for while the saline in which the bacteria had been heated contained a substance which lessened opsonisation, the bacteria themselves were more easily opsonised than the ordinary cells from an agar culture, as the following shows—

	Cocci per leucocyte.
Bacteria distributed in saline................	3·8
Bacteria heated in saline and then washed	6·2

An attempt was then made to determine the action of the bacterial extract upon normal bacteria, corpuscles and serum individually. The serum and suspensions were so prepared (whole and half volumes) that the final incubation-tests contained similar dilutions of suspensions and of serum.

	Cocci per leucocyte. Total cells.
1. Bacterial extract + an equal volume of bacterial suspension, incubated for 15 minutes, centrifugalised, washed, suspended in original volume of normal saline..............	3·6
2. Bacterial extract + an equal volume of corpuscular suspension, incubated for 15 minutes, centrifugalised, washed, suspended in original volume of normal saline...	4·4
3. Bacterial extract + an equal volume of bacterial suspension, no preliminary incubation.............	3·0
4. Bacterial extract + an equal volume of serum, incubated for 15 minutes................	1·9

The action of the bacterial extract upon the serum (No.4) shows that the depressing action of the substance extracted by the hot normal saline from the bacteria has been exerted upon the serum only, and, since it is the opsonic activity that had been determined, it follows that the extract contains anti-opsonin.

The temperature of growth.—A preliminary test having shown that the bacteria which had been grown on agar at 22° were more easily opsonised than those grown at 37°, the following tests were made :—

	Cocci per leucocyte.							
	i.	ii.	iii.	iv.	v.	vi.*	vii.	viii*
Bacteria grown at 37°................ ...	31	41	10	7	14	12	4	4·5
Bacteria grown at 22°....................	55	53	17	11	20	24	5	6

vi*., a three days' culture; viii.*, a four days' culture.

It is clear from these experiments that the lower temperature of growth enables the bacteria to be more strongly or more easily opsonised. This was also noted in a former paper where it was suggested that the lower temperature permitted the elaboration of a greater amount of opsonisable substance in or upon the bacterial cells. A similar experiment was made at a later date with the following results :—

	Cocci per leucocyte.	
	i.	ii.
Bacteria grown on agar at 37°	5·1	3·8
Bacteria grown on agar at 22°	8·6	6·9

It was noted that the bacteria within the phagocytes in the case of the cells grown at 37° were single while those grown at 22° were chiefly in pairs. Upon repeating the enumeration and counting the pairs as units, numbers were obtained which were approximately the same. For example, a fifty count of a 22° test gave 183 groups of pairs and units, and counting each pair as consisting of two units, the count came to 318. If the phagocytic indices of the bacteria grown at 22° are multiplied by 0·58 ($=\frac{183}{313}$), they approximately equal the indices of the bacteria grown at 37°.

In testing the cells grown in bouillon, it was found that there was little difference in the 24 hours' cultures. In older growths, however, there was a considerable difference, probably resulting from the increased elaboration of anti-opsonin at the higher temperature.

	i.	ii.	iii.	iv.*	v.	vi.*	vii.
Bacteria grown in bouillon at 37°	11	5	16	15	6	4	5·4
Bacteria grown in bouillon at 22°	11	8	16	26	7	8	6·3

iv.*, a three days' culture; vi.*, a four days' culture.

The addition of dilute acid and alkali.—A test in which the condensed water of an agar culture was added to the mixture of serum and suspension gave an increased phagocytic index. It could not, however, be confirmed. But it led to testing the action of dilute acid and alkali. The proportion of serum to the saline, etc., was 3 : 5, the ratio of the various constituents being 3 : 3 : 1 : 1.

Ordinary mixture with the addition of	Cocci per leucocyte.
normal saline	21
distilled water	24
sodium hydrate, to make N/80	8
phosphoric acid, to make N/80	22

The addition of the distilled water raised the index, probably by lowering the saline content of the test, as will be seen later. The dilute alkali destroyed the majority of the leucocytes; they were either so contracted that the ingested bacteria could not be counted or the nuclei were fused, swollen and destroyed. It is interesting to note that the dilute phosphoric acid had very little effect either upon opsonisation or upon phagocytosis.

The segregation of the phagocytes in the smears.—In counting the ingested bacteria in the smears, the idea is frequently impressed upon one that the leucocytes are more or less segregated. A few polymorphonuclears with a large individual count will be found together and at an adjacent part of the smear several with none, or at most a few bacteria will form a cluster. This is noticeably the case when the suspension is rich in leucocytes and counts are made along the margin and within the smear. The cells with a moderate number of bacteria appear to lie on or near the margin, while there is a greater proportion of empty leucocytes within the film. This segregation probably does not affect the count when a sufficient number such as 100 phagocytes are enumerated and the index is not taken to the second place of decimals. When there is a variety of white corpuscles in the corpuscular suspension such as obtains when leucocyte " cream " is employed, and when a clumping of the cells has occurred, as occasionally happens, the clumps generally contain one kind of white blood-corpuscle. The polymorphonuclears are in groups by themselves, and the large mononuclears have clumped together.

But even when 100 cells are counted the index may be false and it is fortunate that sometimes we can tell that it is so and, repeat the count. I cannot but think that in such cases something has happened to the corpuscular suspension which induces an abnormal segregation of the white corpuscles. When hæmolysis occurs, the polymorphonuclears become more or less everted; and it may be that a partial hæmolysis produces differences in the phagocytic avidity as well as in the segregation during smearing. At one time, a set of experiments will show regular variations; at another time a duplicate set will vary irregularly. This would not occur in routine work, for the tests would always be made in the same manner, but in a work such as this the conditions were being continually altered, and variations were to be expected.

The segregation of the polymorphonuclears was tested in an experiment which was made for the purpose and in which the total corpuscles were employed. The smears were made with a one and one-quarter inch circle held at an angle which varied with the size of the droplet of corpuscular mixture. As a rule the smear measured 40 mm. from the base to the tip of the wedge, and a line was scratched at a distance of 10 mm. from the tip. Holding the smear as it was made, with the base to the left, *ab* represents the upper margin from base *a* to the scratch *b*, *bc* is the upper margin from the scratch *b* to the tip *c*, *bcd* is the whole tip bounded by the scratch *bd*, and *de* is the lower margin from the scratch *d* to the base *e*.

In the columns, the first numbers are the leucocytes in the portion examined; the second numbers are the cocci per leucocyte or phagocytic indices.

	ab Upper margin, first portion.	*bc* Upper margin, second portion.	*bcd* Total tip.	*de* Lower margin.
1	40=10·4	68=10·4	145= 9·4	17= 8·8
2	21= 7·5	61= 8·1	314= 7·3	20= 8·8
3	11= 9·6	40=10·2	66= 8·7	9= 8·7
3a	19= 9·3	25= 8·6	107= 6·5	50= 9·1
4	9=15·5	20=13·5	126=11·0	6=12 8
5	35= 9·0	40= 8·6	320= 8·8	20= 7·9
6	14= 9·2	53=10·0	143= 9·7	20= 9·3

It is clear from these indices that a segregation has occurred and that the polymorphonuclears within the tip of the smear contain fewer bacteria than those of the margin.

While writing this paper some time after the work had been done, I saw that the matter had received attention, especially from the workers in the Johns Hopkins Hospital.*

Jeans and Sellards showed that variations in the counts occurred in different parts of the same smear. Moss found that the leucocytes with the fewest bacteria were at the base of the smear and those with most at the tip. He believed that in the process of smearing the smaller leucocytes were the first to slip under the spreader and were accordingly deposited towards the base of the smear. The larger leucocytes were carried to the end of the smear, where they were deposited.

The polynuclear "Separate."—It is the usual practice and one that was suggested by Wright, to skim off the top layers of the centrifugalised blood-corpuscles, or better to gently rotate the tube, when the upper layers are loosened and mix with the small quantity of saline which is allowed to remain above the deposit. The thin suspension is removed and centrifugalised in a small hæmatocrit tube. The whole of the deposit of the top portion only is taken. This so-called "cream" is rich in white blood-corpuscles. It occurred to me that a better separation might be obtained by slowly centrifugalising the suspension, until half of the cells had deposited, removing the supernatant suspension, shaking it up and again slowly centrifugalising until half had deposited and once more repeating the process, a suspension might be obtained which would contain all the leucocytes of the original suspension. Although the leucocytes are said to have a lower specific gravity than the erythrocytes and although one would expect to obtain all the leucocytes by this centrifugalising, it is strange that there is an utter absence of polynuclears in the "cream" centrifugalised in this manner. One may obtain lymphocytes and a few mononuclears, for these constitute the white film that is found on the top of the centrifugalised sediments. If

* Johns Hopkins Hospital Bulletin, xviii. Nos. 195, 196.

one proceeds in the same manner with the sediments instead of the supernatant suspensions so as to separate out the heavier corpuscles, one finally obtains a suspension which is exceedingly rich in polynuclears and which contains very few of any other kind of white corpuscle. This I call the "polynuclear separate." It is obtained by dropping the blood into 9 c.c. of citrate-saline and rotating the centrifuge quickly until all the cells are deposited. Then they are suspended in 1 % normal saline and slowly rotated in a Metzler hand-centrifuge giving 90 turns in three minutes = 2500 revolutions. The supernatant suspension is removed and the deposit is shaken up with 1 % saline and again rotated. The deposit is pipetted into a small tube and quickly rotated to separate the excess of normal saline. After removing the saline, the corpuscles are uniformly mixed by means of the pipette. The white corpuscles travel faster through the fluid, the biconcave erythrocytes being retarded by friction. If spheres and discs are cut out of paraffin and immersed in dilute spirit of such a density that the balls and discs fall slowly, it will be found that the spheres gravitate much faster than the biconcave discs, which fall slowly like parachutes, face downwards and with little inclination to wobble.

Following is an experiment to determine the distribution of the leucocytes. The plasma was removed by citrate-saline and the corpuscles were distributed in normal saline. The tubes were rotated slowly in the centrifuge as has been already described. The sediments were again shaken up with new saline and rotated.

Corpuscles in 1% saline.	suspended	suspended	suspended	(45 vols.) no leucocytes, few diffuse nuclei.
			sediment	(32 vols.) no leucocytes.
		sediment	....	(33 vols.) few leucocytes, chiefly mononuclears.
	sediment	suspended	suspended	(21 vols.) many mononuclears.
			sediment	(16 vols.) few diffuse nuclei.
		sediment	suspended	(14 vols.) many polymorphs.
			sediment (= "separate")	(10 vols.) very many polymorphs.

In the next two experiments, after the removal of the serum, the corpuscles were suspended in saline and rotated slowly in a wide tube with a drawn-out point for 2,500 revolutions, the sediment which contained half the corpuscles was transferred to a small tube, mixed with more saline and turned until the cells were completely deposited.

Corpuscular sediment in 0·85 % saline	upper portion (20vols.) many leucocytes, chiefly mononuclears.
	middle portion (10vols.) no leucocytes.
	lower portion (20vols.) very many leucocytes, chiefly polymorphs.

Corpuscular sediment in 0·6 % saline.	upper half, no leucocytes.
	lower half, many mono- and polynuclears.

It is clear from these experiments that by slowly centrifugalising the corpuscles, one can finally obtain a suspension or "separate" very rich in the mobile phagocytes.

By quickly centrifugalising, and especially with the corpuscles in a small hæmatocrit tube, the conditions are reversed and the bulk of the leucocytes are found in the upper layers, probably on account of the increased speed causing the red cells to travel edge on and therefore faster than the leucocytes. Furthermore, in the small tubes the red corpuscles have not so far to travel and friction does not influence the deposition to so great an extent.

The concentration of the polymorphonuclears.—A concentration of the white corpuscles can also be obtained by slowly smearing the thick suspension over glass and pipetting up the portion which has followed the smearing implement. The principle is the same as making the smears on the glass slides. Unfortunately a number of polymorphs are lost at the margins of this large smear. It is possible that the facility with which the leucocytes travel with the stream accounts for so many being found in the "cream," as obtained by sloping the tube and allowing the upper layers of the sediment to run away from the lower.

The same thing obtains when preparing the smears. The greater part of the white corpuscles of the mixed drop run into the capillary pipette before the bulk of the red corpuscles, so that in blowing out the mixture the first droplet is relatively poor in leucocytes and the last droplet correspondingly rich. Furthermore, the more mobile leucocytes with the greater number of ingested bacteria are in the droplet last to be blown out.

This is shown numerically in the following experiment in which the corpuscular mixture was, after incubation, blown out upon a glass slide and thoroughly mixed by sucking up and blowing out several times; finally the mixture was sucked up into the capillary pipette and blown out upon four slides, upon which the smears were made.

Order of drops from the capillary pipette.	Cocci per leucocyte.					
	i.	ii.	iii.	iv.	v.	vi.
1	4·4	6·0	7·2	5·5	4·4	6·0
2	—	—	—	—	4·4	6·4
3	—	—	—	—	4·5	6·6
4	5·6	6·4	8·7	5·5	4·4	6·2

The same thing is shown in a slightly different way by abstracting small portions from the large mixed drop, the fourth portion being the equivalent of No.1 of the preceding experiment.

	Cocci per leucocyte.		
	i.	ii.	iii.
Fourth portion	7·2	9·2	5·1
Third portion	7·0	—	5·7
Second portion	7·2	10·4	5·1
First portion	7·8	9·3	5·5

The portion last extracted from the large drop after mixing on the slide contains the less mobile phagocytes and *in these as a rule the ingestion is most uniform.*

In connection with test (v.) of the second last experiment, the numbers show a very uniform ingestion, and one might be led to think that in such a case it would have been sufficient to count 50 cells only. This might have led to error, for while the 100 counts were uniform the 50 counts were not so, as the following shows:—

1. 221, 214=435
2. 246, 192=438
3. 214, 232=446
4. 227, 213 440

The polymorphonuclears of the "Cream" and of the "Separate."—There are undoubtedly differences in the speed of deposition of the polymorphs themselves during centrifugalisation. The more compact and less mobile will deposit first and be found in the lower layers, while the less compact and more mobile ones will occur in the upper layers. The latter will be found chiefly in the "cream," whether they are joggled up from the lower layers in a large tube or are deposited in the upper layers of a small tube. The more mobile phagocytes of the "cream" should give a higher phagocytic index than the less mobile cells of the "separate." Such was found to be the case in the following experiment in which different spreaders were used in making the smears in order to vary the individual tests.

Phagocytes from the	No. of smear.	Kind of spreader.	Portion of smear examined.	Total count of 50 leucocytes.
cream.	ia	¾in. square cover glass.	across end	145
,,	ib	,, ,, ,, ,,	across end	171
,,	ic	,, ,, ,, ,,	across end	169
,,	id	¾in. square paper.	upper margin	153
,,	ie	1¼in. circular cover glass.	across tip	217
,,	if	1¼in. oiled silk, oblique angle	upper margin	126
,,	if	,, ,, ,,	lower end	126
,,	ig	1¼in. oiled silk, rectangle	across end	190
				——166
cream.	iia	convex cut slide.	across end	137
,,	iib	,, ,, ,,	across end	172
,,	iic	,, ,, ,,	upper margin	109
,,	iid	¾in. square cover glass.	upper margin	154
,,	iie	,, ,, ,, ,,	upper margin	204
,,	iie	,, ,, ,, ,,	across end	154
,,	iif	,, ,, ,, ,,	upper margin	145
				——154
separate.	iiia	¾in. square cover glass.	upper margin	137
,,	iiia	,, ,, ,, ,,	across end	146
,,	iiib	,, ,, ,, ,,	across end	135
,,	iiic	,, ,, ,, ,,	across end	133
,,	iiid	,, ,, ,, ,,	across end	139
				——138

The experiment shows that the "cream" counts are very irregular and have a higher average than the "separate." These are the most important points, but besides these the experiment showed that the kind of spreader was immaterial. I have tried other spreaders, including a concave cut slide and a cover glass, notched like a fine saw, but have reverted to the original $\frac{3}{4}$in. square cover glass as being the most advantageous, and I count the polynuclears along the margins. I find that flaming the slides, to remove traces of fat, is superior to scratching with fine emery cloth.

Another test confirmed the previous one so far as the regularity of ingestion and the lower phagocytic count are concerned. It is probable that the polymorphonuclears of the "separate" are smaller and more compact than those of the "cream," and that being of one kind the ingestion of the bacteria is generally more regular.

	50 and 100 counts.	
	"cream"	"separate"
B. tuberculosis.....................	391, 482=873	386, 410=796
M. aureus.........................	272, 315=592	260, 241=501
,, ...	515, 418=933	405, 376=781
,, ...	386, 464=850	393, 431=824
,, ...	536, 485=1021	444, 474=918

In the last experiments the "cream" and "separate" were taken from different portions of the same blood. The differences might be more marked if the division between the two kinds were more clearly made. In the following this was accomplished by taking a suspension measuring 0·7 c.c., putting it into a narrow tube of such calibre that the suspension measured 1·75 inches. The tube was rotated slowly in the centrifuge, giving the handle 20 turns = 580 revolutions of the spindle. The bottom half-inch of deposit was removed and constituted the "separate." The number of the polymorphs in each concentrated suspension was approximately equal.

	50 and 100 counts.	
	"separate"	supernatant suspension.
Experiment i.	507, 490= 997	680, 636=1316
Experiment ii.	504, 511=1015	703, 625=1328

The differences in the counts are more pronounced than in the preceding table, while the lesser differences in the 50 counts are corroborated.

In relation to the differences in the phagocytic activities, it may be noted that Bushnell* brought forward evidence to show that the leucocytes varied in their capacities for absorbing bacteria, and that Briscoe* showed that of all the polymorphonuclears those with tripartite nuclei are more active than others with greater or less divided nuclei.

The regularity of phagocytosis.—It has been found necessary when determining the opsonic or the phagocytic index of a serum to count at least 100 polymorphonuclears. It is even deemed advisable to enumerate 200, and although this will give a truer result, it will occupy more time than is, perhaps, warranted. Even the counting of 100 cells may occupy from 20 minutes to half-an-hour. If, therefore, some of this time could be saved by determining the conditions of phagocytosis so that a smaller number of leucocytes could be depended upon to give a true index, it would be advantageous to all opsonic workers.

The most important factors which contribute to produce differences in the phagocytic indices and the rate of phagocytosis are probably the following :—

1. The nature of the white corpuscles.
2. The method of smearing and segregation of the white corpuscles.
3. The nature of the fluid in which phagocytosis takes place.
4. The duration of phagocytosis.
5. The temperature of phagocytosis.
6. Other known factors such as the serum, intracorpuscular digestion, etc.

The first two have been already considered; the last need not be discussed. The third factor, if it were fully investigated, would involve a vast amount of work, possibly without any commensurate result. However, the question was examined in part with numbers 4 and 5.

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* Brit. Med. Journ. Nov. 16th, 1907, 1422, 1423.

The nature of the fluid in which phagocytosis takes place.— As a rule the corpuscles and bacteria are suspended in normal saline varying from 0·6 % to 0·9 % of sodium chloride. Sometimes, as in the case of tuberculopsonisation, the corpuscles are suspended in 0·85 % saline and the bacteria are distributed in 0·1 %. It is probable that different percentages of salt will exert some influence upon the extent of opsonisation and therefore upon the rate of phagocytosis. It is further to be expected that a slowing of the rate of ingestion will induce a more regular englobment. In the following, an attempt was made to see in which direction further experiments should be made.

Corpuscles in 0·6 % saline; bacteria in	20 counts.	Total 100 count.
1. Saline, 0·1%	83, 103, 91, 60, 58	395
2. Saline, 0·1%	69, 79, 86, 69, 99	402
3. Saline, 0·85%	99, 118, 109, 108, 98	532
4. Citrate, 0·5%	51, 53, 53, 50, 40	247
5. Citrate, 1·0%	93, 36, 32, 98, 90	350
6. As No.1, but with dead bacteria	39, 40, 69, 67, 64	285

The increase of the saline content has augmented the phagocytosis both in the common salt and the citrate tests. The citrate made the ingestion slower, and in No.4 it was comparatively regular, although perhaps not more so than No.3 which had the high common salt content. This table shows very well the differences which usually occur in the counts. Although in the subsequent experiments the counts were carefully scrutinised, I shall not record them for reasons which will become apparent.

I was informed by Dr. Freeman, in Sir A. E. Wright's laboratory, that if a typical count is plotted, making the number of bacteria ingested by each leucocyte the abscissæ and the numbers of leucocytes the ordinates, the curve should gradually rise to a maximum and as gradually fall.

These and many other counts were examined in this manner, but in no case was the curve of this nature. As a rule the zero was high, from which the curve rose slightly to a maximum and fell slowly stepwise. In three counts of a test in which the indices were very close, the curves were quite different one from the other. In other cases no regularly rising and falling curve has been obtained. No indication, therefore, as to the reliability of a count can be obtained from its graphic representation.

Corpuscles in	Bacteria in	Cocci per leucocyte. Duration of phagocytosis. 15 min.	30 min.	60 min.
Citrate, 1 per cent.	Citrate, 1 per cent.	1·5	3·4	5·8
Saline, 0·9 ,,	Saline, 0·9 ,,	7·6	11·6	—
,, ,, ,,	,, 1·1 ,,	4·6	10·3	—
,, 0·85 ,,	,, 0·85 ,,	5·2	6·1	—
,, ,, ,,	,, 1·15 ,,	4·6	6·0	7·7
,, ,, ,,	,, 1·55 ,,	2·6	4·2	—
,, ,, ,,	,, 1·95 ,,	1·4	2·6	—

It is clear that phagocytosis is not complete in 15 minutes, but goes on steadily with the time. It was not so clear which of these salt-contents is the best to employ to ensure a regularity of phagocytosis. One cannot use an amount of citrate in which to suspend the corpuscles smaller than 1%, for hæmolysis occurs when less is used and the leucocytes become everted and destroyed. There was a tendency to show a greater regularity of ingestion when the suspensions were incubated for 30 minutes. The high salt-content did not increase the regularity of phagocytosis, and this was confirmed with some later investigations with 1·5% saline.

The next experiment was made with smaller amounts of salt, using a moderately rich and a moderately poor suspension of bacteria. Measured and equal volumes of thick bacterial suspension were added to measured volumes of saline of varying strengths to obtain the final bacterial suspension.

Varying Strengths of Saline.

Corpuscles in 0·6 per cent. saline; bacteria in	Cocci per leucocyte.			
	Poor suspension.		Rich suspension.	
	15 min.	30 min.	15 min.	30 min.
0·1 per cent.	—	—	10·8	10·5
0·2 ,,	—	—	9·5	12·7
0·4 ,,	—	—	11·5	16·1
0·6 ,,	1·3	2·4	12·7	13·9
0·8 ,,	1·9	3·1	8·6	12·4
1·0 ,,	1·7	2·3	8·0	11·5
1·2 ,,	1·3	2·1	7·2	8·3
1·4 ,,	0·8	1·9	6·2	9·2

For a maximum phagocytosis, the salt-content should be from 0·6 to 0·8%. In all the tests the differences between the 20 and between the 50 counts were proportional to the total number of bacteria ingested. There was nothing to recommend any particular percentage as being conducive to a more regular englobment.

In the belief that a better fluid than normal saline could be obtained which would give more concordant results and also that this would only result from a slowing of the rate of phagocytosis, experiments were made with citrate. It is not advisable to use citrate alone for the suspension of the corpuscles, as more or less hæmolysis occurs with eversion of the white corpuscles. A solution containing 0·6% of sodium chloride and 0·4% of sodium citrate was therefore employed while the bacteria were suspended in distilled water and equal volumes were pipetted into varying strengths of citrate.

Bacteria suspended in citrate.	50 counts.		100 counts.
0·0 per cent.	160	144	304
	171	204	375
0·2 ,,	135	102	237
	106	108	214
0·4 ,,	130	127	257
	108	131	239
	111	119	230
0·6 ,,	88	78	166
	73	91	164
0·8 ,,	110	135	245
	119	123	242
1·0 ,,	59	121	180
	107	80	187

Experiments were also made with the same suspensions permitting the phagocytosis to proceed for 30 minutes at 37°. The results, however, were very irregular, and there appeared to have been a considerable amount of intracorpuscular digestion. The experiment shows that a suspension of bacteria in 0·4% to 0·8% citrate gives very concordant counts, and much might be gained by using this salt should a better not be found.

The effect of glycerin was then tried. A preliminary experiment showed that it was not advisable to suspend the corpuscles in glycerin alone on account of the hæmolysis of the erythrocytes. They were therefore suspended in the citrate-saline of the previous experiment.

Bacteria suspended in glycerin.	Cocci per leucocyte.
0·2 per cent.	9·9
0·4 ,,	7·0
0·8 ,,	6·4
1·2 ,,	7·5
1·6 ,,	7·6
2·0 ,,	6·3

The glycerin had a distorting action upon the leucocytes and appeared to hinder the regular ingestion of the bacteria. There was nothing to recommend the glycerin over the citrate.

A shorter period of incubation was then tried with bacterial suspensions containing glycerin and citrate. As in all the other experiments, unless otherwise stated, the temperature of incubation was 37°. An extension of the experiment was made in the direction of keeping two of the tests at room-temperature (23°) for 30 minutes.

Bacteria suspended in	Cocci per leucocyte. Duration of phagocytosis.				
	2 min.	5 min.	10 min.	15 min.	30 min. at 23°
Glycerin, 0·8 p.cent.	3·2	3·8	4·1	4·9	4·5
Citrate, 0·6 p.cent.	1·9	2·5	3·2	3·3	2·9

The most regular of the counts were those which had been incubated for 15 min. An interesting part of the experiment, however, was the phagocytosis at room-temperature, viz., 23°.

When the tubes containing the mixed suspensions were allowed to lie upon the bench for 30 minutes and were then smeared and enumerated, the phagocytosis was found to be the same as if the tests had been incubated at 37° for 12½ minutes (glycerin) and for 8 minutes (citrate).

The influence of time and temperature.—The last experiment led to the making of several to determine the minimum, optimum and maximum temperatures during which phagocytosis occurs.

Temperature.	Cocci per leucocyte. Duration of phagocytosis in minutes.		
	5	10	20
3°	0·0	0·0	0·0
23°	0·5	1·1	2·2
30°	1·3	2·2	3·6
37°	—	—	4·4

The Influence of Temperature.

Temperature.	Cocci per leucocyte.			
	a	*b*	*c*	*d*
3°	0·0 (30min.)	0·0 (60 min.)	—	—
10°	0·0	0·0	—	—
12°	0·0	—	—	
15°	0·1	0·3	—	—
18°	0·3	—	—	—
20°	0·4	0·9	—	—
22°	0·5	—	—	—
25°	0·5	1·3	—	—
30°	0·7	1·9	-	—
33°		2·0	—	—
35°	—	2·5	3·5	
36°	—	—	3·8	—
37°	1·5	3·4	4·5	—
38°	—	3·2	5·0	3·4
39°	—	3·9	5·3	4·2
40°	1·3	4·1	6·3	4·5
41°	-	3·9	6·5	6·4
42°	1·0	3·2	6·1	5·4
45°	0·7	—	—	—
47°	0·5	—	—	—

From these experiments, it appears that the phagocytosis below 12° is negligible, but that it is pronounced at higher temperatures This is of considerable importance in the technique of opsonic work, for it is evident that, with a room-temperature of over 12°, the work must be done as expeditiously as possible. It is a mistake to permit the mixture of serum, corpuscles and bacteria in the capillary tubes to remain upon the bench either before or after incubation. After mixture, the test should be incubated and smears made immediately the incubation is finished.

The experiments show that the optimum temperature is 41°C. With regard to the regularity of ingestion, although in the majority of cases the 50 count would approximate to half the value of the 100 count, in the minority of cases the differences were sufficiently high to show that 100 leucocytes are the least that should be enumerated. In one case, that of Expt.c. at 41°, two 100 counts totalled 647 and 632, while the next count in each case brought the totals for 101 leucocytes to 653 and 652; these were counted along one margin of the far side and the margin of the near side, while across the tip of the same smear 100 cells totalled 650. Although the optimum temperature is 41°, the analysis of the individual counts showed that 37°, 38° and 39° gave the most regular phagocytosis.

The scrutiny of the counts obtained in the experiments with different fluids, with varying temperatures and times of phagocytosis, showed that nothing was gained by deviating from the customary method. Some experiments raised the hope that citrate-saline would be better than normal saline for the suspensions, but further work showed that no advantage accrued from its use.

The capillary pipette.—The capillary tubes that are made for holding the tests during incubation are generally very uniform, and for good work it is essential that they should be so. In a wide capillary the phagocytes will settle upon the wall of the tube in a thicker layer than in a narrow one and will not have the chances of meeting so many bacteria. This was shown in the following, in which similar volumes of mixed suspensions and serum in the tubes measured 10 centimeters in the narrow and 1·7 centimeters in the wide tube.

	Cocci per leucocyte.
Narrow capillary	32
Wide capillary	28

The effect of agitation during phagocytosis.—That the corpuscles settle so quickly as compared with the bacteria is doubtless responsible for the comparatively long time that is required for complete phagocytosis. We know that by placing the capillary pipettes in an incubator for 15 minutes only a partial phagocytosis is obtained, but when all the tests are made in the same manner this is of no consequence, and it is certainly the easier process to employ. One can obtain a greater phagocytosis by agitating the capillary pipette during incubation. This has been done by Millar,* who attached the pipette to a rotating wheel.

Before seeing this method, I had noted the effect of agitation as obtained by blowing the mixed suspensions in and out of a pointed tube for three minutes at 37°. The count showed that the process undoubtedly increased the phagocytosis, but the experience showed that the method would introduce many sources of irregularity, and it could not be recommended for consistent work.

	Cocci per leucocyte.	
	a	*b*
Ordinary method, 15 min. at 37°	3·5	4·4
Agitated, 3 min. at 37°	5·5	8·2

The fact that agitation as produced by blowing the suspensions in and out of the capillary pipette increased the phagocytosis so much, suggested the possibility that ingestion might occur while the suspensions and serum were being mixed previous and subsequent to incubation.

* Centrlb. für Bakt. Orig. 41 (1908), 728.

In the following, the opportunity was taken to test the action of bacteria which had been grown in ordinary neutral bouillon and in the same with the addition of 2% of saccharose.

Washed bacteria from	Cocci per leucocyte.	
	ordinary mixing(4 times)	excessive mixing(20 times)
Neutral bouillon........	5·2 – 5·3 – 4·9	8·8 – 6·0 – 6·0
2% saccharose bouillon.	3·7 – 4·0	4·8 – 5·6

The differences between the duplicates of the excessive mixing are considerable, and upon consideration it appeared possible that they arose from variations in the bore of the capillary pipettes and especially in the internal diameter of the orifice. In the next experiment, an idea of the average bore was obtained by sucking a volume of water into the pipettes and measuring the lengths of tube which the volume occupied. The pipettes were in pairs, having been made from one piece of tubing. The lengths of the volume of water are in centimeters and in the table are enclosed in brackets.

	Cocci per leucocyte.		
	ordinary mixing (4 times).	excessive mixing (20 times).	difference for 16 times of mixing.
Pipette with wide bore (=3·0cm.)	3·2	3·6	0·4
Pipette with wide bore (=4·0cm.)	3·1	3·7	0·6
Pipette with narrow bore(=5·6cm.)	3·3	4·1	0·8
Pipette with narrow bore(=6·6cm.)	3·2	4·5	1·3

In the case of the narrowest pipette, the phagocytic index or number of cocci ingested per leucocyte has been raised nearly 0·1 for every time of mixing. It is evident that in mixing the suspensions the fluid should be blown in and out of the pipette a definite number of times.

On the whole this portion of the research did not hold out any hope of shortening the process of determining the opsonic activity of serum. It is absolutely necessary, as Sir A. E Wright told me, to count 100 leucocytes, as smaller counts are liable to give misleading results. But while the time may not be shortened, the counts may be rendered more representative by taking advantage of several points which have been indicated. Thus the corpuscular "separate" may with decided advantage replace the leucocyte "cream."*

The need for uniformity of work has been shown by the necessity for always taking the first drop blown out from the capillary pipette in preparing the smears. The necessity for mixing the suspensions a definite number of times and for always counting the same portion of the smears has been indicated. When the room-temperature is above 12°C., the sealed capillary tubes containing the mixed serum and suspensions should be incubated immediately after mixing and the smears should be made upon the withdrawal of the pipette from the incubator.

When using the "separate," one meets few leucocytes with relatively high numbers, and when one does my experience has been that they should be included. There may be a high number in the first 50 cells, but the chances are that in the second 50 there are two or more moderately high numbers that balance the high count of the first 50. It appears to make little difference whether or not the zeros are included, for in a series of tests such as have continually been made in this research, the zeros in each duplicate test have been approximately equal. I have noted a divergence in some instances, and am therefore in favour of including the zeros in the counts. I have tried various methods of obtaining a phagocytic index, such as by taking the average of the fiftieth and fifty-first cells, of the middle 80, 60, 40 and 20, but have always found them to be misleading. The only method that can be trusted is the usual one of counting 100 or more leucocytes and taking the average per leucocyte. It is advisable to have the bacterial suspension of such concentration that about five bacteria are ingested by the average leucocyte under the conditions of the experiment.

* According to Fleming (Practitioner, 1908) the use of the "cream" has been abandoned, and a uniform suspension of the total corpuscles is employed.

In the earlier part of this research and at a time when less than 100 polymorphs were enumerated a number of minor experiments were made. It may be of interest to note two of these.

The effect of the addition of small quantities of certain salts was tested. They were added in the proportion of one part of saline solution to seven of the mixed serum and suspensions, the ratio of suspensions, etc., being 3 : 3 : 1 : 1.

	Cocci per leucocyte.
i. Sodium chloride, 0·1%	22
Calcium citrate dissolved in phosphoric acid (0·05%), 0·1%	23
Calcium lactate, 0·1%	18
Calcium acetate, 0·1%	18
Magnesium sulphate (anhydrous), 0·1%	21
ii. Sodium chloride 0·2% in phosphoric acid (0·15%)	24
Magnesium phosphate 0·2% ,, ,, ,,	25
Calcium phosphate 0·2% ,, ,, ,,	25

When bacteria, *e.g.*, *M. aureus*, are killed by heat and tested daily afterwards, the speed of intraphagocytic digestion is found to increase with the time that has elapsed since their death. For example, a suspension of bacteria was heated for 10 minutes at 80°, centrifugalised to remove the clumps, and the supernatant suspension was removed. This suspension was tested upon the two succeeding days. The number of bacteria ingested was counted and the following numbers per leucocyte obtained. The staining characteristics of the cocci showed that the lessened numbers resulted in great part or entirely from a loss of staining power, *i.e.*, from the intracorpuscular digestion.

	Cocci per leucocyte.
Day of death	23
One day after	19
Two days after	11

The opsonin of antituberculous serum (Marmoreck).—In testing Marmoreck's antituberculous serum, Riviere* concluded that a series of daily doses will, when administered rectally, usually produce a rise in the tuberculopsonic index. The rise soon

* Brit. Med. Journ. April 13th, 1907, p.857.

reaches a maximum which is maintained while the serum is being given. The rise is in some cases coincident with an improvement in the general condition of the patient. The action of the serum might be explained by the serum containing an excess of opsonins, but as it only gives an index of 0·127 some other explanation must be found.

I have already shown* that heat only retards or slows the action of staphylopsonin, and age may have the same action upon the tuberculopsonin in Marmoreck's serum. This was tested in the following manner. Equal volumes of Marmoreck's serum and a suspension of dead *B. tuberculosis* in 0·6% saline were heated at 37° for 20 hours when a third volume of corpuscles was added and the phagocytic index determined in the usual manner. A control quantity of serum was heated at the same time at the same temperature after which the corpuscles and the bacterial suspensions were added.

	Cocci per leucocyte.
Serum in contact with bacteria for 20 hours.......	1·16
Control..	0·15

The bacteria in the control were isolated while those in the contact test were agglutinated. To avoid this agglutination another test was made in which the bacteria was suspended in 0·1% saline.

	Cocci per leucocyte.
1. Serum in contact with bacteria for 20 hours.....	2·4
2. Serum in contact with bacteria for 44 hours......	1·6
3. Control serum incubated for 20 hours...	0·0
4. Normal serum (15 min contact)....................	7·9

In No.1 there were a few clumps in the films and in the leucocytes enumerated there were three which contained four clumps comprising 37 bacteria. Clumps were absent in Nos.3 and 4. In No.2 the bacteria had largely disappeared, and most of the remainder, including those which had been phagocytosed, stained faintly, showing clearly the action of the immune bodies. It would have been useless to endeavour to destroy the complement by heating the serum at 60°, for I have already shown that, like

* These Proceedings, 1905, p.559.

the opsonins, the complement is not destroyed at 60°, but is only slowed in its action. The experiment, however, clearly shows that in antituberculous serum there are latent opsonins.

Compared with normal serum, the latent opsonins were small in amount, but it must not be forgotten that the experiment may only have shown the action of a small portion of the total quantity. It may be that a much greater amount is rendered active *in vivo.*

The influence of clotting upon the production of opsonins.— In obtaining serum, the blood is as a rule allowed to lie for some time to allow of the formation of a clot and the separation of the serum. With short intervals of time, say from one to six hours, there is no diminution of the opsonic content at ordinary temperatures. It is, however, not known if the opsonins of the serum suffer any diminution or augmentation while lying in contact with the clot. If we go by the ideas of the Metchnikoff school that the immune bodies are derived from leucocytes and are liberated only upon their destruction, we should expect that contact with the clot should cause the transference of an increased quantity of immune bodies into the serum. Possibly this might apply to the opsonins, and to see if such really did occur the following experiments were made.

	Cocci per leucocyte.		
	a	*b*	*c*
Serum centrifugalised 5·7 min. after drawing the blood	12·2	9·3	7·4
Serum centrifugalised 30 min. after drawing the blood	10·6	7·5	9·0

	a	*b*	*c*	*d*
Blood centrifugalised immediately after drawing; plasma allowed to clot and serum separated	10·1	13·3	9·2	8·6
The same serum 30 min. after	—	—	9·9	8·4
Serum from blood clot, 30 min. after drawing	9·5	12·9	10·2	8·9

The results are too conflicting to lead us to believe that there is any difference in the opsonic content of the serum when obtained by any of these methods. The inference is that the opsonins exist already formed in the blood-plasma and are not liberated from the leucocytes upon their destruction during clotting. Briscoe* has either brought forward or emphasised the idea that the opsonins are in some way related to the formation of fibrin, and indeed are largely derived from the original fibrinogen and liberated during clotting. Experiments were made to elucidate this problem. The plasma was rapidly centrifugalised and while still unclotted was mixed with a suspension of bacteria in 0·8% citrate and to this the corpuscles in 1% saline were added.

	Cocci per leucocyte.			
	a	*b*	*c*	*d*
Plasma citrated	1·8	3·0	10·4	3·8
Serum citrated	1·8	3·2	10·0	3·8

These show that the formation of clot does not influence the production of opsonin in any way.

Conclusions regarding the opsonisation, chiefly of M. AUREUS.—The following is a brief summary of the conclusions which have been arrived at from the research :—

1. A two-day's culture is more completely opsonised than a younger or an older culture.
2. The older the culture the greater is the intraphagocytic digestion.
3. There are no auto-opsonins formed in moderately old cultures.
4. Races of different ages are opsonised to the same extent.
5. Bacteria from agar cultures are more easily opsonised than the washed bacteria from bouillon cultures.
6. The presence of calcium phosphate in bouillon lessens the opsonisibility of the bacteria grown in it, while the presence of sodium chloride increases the action.

* Brit. Med. Journ. Nov. 16th, 1907, 1423.

7. The addition of sugar to bouillon lessens the opsonisability of the bacteria.

8. Anti-opsonins are present in bouillon cultures.

9. Staphylococci heated with normal saline at 60° give up an anti-opsonin and become more freely opsonised.

10. Bacteria grown at 22° and at 37° have an equal capacity for opsonin, if pairs of cells are counted as single cells.

11. Dilute soda destroys the leucocytes, while dilute phosphoric acid has no action either upon the leucocytes or upon opsonisation; calcium acetate and lactate lessen opsonisation, while the citrate and phosphate have no action.

12. Marmoreck's antituberculous serum contains latent opsonins among other immune bodies.

13. Clotting has no influence upon the opsonic content of the blood.

Regarding opsonic technique,

1. The labour of counting cannot be lessened by modifications in the suspension fluids or in departures from the usual time and temperature of incubation.

2. Segregation of the phagocytes occurs in the smears.

3. The leucocytes that are the last to enter or the first to be expelled from the capillary pipette have a more uniform phagocytic activity than the others.

4. By slowly centrifugalising corpuscular suspensions there is obtained a leucocytic "separate" which contains polymorphonuclears chiefly; these have a more uniform phagocytic activity than those found in leucocyte "cream."

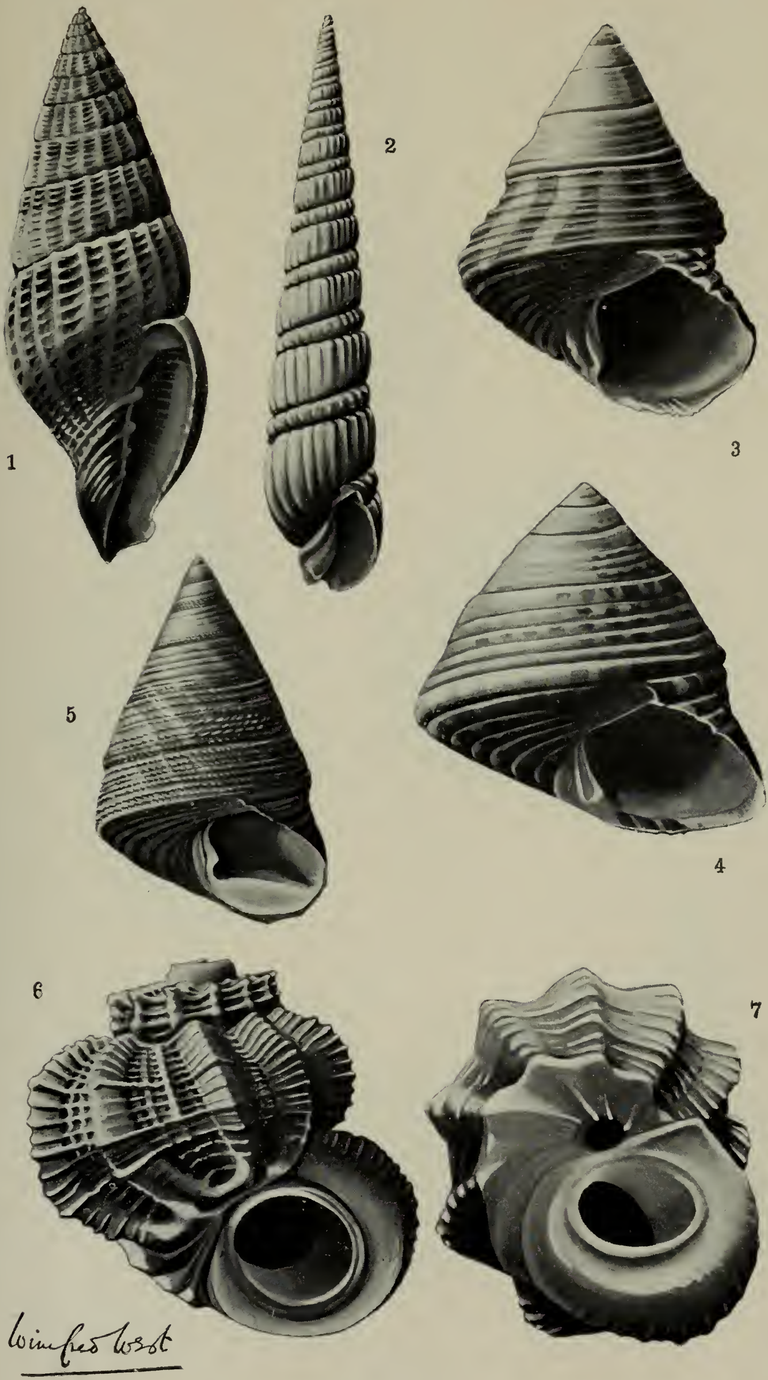
5. Phagocytosis occurs during the mixing of the suspensions with the serum.

6. Phagocytosis begins about 12° and reaches an optimum at 41°.

7. Mixing and smearing should be done as expeditiously as possible when the laboratory temperature is over 12°.

8. Opsonic determinations should always be made in exactly the same manner in every detail.

[Printed off November 18th, 1908].



AUSTRALIAN MOLLUSCA.

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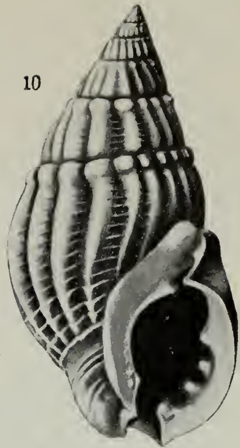

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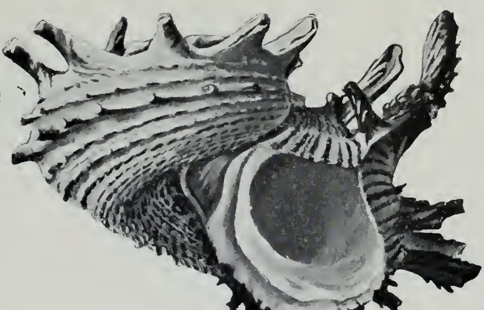

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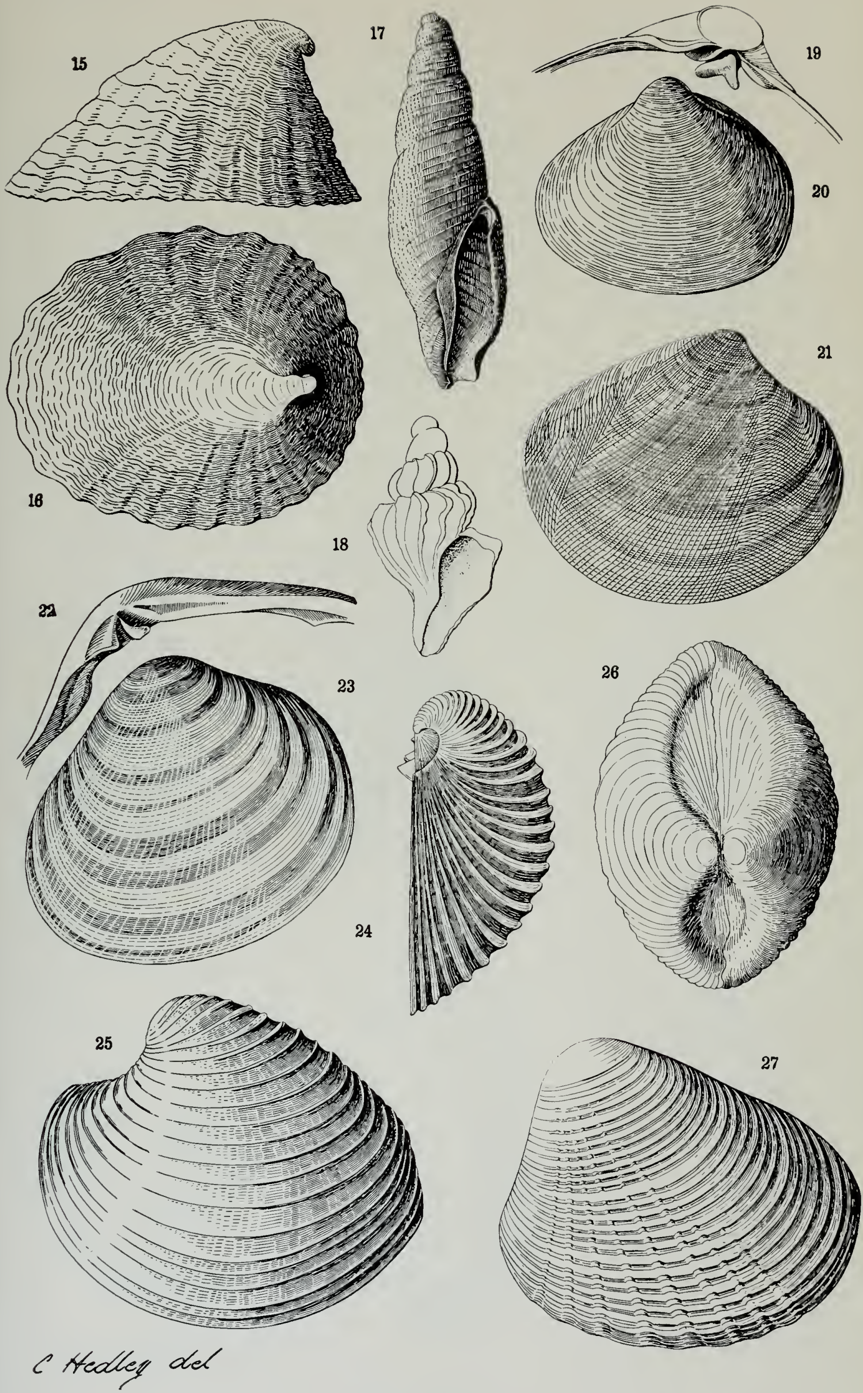
Winifred West

AUSTRALIAN MOLLUSCA.



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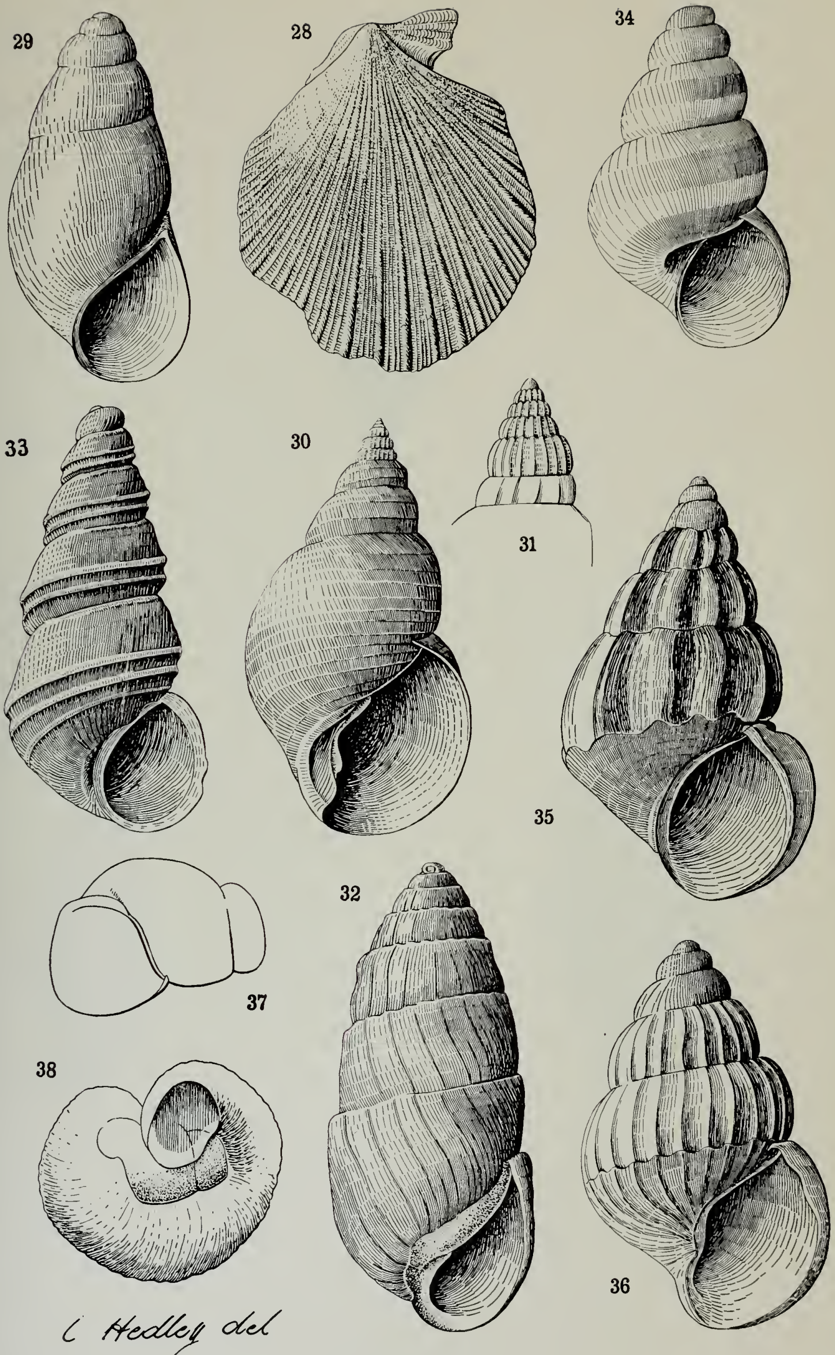


AUSTRALIAN MOLLUSCA.

FIG. 1.

FIG. 2.

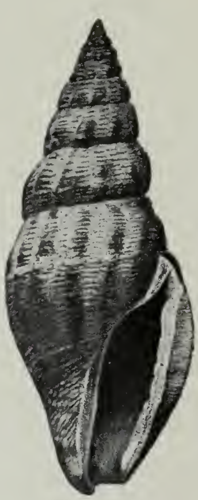
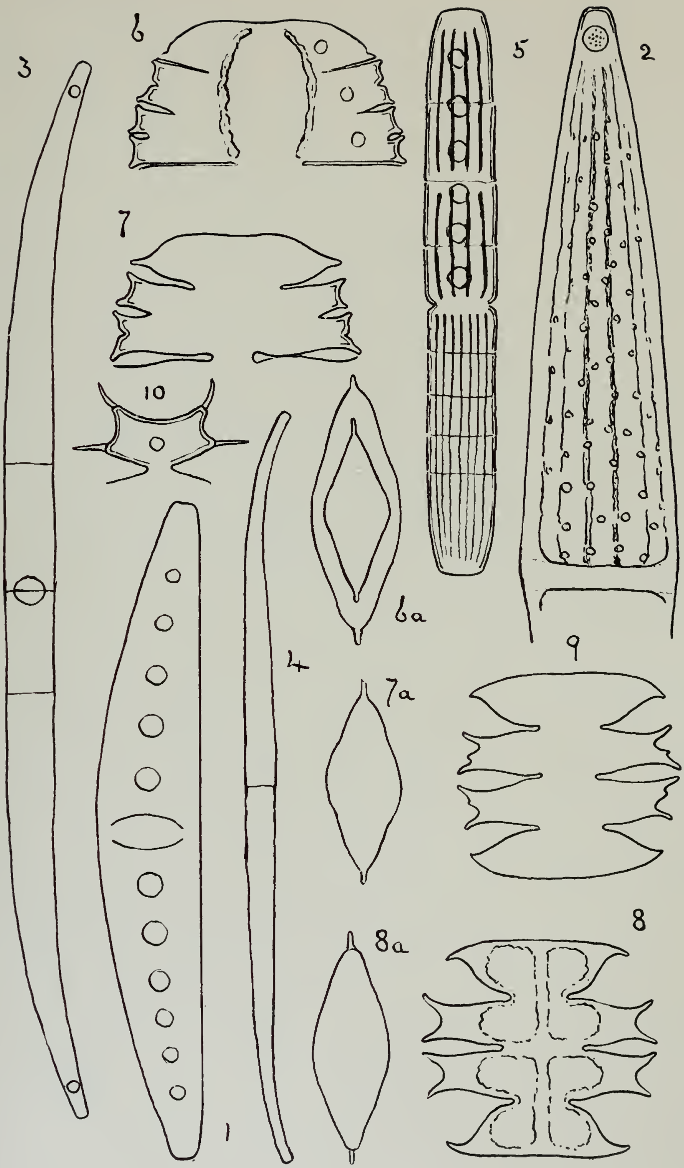
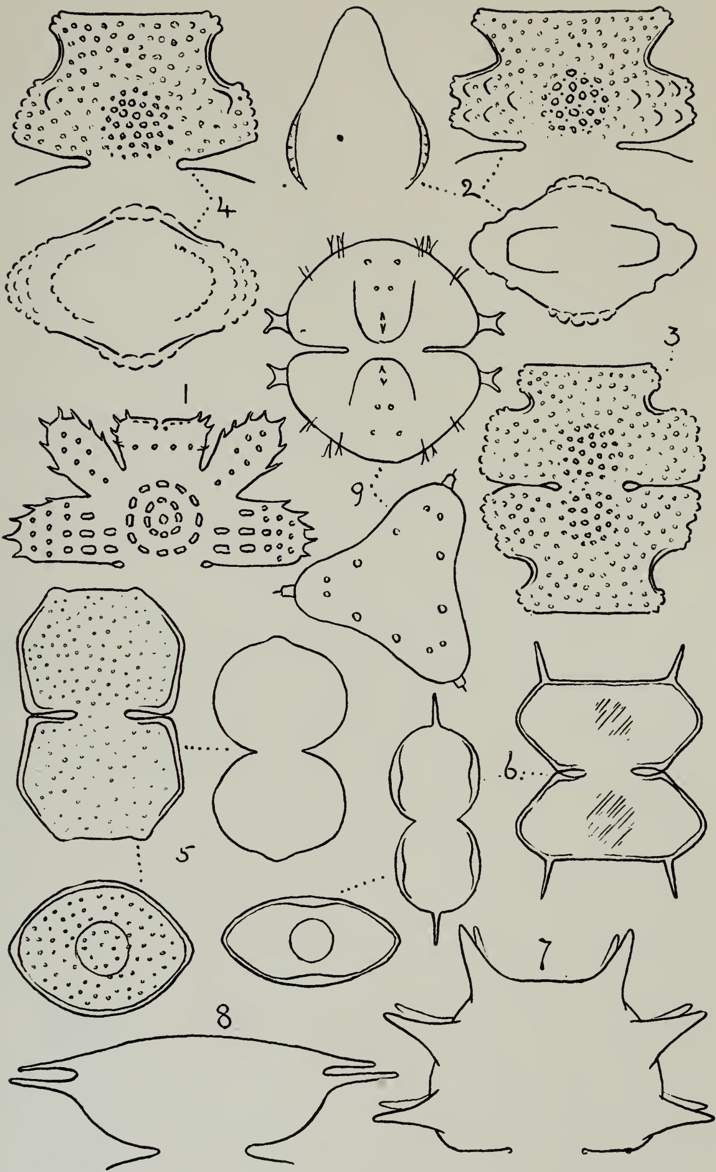


FIG. 3.

AUSTRALIAN MOLLUSCA



SYDNEY DESMIDS.



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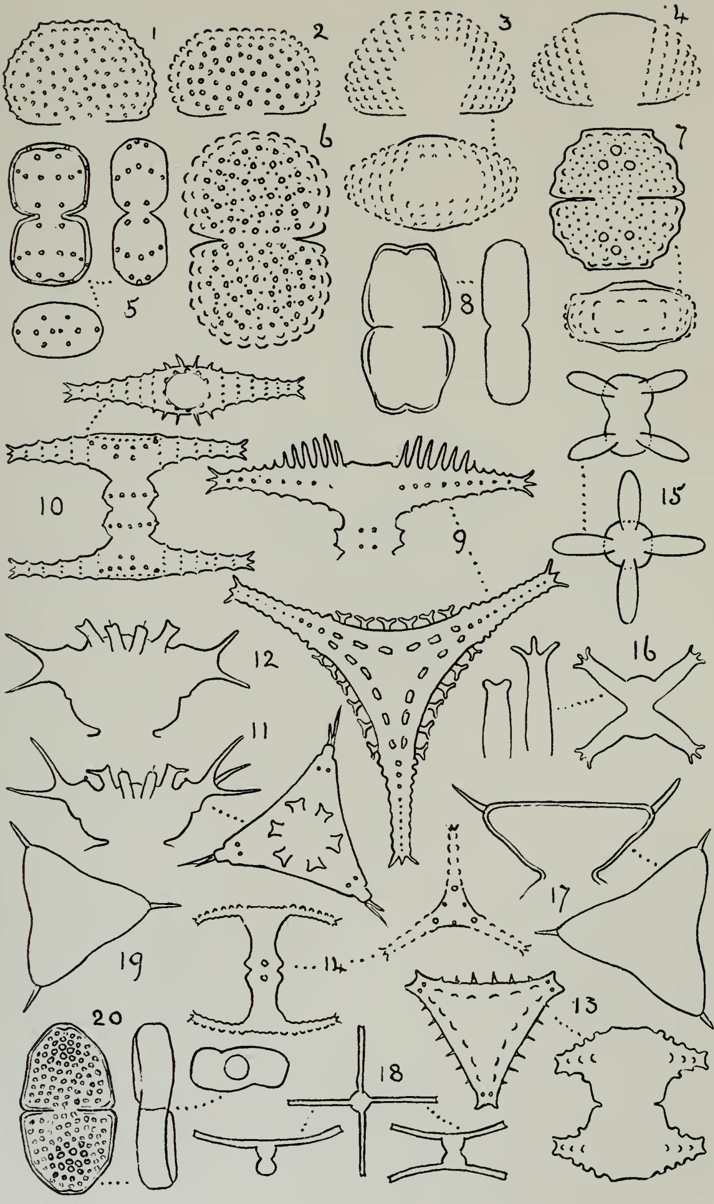
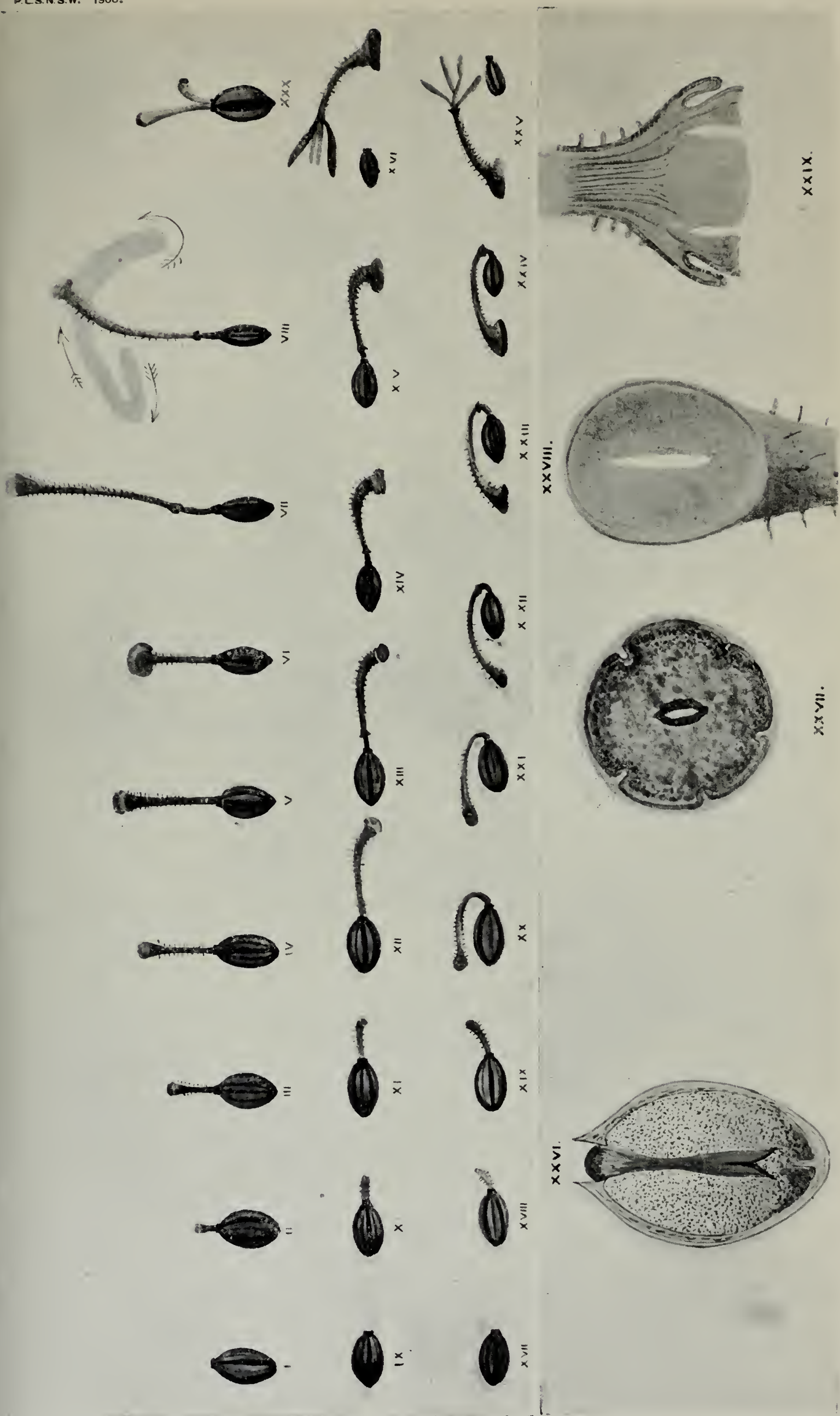


SYDNEY DESMIDS.

AUSTRALIAN LIBELLULINÆ.



LORANTHUS EXOCARPI Behr.

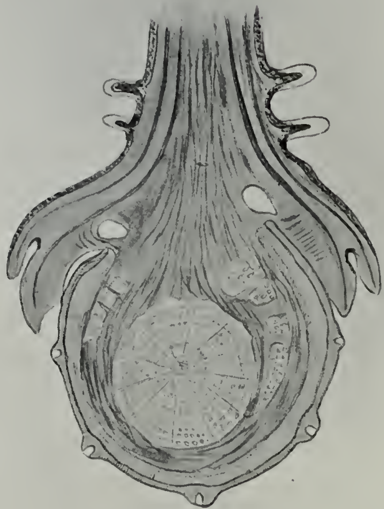


Fig I

Fig II

Fig III

LORANTHUS EXOCARPI Behr.

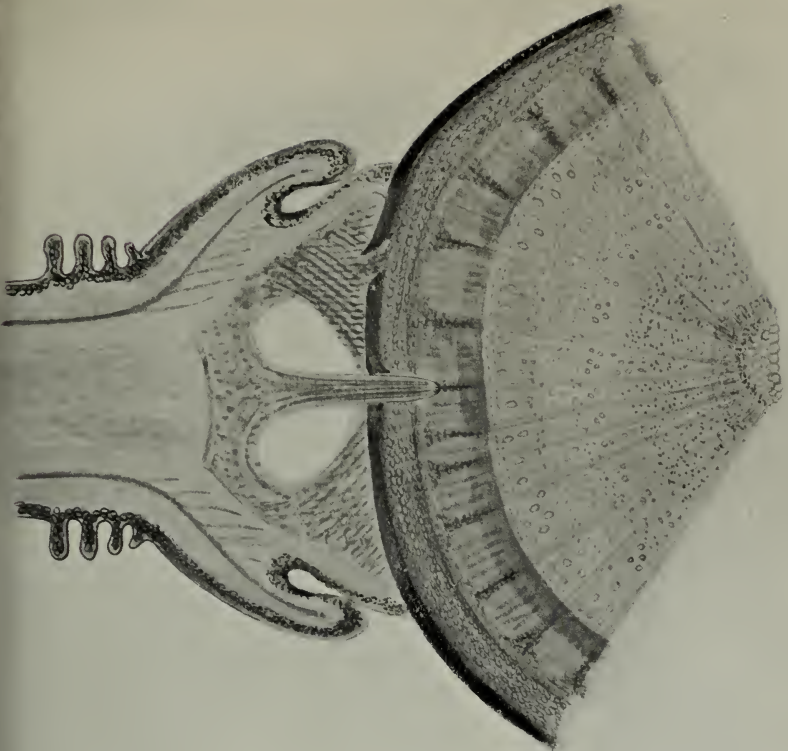
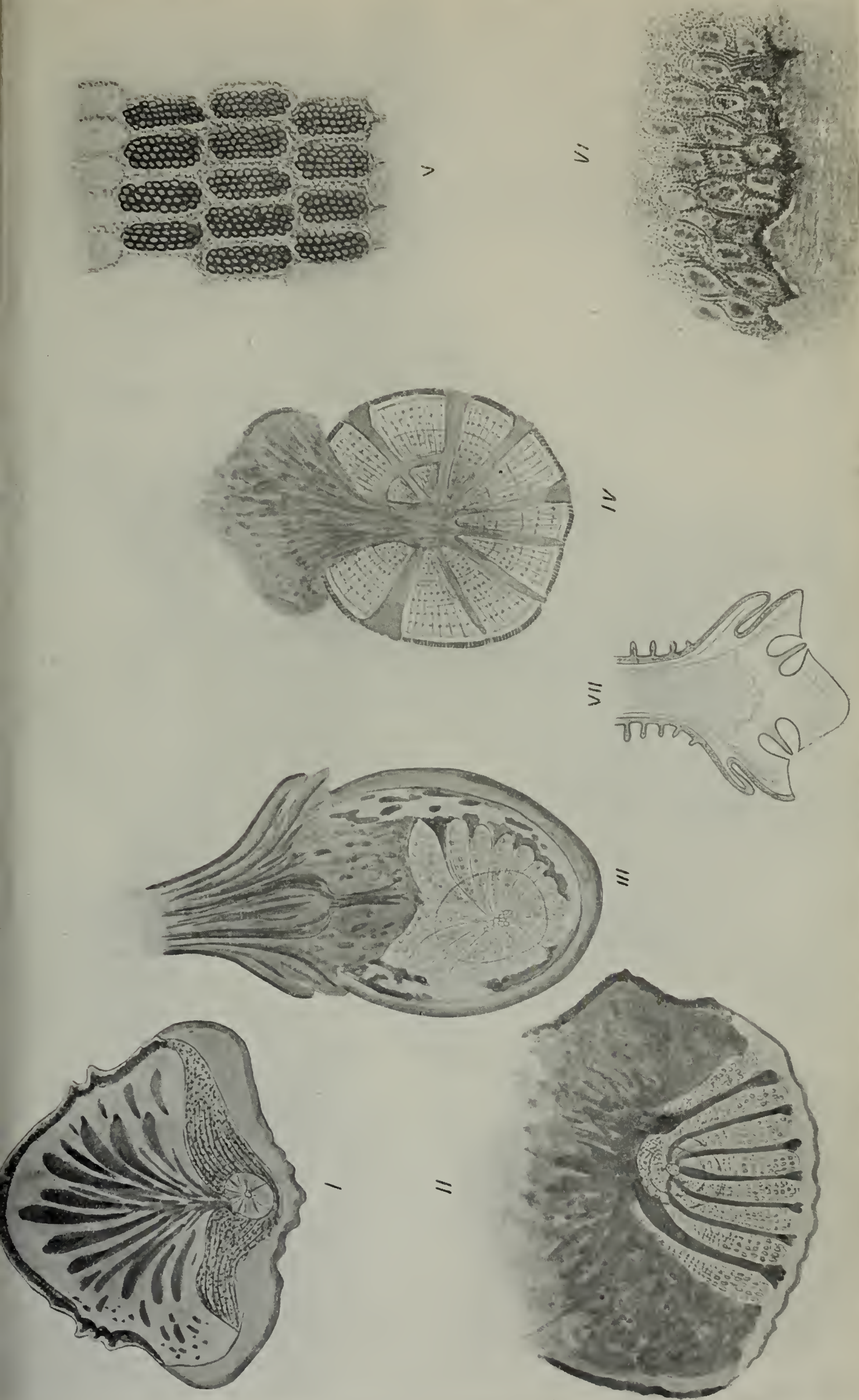


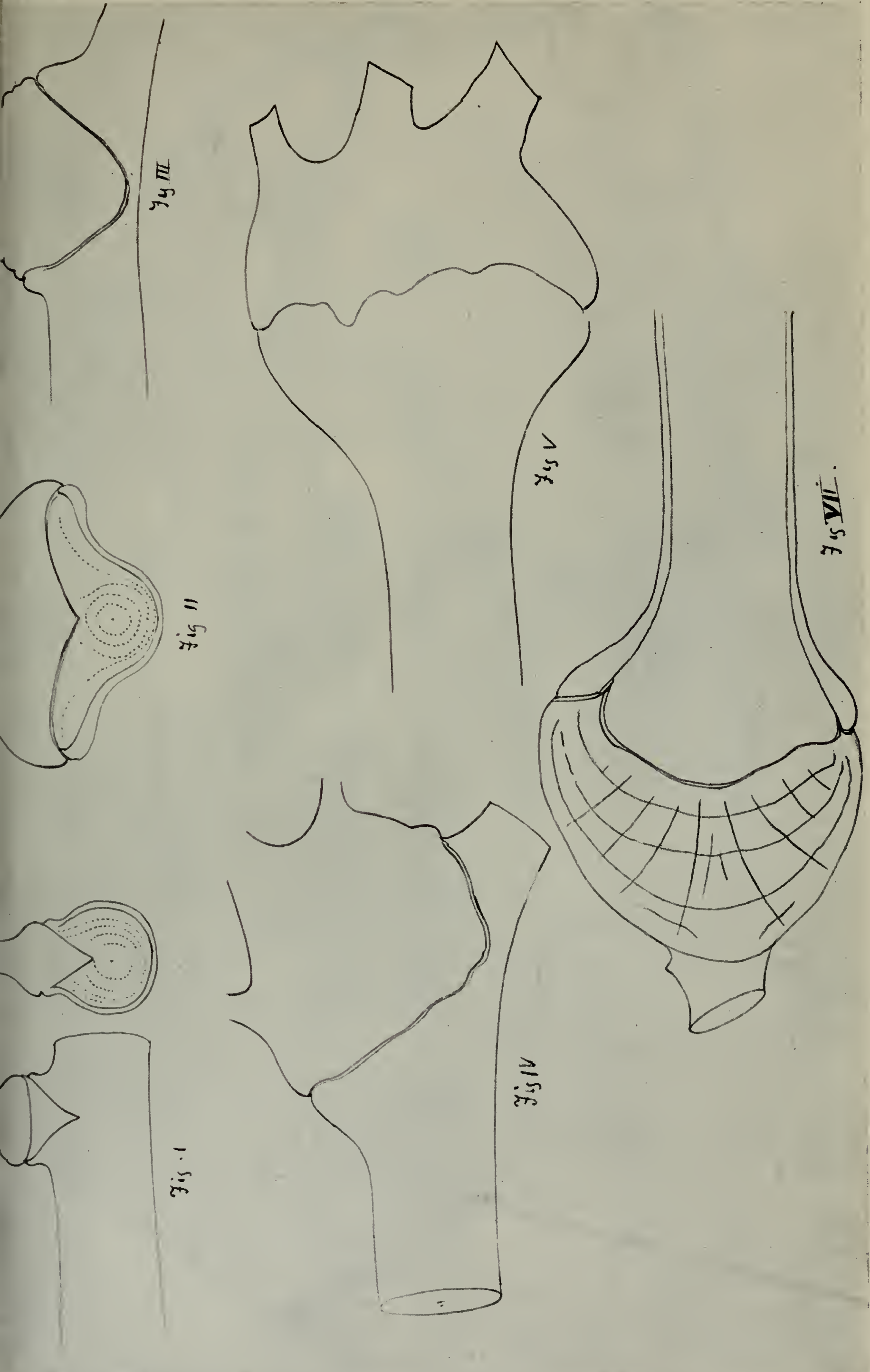
Fig. II

Fig. I

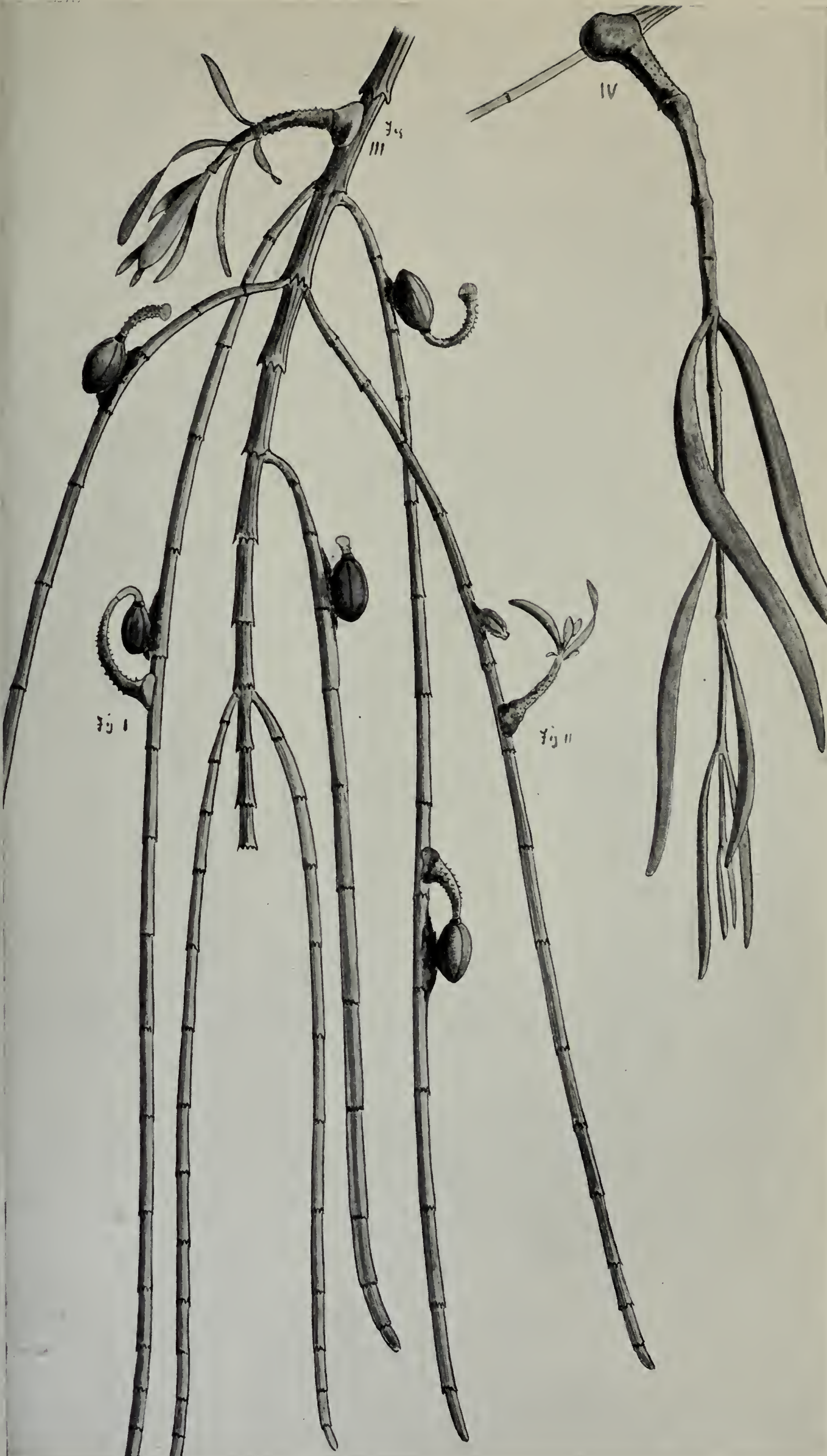
LORANTHUS EXOCARPI Behr.



LORANTHUS EXOCARPI Behr.



LORANTHUS EXOCARPI Behr.



LORANTHUS EXOCARPI Behr.

REVISION OF THE AUSTRALIAN CURCULIONIDÆ BELONGING TO THE SUBFAMILY *CRYPTORHYNCHIDES*.

Part IX.

By Arthur M. Lea.

This part deals with *Chœtectetorus* and some of the allied genera; but as there are too many of these for inclusion in one paper, some of the genera, and the table dealing with the whole of them, have been withheld for the present.

Tituacia Pascoe.

Trans. Ent. Soc. 1870, p.476.

Head feebly convex, not concealed by prothorax; ocular fovea concealed. *Eyes* not very small, coarsely faceted, distant. *Rostrum* rather long, not very thin, arcuate throughout. *Antennæ* slender; scape inserted nearer apex than base of rostrum; funicle the length of scape, two basal joints elongate; club thin, elliptic. *Prothorax* transverse, convex, apex produced and more than half the width of base. *Scutellum* small, not very distinct. *Elytra* broad, cordate, convex, sides strongly arcuate towards apex, apex narrow and feebly emarginate. *Pectoral canal* wide and moderately deep, terminated behind middle coxæ. *Mesosternal receptacle* raised, U-shaped, sides thin; open. *Metasternum* very short, episterna moderately long. *Abdomen* large, sutures distinct; two basal segments large, 1st feebly incurved to middle at apex, intercoxal process wide, almost truncate; intermediates combined the length of apical and slightly shorter than 2nd. *Legs* moderately long; femora feebly grooved, edentate, posterior terminated before apex of abdomen; tibiæ compressed, curved only at base; tarsi short, 3rd joint wide, deeply bilobed, claw-joint elongate and feebly setose. Short, broad, convex, subovate, squamose, apterous.

The very short metasternum (the mesosternal receptacle appearing actually to impinge on the abdomen till the scales have been removed), wide intercoxal process of abdomen and absence of wings render this genus one of the most aberrant of the allies of *Chætectetorus*. Mr. Pascoe regarded it as a "modification" of *Tychreus*, but I cannot see that they are at all closely allied.

TITUACIA OSTRACION Pasc.; Mast. Cat. Sp. No.5524.

Piceous-brown, antennæ and claw-joints red. Densely clothed with coarse muddy-grey and brown scales; rostrum glabrous except at base. Prothorax with a distinct fasciculate patch of brown scales on each side of base and apex separated by a rather feeble median line. Elytra fasciculate on tubercles. Under surface and legs with coarse greyish scales.

Rostrum slightly longer than prothorax, sides scarcely visibly incurved to middle; densely and moderately strongly punctate. Funicle with 1st joint not twice the length of 2nd; club almost the length of five preceding joints. *Prothorax* transverse, sides rounded, increasing to near base, densely and strongly punctate, punctures concealed. *Elytra* cordate, considerably wider than and about twice the length of prothorax, widest about the middle; sides regularly striate-punctate, disc very irregularly punctate; with numerous small fasciculate tubercles, a very distinct tubercle on each side at summit of posterior declivity. *Under surface* finely punctate, punctures entirely concealed. Length $3\frac{2}{3}$, rostrum $1\frac{1}{4}$; width 2 mm.

Hab.—W.A.: King George's Sound.

On the elytra there is a patch of whitish scales about the middle, but on the two specimens under examination it is very feebly defined

PHLŒOGLYMMA Pascoe.

Trans. Ent. Soc. 1870, p.483.

Head not concealed by prothorax; ocular fovea large and round but rather shallow. *Eyes* round, very finely faceted, distant.

Rostrum about the length of prothorax, curved, moderately wide or rather narrow. *Antennæ* moderately stout; scape short, considerably shorter than funicle, inserted nearer base than apex of rostrum, and not extending to apex; two basal joints of funicle elongate, the others transverse; club ovate. *Prothorax* slightly longer than wide or feebly transverse, subconical, apex produced, base bisinuate, ocular lobes almost rectangular. *Scutellum* slightly longer than wide, feebly raised. *Elytra* about twice the length of prothorax, sides subparallel or feebly decreasing from near base, base trisinuate; shoulders prominent, apex rounded. *Pectoral canal* narrow, moderately deep, terminated almost at metasternum. *Mesosternal receptacle* very feebly raised, U-shaped, sides very narrow; open. *Metasternum* shorter than basal segment of abdomen, episterna moderately large. *Abdomen* large, sutures distinct; basal segment somewhat larger than 2nd, its apex incurved to middle, intercoxal process narrow, produced in middle; 3rd and 4th combined slightly shorter than 2nd, and slightly longer than 5th. *Legs* rather short; femora moderately stout, strongly dentate, the four posterior feebly grooved, posterior terminated before apex of abdomen; tibiæ short, feebly compressed, arcuate at base; tarsi moderately long, 3rd joint wide, deeply bilobed, claw-joint elongate, feebly squamose;* claws moderately separated. Rather strongly convex, elliptic, subcylindrical, squamose, fasciculate, winged.

Mr. Pascoe remarks:—"In Lacordaire's arrangement, this genus would come next to *Enteles*, but in habit it resembles *Mecistostylus Douei*." I cannot see that the genus is at all close to *Enteles*, and it is certainly one of the allies of *Chætectetorus*. In 1873, Mr. Pascoe described another genus, *Axides*,† comparing it with *Chimades*, but not mentioning *Phlœoglymma*. The species, however, (*P. alternans* and *A. dorsalis*) are undoubtedly congeneric, agreeing in the open mesosternal receptacle, very finely

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* Mr. Pascoe describes the claw-joint of *Axides* as "*esquamosa*": in this, however, he was mistaken, though the scales are much smaller than in *Chætectetorus*.

† Ann. Mag. Nat. Hist. (4), xii. p.285.

faceted eyes, dentate and feebly grooved femora, short scape, etc.; the only character which, in a highly artificial arrangement, could possible separate them being that in *P. dorsalis* the rostrum is rather wider than in *P. alternans.*

Ocular fovea very distinct... .... *dorsalis* Pasc.
Ocular fovea feeble.
  Rostrum at apex almost as wide as scape is long......... *mixta* Lea.
  Rostrum at apex much narrower................................ *alternans* Pasc.

PHLŒOGLYMMA ALTERNANS Pascoe; Mast. Cat. Sp. No.5570.

Reddish-piceous, antennæ dull red. Moderately densely clothed with suberect scales, denser on head, base of rostrum and prothorax than elsewhere, scales varying in colour from white to dark brown, but mostly ochreous. Prothorax with a small fascicle on each side of apex, the median line and a stripe on each side composed of smaller scales. Scutellum squamose. Elytra feebly crested on 2nd, 4th and 6th interstices about the middle, and on the 4th and 5th near base, the 3rd distinctly crested at base, the crest composed of dark scales; towards apex with paler scales than elsewhere; each puncture with a distinct grey scale. Under surface more regularly clothed than upper, pectoral canal naked.

Rather narrow and subcylindrical. *Head* flat between eyes, ocular fovea almost concealed by scales. Rostrum thin, slightly curved, considerably wider at base than at apex, a shallow groove on each side of base; in ♂ moderately, in ♀ very finely punctate; shorter in ♂ than in ♀. Scape about two-thirds the length of funicle, inserted two-fifths from base of rostrum in ♀, slightly nearer the middle in ♂; 1st joint of funicle almost twice the length of 2nd. *Prothorax* subconical, in ♀ slightly longer than wide, in ♂ feebly transverse; apex half the width of base; densely punctate, punctures round and almost concealed. *Elytra* considerably wider than and feebly raised above prothorax, sides very feebly decreasing from base to near apex; striate-punctate, punctures rather large and more or less rounded; interstices convex, not much wider than punctures, feebly elevated beneath crests. *Under surface* densely punctate, punctures round and rather denser on metasternum than elsewhere. Length $4\frac{1}{2}$, rostrum $1\frac{1}{4}$; width $2\frac{1}{6}$; variation in length 4-5 mm.

Hab.—N.S.W.: Rope's Creek and Sydney.

The clothing is somewhat variable; in some specimens the paler scales are almost white.

PHLŒOGLYMMA MIXTA Lea, Proc. Roy. Soc. Vic. 1908, p.193.

Hab.—King Island.

PHLŒOGLYMMA DORSALIS Pasc.; *l.c.* 5506. (*Axides dorsalis* Pasc.)

Piceous; elytra and under surface reddish-piceous; antennæ dull red, club darker. Densely clothed with rounded scales. Head with ochreous scales, becoming pale yellow on vertex and base of rostrum. Prothorax with pale yellow scales about apex and sides, a subquadrate dark patch at base, elongate erect scales scattered about and condensed to form six loose feeble fascicles, four across middle and one on each side of apex. Elytra with pale scales on shoulder and apical two-fifths, a dark dorsal patch abruptly terminated posteriorly, but towards base and sides more or less encroached upon by paler scales, a moderately large round ochreous patch on each side of base; each puncture containing a scale; each elytron with four feeble fascicles: two on the 2nd interstice, one on the 4th about middle and one on the 3rd near base; elongate suberect scales placed almost regularly on the interstices. Under surface and legs with regular and almost white scales.

Moderately wide and suboblong. *Head* with the ocular fovea very distinct. Rostrum shorter, wider and more strongly curved than in *P. alternans*, wider at base than at apex, feebly grooved at sides of base; in ♂ moderately, in ♀ rather finely punctate. Scape scarcely two-thirds the length of funicle, inserted two-fifths from base of rostrum; first joint of funicle once and one-half the length of second. *Prothorax* subconical, transverse, apex half the width of base, a very feeble median carina (usually concealed) commencing at base and terminating before apex; densely punctate, punctures round and each overlapped by a scale. *Elytra* considerably wider than and feebly raised above prothorax, sides parallel to near apex; striate-punctate, punctures moderately large, interstices feebly convex, considerably wider than punctures, in parts very feebly elevated. *Under surface* with very dense small round and almost entirely concealed punctures. Length $5\frac{1}{2}$, rostrum $1\frac{1}{2}$; width $3\frac{1}{6}$; variation in length $3\frac{1}{2}$-6 mm.

Hab.—N.S.W.: Sydney (on *Ricinocarpus pinifolius* Desf.).

Considerably wider and less convex than *P. alternans*, and like it somewhat variable in the clothing. In several specimens the pale scales on the upper surface are white and the dark patches sooty; in others the paler scales are of a leaden-grey, the darker patches on the prothorax and elytra being very feebly defined; in a number of specimens the pale scales on the shoulders are semicircularly continued almost to the suture. In one specimen the posterior femora are marked with a feeble dark ring.

METYRCULUS, n.g.

Head rather large, ocular fovea feeble. *Eyes* large, round, coarsely faceted, widely separated. *Rostrum* rather stout and short, feebly curved. *Scape* stout, inserted almost in middle of side of rostrum, considerably shorter than funicle; two basal joints of funicle moderately long and stout; club elliptic-ovate, subcontinuous with funicle. *Prothorax* feebly transverse, apex produced and overhanging head, base feebly bisinuate; ocular lobes somewhat rounded and considerably in rear of apex. *Scutellum* small. *Elytra* closely applied to and outline almost continuous with that of prothorax. *Pectoral canal* rather deep and wide, terminated between four front coxæ. *Mesosternal receptacle* scarcely raised, walls rather thick and briefly U-shaped, emargination strongly transverse; cavernous. *Metasternum* shorter than basal segment of abdomen; episterna distinct. Basal segment of *abdomen* the length of 2nd and 3rd combined, 3rd and 4th combined the length of 2nd and considerably longer than 5th. *Legs* thin and rather long; femora edentate, distinctly grooved, posterior extending to apical segment; tibiæ slightly compressed, curved at base; tarsi not very thin, 3rd joint rather wide and deeply bilobed; claw-joint thin. Elliptic, convex, squamose, winged.

Apparently allied to *Meniomorpha*, but differing considerably in the head, rostrum, club, apex of prothorax and mesosternal receptacle.

Metyrculus bimaculatus, n.sp.

Piceous-red or reddish-piceous, antennæ and tarsi dull red. Densely clothed with large soft scales of varying shades of fawn and brown; each elytron with a small distinct angular patch of white scales before the middle. Under surface with larger, softer and paler scales than on prothorax, many of them (especially on flanks of metasternum) perfectly round; legs densely clothed.

Rostrum short, feebly curved, with rather large round and deep punctures, dense only at base. Scape about half the length of funicle and club combined. *Prothorax* transverse, apex strongly but not abruptly narrowed, sides rounded, behind middle slightly decreasing to base; with dense round punctures which are not entirely concealed. *Elytra* elongate-subcordate, outline regular, punctate-striate, neither punctures nor striæ well defined anywhere and very indistinct towards suture. *Under surface* densely punctate, punctures partially concealed, a single row on each of the metasternal episterna. Length 4¼, rostrum 1 (vix); width 2 mm.

Hab.—Q.: Endeavour River; N. W. Australia (Macleay Museum).

Three specimens from the above localities agree in all details and are apparently males. A specimen in the Macleay Museum from Norfolk Island is probably a female; it differs only in being larger (6 mm.) and in having the rostrum slightly longer, paler and with less coarse punctures. The patches of white scales are exactly half-way between apex of prothorax and apex of elytra; no fascicles are traceable.

Deretiosus Pascoe.

Journ. Linn. Soc. Zool. 1871, p.184.

Head convex, almost concealed by prothorax; ocular fovea concealed. *Eyes* rather coarsely faceted, distant. *Rostrum* rather long and thin, feebly curved. *Antennæ* slender; insertion of scape variable; two basal joints of funicle elongate; club elliptic or elliptic-ovate. *Prothorax* transverse, sides more or less flattened, apex produced and much narrower than base, ocular lobes slightly produced. *Scutellum* more or less rounded, distinct. *Elytra* wider than and elevated in parts above prothorax, base trisinuate, shoulders prominent, sides more or less parallel, apex rounded. *Pectoral canal* rather narrow, equally deep throughout, bounded behind by metasternum and slightly encroached upon by anterior coxæ. *Mesosternal receptacle* absent.* *Metasternum* shorter than basal segment of abdomen, semicircularly emarginate between coxæ; episterna large and gradually increasing posteriorly. *Abdomen* large, sutures distinct, basal segment longer but scarcely larger than 2nd, intercoxal process rounded, apex incurved to middle; 3rd and 4th combined longer than 5th, but considerably shorter than 2nd. *Legs* rather short; femora stout, strongly dentate, not grooved, posterior terminating before apex of abdomen; tibiæ slightly compressed, rather strongly arcuate at base, more or less angular; tarsi shorter than tibiæ, 3rd joint wide, deeply bilobed, 4th elongate, squamose and setose; claws not widely separated. Suboblong or elliptic, squamose, fasciculate, winged.

The genus in Australia appears to be confined to North Queensland. The entire absence of the mesosternal receptacle renders it the most distinct of any of the genera allied to *Chætectetorus*; its nearest ally is perhaps *Chimades*.

I have five species under examination, but on account of paucity of specimens cannot scrape off the scales to see the punctures and the colour of the derm. The colour, judging from the exposed portions, appears to be of a reddish-brown; the punctures appear to be coarse on the prothorax and elytra and fine on the under surface.

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* The mesosternum is excavated between the intermediate coxæ so that these are free internally, whilst the canal actually mpinges on the metasternum.

Each elytron with an interrupted fascicular crest on 3rd interstice.
Clothing almost uniform in colour.................................. *aridus* Pasc.
Clothing variegated .. .. *blandus*, n.sp.
Each elytron with a fascicular crest on 3rd interstice at base.
Funicle apparently 6-jointed....................... .... *aspratilis*, n.sp.
Funicle distinctly 7-jointed.
Prothorax and elytra with scattered erect setæ... ... *hystricosus*, n.sp.
Prothorax and elytra without erect scales except in centre of pustules.. ... *verrucifer* Faust.

Deretiosus aridus Pasc.

Journ. Linn. Soc. Zool. 1871, p.185, pl.viii. fig.10.

Densely covered all over with fawn-coloured scales, except on the rostrum in ♀, apex of rostrum in ♂, and a small space between the front coxæ in both sexes; apical segments of abdomen with darker scales. Prothorax with the sides, apex and middle fasciculate, the fascicles consisting of masses of small scales in which numerous stout ones are placed. Each elytron with a fasciculate crest on 3rd interstice, commencing near base, interrupted at its middle and terminated at summit of posterior declivity, 5th interstice with a small fascicle near base and another near apex, sides with small subfasciculate masses of scales; suture between crests at summit of posterior declivity with a small darker velvety patch, the patch terminated by a feeble (but distinct) V-shaped ridge. Undersurface with a few, the legs with numerous suberect scales.

Broad, depressed. *Rostrum* rather feebly curved and coarsely punctate in ♂, more strongly curved and feebly punctate in ♀. Antennæ thin; scape the length of funicle, inserted one-third from apex of rostrum in ♂, two-fifths in ♀; 2nd joint of funicle thinner and slightly longer than 1st; club elliptic. *Prothorax* strongly transverse, sides dilated and slightly elevated, apex produced and scarcely half the width of base, base bisinuate, disc uneven; densely punctate. *Scutellum* feebly raised, subquadrate. *Elytra* wider than and raised above prothorax, base trisinuate, shoulders feebly rounded, sides parallel to near apex; striate-punctate, punctures concealed, striæ feebly traceable. *Femoral* *teeth* large, triangular, acute, subequal. Length 8, rostrum $1\frac{1}{2}$; width $3\frac{3}{4}$ mm.

Hab.—Q.: Cairns (Macleay Museum). "Dorey; Saylee (New Guinea); Ceram" (Pascoe).

DERETIOSUS BLANDUS, n.sp.

♂(?). Densely clothed with fawn-coloured, ochreous and various shades of brown scales, a few white scales on elytra towards apex. Under surface with paler scales, the three apical segments of abdomen and the legs prettily variegated with brown. Apical half of rostrum and a space between the front coxæ naked. Prothorax with fascicles much as in the preceding species, but leaving a median line. Each elytron with two moderately long fascicles on the 3rd interstice, the space separating them being rather more than in the preceding species, 5th with four rounded fascicles, the 7th with two or three; suture at summit of posterior declivity with a dark velvety patch bounded behind by a white V-shaped ridge. Under surface with a few, the legs (especially the front femora) with numerous stout, suberect scales.

Broad, depressed. *Rostrum* curved towards apex, sides very feebly incurved to middle, finely punctate. Antennæ slender, scape the length of funicle, inserted three-sevenths from apex of rostrum; two basal joints of funicle subequal in length; club elliptic. *Prothorax* strongly transverse, sides dilated and but feebly elevated about middle, apex produced and considerably less than half the width of base, base feebly bisinuate, disc very uneven; densely punctate. *Scutellum* feebly raised, subquadrate. *Elytra* wider than and raised above prothorax, base feebly trisinuate, shoulders slightly rounded, sides parallel to near apex; striate-punctate, punctures partially visible. *Femoral teeth* large, triangular, acute, the posterior larger than the others. Length 6, rostrum $1\frac{1}{3}$; width 3 mm.

Hab.—Q.: Cape York (Macleay Museum).

A beautiful species, in shape resembling some of the *Tenebrionidæ* (*e.g.*, *Ulodes*, *Dipsaconia*). Seen from in front, the elytra appear to be marked at summit of posterior declivity with a W-shaped ridge of white scales.

Deretiosus aspratilis, n.sp.

♂. Densely covered all over (except apex of rostrum and a space between front coxæ) with pale fawn-coloured scales, paler on head, rostrum and under surface than elsewhere. Prothorax scarcely fasciculate, but with a number of very stout, erect scales, especially towards the apex. Each elytron with a strong fasciculate crest on 3rd interstice, commencing at base and terminating before middle, the scales composing it being large, wide and fluted throughout, shoulder with a small fasciculate crest, a number of stout scales arising elsewhere and marking the positions of feeble fascicles.

Rather narrow, moderately convex. *Rostrum* almost straight, sides feebly incurved to middle. Antennæ slender; scape about the length of funicle, inserted in exact middle of rostrum; 1st joint of funicle obtriangular, longer than 2nd, the 7th apparently soldered to the club and causing it to appear elongate-elliptic. *Prothorax* strongly transverse, sides not suddenly dilated and not elevated, apex produced and fully half the width of base, base trisinuate, disc somewhat uneven. *Scutellum* transverse. *Elytra* raised above and not much wider than prothorax, base strongly trisinuate, shoulders produced and rounded, sides parallel to near apex; striæ scarcely traceable. *Femoral teeth* moderately large and acute, the intermediate smallest, the posterior longest and very acute; tibiæ very short. Length $5\frac{1}{2}$, rostrum $1\frac{1}{3}$ (vix); width $2\frac{1}{3}$ mm.

Hab.—Q.: Endeavour River (Macleay Museum).

In another specimen the elytra at the summit of the posterior declivity are marked with a transverse narrow whitish fascia and several small whitish patches along suture. The apparently 6-jointed funicle is not due to accident, as it is exactly the same in the two specimens under examination; the 7th joint is clothed like and appears to be truly a part of the club. This and the two following species are narrower and less depressed than the two preceding, and the prothorax is somewhat differently shaped.

Deretiosus hystricosus, n.sp.

Densely covered all over (except apical two-thirds of rostrum) with pale fawn-coloured scales, feebly variegated on head and slightly paler on under than on upper surface. Prothorax with six fascicles of which the two in front are distinct, a few elongate stout setæ at sides; each elytron with a moderately large (but not very distinct) fasciculate crest on 3rd interstice near base; elsewhere with rather numerous long erect stout setæ.

Narrow, cylindrical, convex. *Rostrum* slightly curved, sides feebly incurved to middle. Antennæ slender; scape slightly shorter than funicle, inserted slightly nearer apex than base; funicle distinctly seven-jointed, *Prothorax* moderately transverse, sides rounded. *Scutellum* subtriangular. *Elytra* raised above and about once and one-half the width of prothorax, base trisinuate, shoulders rounded, sides parallel to near apex; striæ not traceable through clothing. *Femora* subclavate, teeth large and acute. Length 4, rostrum 1; width $1\frac{2}{3}$ mm.

Hab.—Q.: Cairns. (Type in Macleay Museum).

Closely resembles the preceding species, but the funicle and club are normal; the elytral crests are much smaller, the scattered erect setæ are more numerous, longer, more upright and thinner, and the whole insect is smaller.

After the above description was drawn up, I received numerous specimens from Mr. Hacker (also from Cairns); and nearly all of these have a somewhat sooty and almost circular patch of scales on the posterior declivity. They mostly have also a small patch of sooty scales on the suture, just behind the scutellum.

Deretiosus verrucifer Faust.

Ann. Mus. Civ. Gen., Serie 2a, Vol.xx.(xl.), 1899, p.52.

♀ (?). Densely covered all over (except on rostrum and between front coxæ) with leaden-grey scales, paler on under surface than elsewhere; the apical segments of abdomen mottled with brown; elytra with a dark velvety space on each side of scutellum at base, and a small rounded spot of similar scales on 3rd interstice before middle. Prothorax with several very feeble fascicles across middle, at sides and apex. Elytra with a short broad fasciculate crest on 3rd interstice at base and a smaller one on shoulder; the interstices with regular rows of small round feebly elevated pustule-like fascicles, in the centre of each of which is a stout scale.

Narrow, subcylindrical, convex. *Head* depressed between eyes. *Rostrum* moderately curved, sides feebly incurved to middle; finely punctate. Antennæ thin; scape shorter than funicle, inserted in exact middle of rostrum; two basal joints of funicle subequal; club elliptic-ovate. *Prothorax* moderately transverse, subconical, sides rounded and not at all raised, apex not half the width of base, base bisinuate; densely punctate. *Scutellum* slightly longer than wide. *Elytra* wider than and raised above prothorax, base moderately trisinuate, shoulders almost square, sides parallel to apical fourth and then oblique to apex; striæ distinctly, the punctures less distinctly traceable. *Femoral teeth* moderately large and acute, the posterior more acute but scarcely larger than the others. Length $5\frac{3}{4}$, rostrum $1\frac{1}{3}$; width $2\frac{1}{2}$ mm.

Hab.—Q.: Cooktown, Endeavour River.

Another specimen differs in having the clothing more ochreous. The numerous small pustule-like fascicles on the elytra are very peculiar. The species was described originally from New Guinea.

Genus CHÆTECTETORUS Schönherr.

Gen. et Spec. Curc. Vol.viii. pt.1, p.383; Lacord., Gen. Col. Tome vii. p.112; Pascoe, Trans. Ent. Soc. Lond. 1870, p.469.

Head rounded, feebly convex; ocular fovea concealed. *Eyes* small, round, distant, coarsely faceted. *Rostrum* short or moderately long, slightly curved, sexually variable. *Antennæ* comparatively short; scape inserted about middle of rostrum; two basal joints of funicle moderately elongate, 7th subadnate to club; club short or moderately short. *Prothorax* usually longer than wide, emargination deep, ocular lobes prominent and rather acute; apex produced and overhanging head; disc depressed in places; sides reflexed. *Scutellum* small, raised, distinct. *Elytra* parallel-sided to near apex, wider than and more than twice the length of prothorax, disc somewhat flattened, base trisinuate, apex entire but appearing feebly emarginate, alternate interstices raised. *Pectoral canal* wide, deep, terminated just before middle coxæ. *Mesosternal receptacle* raised, apices produced, emargination semicircular, transverse; sloping from apex to base; basal portion rather large ; cavernous. *Metasternum* large, episterna wide. *Abdomen* with sutures partially concealed by scales, but when these are removed, very distinct; two basal segments large, 2nd as large, larger or slightly smaller than 1st; 3rd and 4th thin, their combined length less than that of 2nd and subequal to 5th, depressed below 2nd and level with 5th. *Legs* moderately long; femora linear, edentate, not grooved, posterior extending to apical segment of abdomen; tibiæ straight or slightly curved; 3rd tarsal joint wide, deeply bilobed, claw-joint long, squamose. Elongate, subparallel, densely squamose, fasciculate, winged.

The clothing of the species belonging to this genus is so dense that the punctures (which are unusually numerous) are nearly always hidden; their presence on the elytra may be easily traced, but they can only be seen elsewhere where scales have been rubbed off; the finer details are also concealed. The antennæ are more or less red, but the colour of other parts cannot be seen unless the scales are removed, consequently I have not mentioned it. I have found it necessary to strictly define the genus and to extend Pascoe's limitations (given below), as *Chætectetorus* has, perhaps, more genera (both Australian and Malayan) distinctly allied to it than any other genus of Australian *Cryptorhynchides*. *C. setosus* Boh., and *C. bifasciatus* Boh., are here regarded the types of the genus; these two species, though originally referred to *Gasterocercus*, were undoubtedly those that Schönherr had under observation when drawing up the diagnosis of the genus. It is necessary either to strictly limit the genus or to include in it *Chimades*, *Deretiosus*, *Achopera*, *Ephrycus*, *Axides*, *Metacymia*, *Menios*, *Phlœoglymma*, and a host of other forms. In the genus as restricted by me, it is doubtful if *C. gronopoides* Pasc., would find a place. I do not know the species, but Pascoe's remark :

"Prothorax in medio, *apice excepto*, profunde sulcatus," causes me to think that it should be excluded. *C. spinipennis* Waterh., belongs to *Euthyrhinus*.

Of *Chætectetorus* Mr. Pascoe* remarks: "There are numerous forms connected with this genus, both Australian and Malayan. I have some doubt of the species from which Lacordaire drew up his characters of the genus, as he describes the rostrum as straight, or nearly so, the eyes finely granulate, and the prothorax without ocular lobes; and he makes no mention of the dilated margins of the prothorax in his otherwise ample description. In treating of the species I think it necessary to exclude all those which (1) have a straight rostrum, (2) and have not the prothorax flattish above and expanded or marginate at the sides, (3) the femora unarmed, (4) the eyes coarsely granulate, (5) the club of the antennæ adnate to the funicle, and (6) all the tarsal joints furnished with erect scales; their presence on the claw-joint is very unusual. These larger scales, which are scattered among the other scales, mostly above and on the legs, seem to be of the ordinary form, only stouter, and more or less erect; they are called *setæ* by Boheman."

I also exclude all those species which have (7) a distinct circular or pear-shaped fovea or deep longitudinal impression in the middle of prothorax, (8) elytra not parallel-sided, (9) posterior femora passing apex of elytra, and (10) mesosternal receptacle open.

The species may be obtained under bark, on or under logs, and at night-time whilst crawling over tree-trunks.

A transverse row of fascicles at summit of posterior declivity.
  Elytra with more or less distinct white fasciæ.
    Without fascicles on posterior declivity.
      Elytra with narrow fasciæ................ *latus* Pasc.
      Elytra with wide fasciæ .... *bifasciatus* Bohem.
    With fascicles on posterior declivity......... *clitellæ* Pasc.
  Colour uniform.. *setosus* Bohem.
Without a transverse row of fascicles at summit of declivity.. *egenus*, n.sp.

* Trans. Ent. Soc. Lond. 1870, p.469.

CHÆTECTETORUS BIFASCIATUS Bohem.; Mast. Cat. Sp. No. 5507.

Upper surface densely clothed with scales of various shapes and colours, sometimes forming fascicles. Prothorax with pale brown scales, a blackish subquadrangular patch in middle of base; sides and apex with elongate scales forming feeble fascicles in places, a row of elongate scales on each side of middle, subfasciculate in middle, a few others irregularly distributed. Elytra with pale brown scales, a small patch of darker scales about suture, an oblique white patch from shoulder (where it is broadened) to near suture, a transverse patch of white or whitish scales at summit of posterior declivity and a few pale scales at apex; 3rd, 5th, and 7th interstices subfasciculate, 3rd and 5th almost equal; shoulders and apex subfasciculate. Under surface densely covered with uniformly sized scales of a greyish colour, darker and less uniform in colour on four apical segments of abdomen than elsewhere. Legs with rings of pale and dark scales, sometimes distinct, sometimes very obscure.

Rostrum of ♂ about twice the length of width of apex, and with punctures entirely concealed; in ♀ longer and thinner and with punctures partly visible on apical half. Scape of ♂ inserted near and just passing apex of rostrum, in ♀ not reaching apex; two basal joints of funicle moderately elongate, 1st longer than 2nd. *Prothorax* longer than wide; disc slightly convex, depressed near sides and in middle; densely punctate, punctures entirely concealed, sometimes with a feeble median carina showing near base. *Scutellum* raised, slightly longer than wide. *Elytra* parallel to near apex; striate-punctate, punctures concealed, alternate interstices raised. Length $6\frac{3}{4}$, rostrum $1\frac{1}{4}$; width $2\frac{1}{2}$, variation in length $4\frac{1}{2}$-$8\frac{1}{2}$ mm.

Hab.—South-Western Australia. Common under bark and widely distributed.

The scales on this species are subject to great variation. On some specimens the majority on the upper surface are mouse-coloured, the dark prothoracic patch and the pale elytral stripes being scarcely visible. On many, the prothorax has two large fascicles at apex and two small ones on disc; several have a moderately large fascicle on each shoulder. On several specimens the prothoracic scales are reddish-ochreous; others have two dark transverse patches on elytra, one near middle and one near apex. One large and handsome specimen has the scales on the upper surface white, or feebly tinged with brown, except the prothoracic patch, a patch on the elytra behind it, a transverse oblique stripe about middle, and a feeble patch just below summit of posterior declivity. On this specimen there are two distinct white fascicles on each side of prothorax, two which are slightly darker at apex, and two others which are almost black in the middle; the third interstice has six fascicles, a long one near base separated from the second some distance, the other five at equal distances behind each other, with the sixth at summit of posterior declivity; the fifth interstice has six fascicles similar to those of the third, except that the basal one is smaller and paler.

This species is noted in the Catalogue (with a query) as coming from New South Wales. Boheman records it from the Swan River. I have never seen specimens from New South Wales, and do not believe that it occurs there.

Chætectetorus latus Pasc.; *l.c.* 5511.

Densely covered with dark mouse-coloured or muddy-brown scales, more uniform and paler on under than on upper surface. Upper surface with elongate darker scales, irregularly distributed, and forming more or less regular fascicles; prothorax with six moderately distinct ones—two at apex and two on each side, a few smaller ones about disc. Elytra with alternate interstices fasciculate, the 3rd with more fascicles than 7th and less than 5th, shoulders and apex subfasciculate, the latter appearing feebly emarginate, posterior declivity not or very feebly fasciculate, white scales forming an oblique, slightly curved stripe (frequently indistinct and occasionally absent) from shoulders to suture; a white transverse stripe near summit of posterior declivity, usually more distinct in middle than towards sides, sometimes entirely absent. Head and base of rostrum with scales irregular both in size and colour. Legs with irregular scales, forming white and brown (or black) rings on femora and tibiæ, more distinct on tibiæ than on femora, sometimes obscure on both.

Rostrum moderately long (longer in ♀ than in ♂); punctures on basal half concealed in ♂, on basal third in ♀. Scape inserted about one-third from apex of rostrum in ♂ and passing apex, in ♀ not extending to apex; two basal joints of funicle elongate, 1st distinctly longer than 2nd. *Prothorax* slightly transverse, the apical fascicle causing it to appear slightly longer than wide, depressed near sides; an irregular depressed space in middle bounded on each side near its apices by a small tubercle (usually fasciculate), and with a feeble carina in its middle. *Scutellum* raised, round. *Elytra* parallel-sided to near apex, distinctly wider than prothorax, shoulders prominent; striate-punctate, punctures large, but almost concealed, alternate interstices raised and apparently granulate. Length 7 (vix), rostrum $1\frac{2}{5}$; width $3\frac{1}{4}$ mm.

Hab.—New South Wales, Victoria. Widely distributed and common in hilly districts.

This species resembles the preceding in form and size and varies in a similar way, though not to such an extent as regards size. It may be distinguished by its greater breadth, darker colour, and more regular fascicles. A specimen from Orange has the prothorax apparently broader than usual, but this is in consequence of the apical fascicles being smaller and denser.

CHÆTECTEOTRUS SETOSUS Bohem.; *l.c.* 5512.

Densely and uniformly clothed with greyish-brown or muddy-brown scales. Upper surface with elongate scales bordering the prothorax and forming an elongate fascicle on each side in middle. Elytra with 3rd, 5th and 7th interstices fasciculate. Legs not ringed.

Rostrum and scape as in *C. latus*. *Prothorax* longer than wide, apex rounded, middle slightly convex, not carinate, a tubercle on each side of middle, near sides longitudinally depressed, sides reflexed. *Scutellum* small, suboblong. *Elytra* almost thrice the length of prothorax, shoulders prominent; alternate interstices raised and tuberculate; striate-punctate; punctures partially concealed, subapproximate, narrower than interstices. *Tarsi*, on account of scales, indistinctly jointed. Length $5\frac{1}{3}$, rostrum $1\frac{1}{6}$; width 2 mm.

Hab.—South-Western Australia. Widely distributed.

This species also is variable as regards its scales, one specimen having them very dark with the elongate scales sooty-black, and on prothorax forming a line on each side of middle from base to apex. Another specimen has the fascicles less distinct and numerous single elongate scales distributed all over the elytra; it perhaps belongs to an undescribed species, but I think it very undesirable to characterise species belonging to *Chætectetorus* and most of its allies without having at least two specimens to examine.

Chætectetorus egenus, n.sp.

Densely covered with ferruginous or muddy-brown scales. Upper surface with elongate scales showing above others and margining the sides of prothorax, forming a row on each side of middle and a few irregularly distributed. Elytra with a few elongate scales irregularly distributed, alternate interstices irregularly fasciculate, summit of posterior declivity not marked by fascicles. Tibiæ at base feebly ringed with blackish scales.

Rostrum moderately long, thick, in ♂ subparallel, in ♀ noticeably incurved to middle; punctures concealed on basal third, shining and densely punctate thence to apex. Antennæ thick; scape very short, thick, inserted distinctly nearer base than apex of rostrum; basal joint of funicle thick, slightly longer than 2nd. *Prothorax* distinctly longer than wide, apparently carinate, but sculpture almost entirely concealed, with trace of a depression near the sides and median tubercle; sides feebly reflexed. *Scutellum* small, feebly raised, apex rounded, base truncate. *Elytra* long, rather narrow, parallel-sided, shoulders moderately prominent; seriate-punctate, punctures large, approximate, partially concealed by scales, appearing narrower but really wider than interstices; alternate interstices feebly raised. Third and 4th segments of *abdomen* above the usual size. *Tarsi* elongate, 3rd joint rather narrow, claw-joint long, feebly squamose. Length $6\frac{1}{3}$, rostrum $1\frac{1}{3}$; width $2\frac{1}{2}$ mm.

Hab.—Q.: Barron Falls (A. Koebele).

All the preceding species conform exactly to the generic diagnosis given above; the present species (of which I have three specimens) differs to a slight extent in the abdomen and tarsi. The elongate scales on the prothorax and elytra appear to be shorter in this than in all the other species; on the prothorax this may be caused by the density of the other scales. The apex of the elytra does not appear to be emarginate. The species is perhaps closest to the preceding, from which, however, it is abundantly distinct.

An abraded specimen from the late Herr J. Faust, which I refer to this species, has a distinct prothoracic carina and large quadrate punctures on the elytra.

CHÆTECTETORUS CLITELLÆ Pasc.; *l.c.*5508.

Hab.—South Australia.

I have but one specimen (in bad condition) of this species. It is allied to *C. bifasciatus*, but appears to be sufficiently distinct, judging by the rostrum of the male, which is shorter and broader than in any other species here noted. Its length is 5 mm.

CHÆTECTETORUS HÆDULUS Pasc.; *l.c.*5510.

Hab.—Queensland. Unknown to me.

CHIMADES Pascoe.

Trans. Ent. Soc. 1870, p.424.

Head feebly convex, not concealed by prothorax; ocular fovea concealed. *Eyes* moderately large, subtriangular, very finely faceted, distant. *Rostrum* the length of prothorax, rather thin, feebly curved. *Antennæ* rather slender; scape inserted in middle of rostrum, the length of funicle; two basal joints of funicle elongate, the others subglobular; club large, subelliptic, distinctly three-jointed, free. *Prothorax* transverse, depressed, apex produced and about one-half width of base, base subtruncate; ocular lobes almost rectangular. *Scutellum* feebly raised, distinct. *Elytra* slightly wider than and raised above prothorax, longitudinally and transversely convex, base feebly sinuate, sides parallel to apical third, then oblique to apex. *Pectoral canal* deep and moderately wide, terminated almost at metasternum. *Mesosternal receptacle* distinctly raised, U-shaped, sides very narrow; open. *Metasternum* slightly shorter than basal segment of abdomen; episterna large, feebly dilating posteriorly. *Abdomen* large, sutures distinct; basal segment about once and one-half the length of 2nd, rather strongly incurved at apex, intercoxal process rather narrow; 3rd and 4th large, their combined length more than that of 2nd or 5th. *Legs* rather short; femora dentate, not grooved, posterior terminating before apex of abdomen; tibiæ short, compressed, curved only at base; tarsi the length of tibiæ, 3rd joint wide, deeply bilobed; claw-joint elongate, feebly setose, claws separated at an angle of about 60°. Suboblong, squamose, fasciculate, winged.

This genus is closely allied to *Phlœoglymma* and *Tychreus*; from the former it differs in the shape of the eyes, the prothorax and elytra, and in the antennæ, especially the club; from the latter by its more finely faceted eyes, antennæ, dentate femora and termination of pectoral canal.

Chimades lanosus Pasc.; Mast. Cat. Sp. No.5519.

Reddish-brown, antennæ and claws red. Densely clothed with whitish scales having a loose appearance and apparently mixed with a greyish exudation; rostrum and pectoral canal glabrous. Prothorax with long erect subfasciculate scales at the sides and apex. Each elytron with two very distinct fascicles on 3rd interstice; one near base and one at summit of posterior declivity, sides with two less distinct fascicles. Under surface with greyish scales, denser on sides of sterna than elsewhere. Legs densely squamose, the tibiæ and femora feebly ringed with brown.

Broad, suboblong. *Rostrum* shining, sides feebly incurved to middle, finely punctate. Funicle with 1st joint slightly longer than 2nd; club almost the length of six preceding joints. *Prothorax* not densely or strongly punctate. *Elytra* almost thrice the length of prothorax; apparently very irregularly punctate; disc raised beneath fascicles. *Under surface* finely punctate. Posterior *femora* terminated before apical segment, teeth of all not very large, the posterior very feeble. Length $7\frac{1}{2}$, rostrum $1\frac{1}{2}$; width 3 mm.

Hab.—New South Wales.

The clothing is so dense as to entirely conceal the colour and punctures, and has a loose woolly appearance. The sides of the elytra appear to be slightly incurved to the middle (the scales there being darker), but this appearance is caused by larger scales near the base and about the apical third.

EPHRYCINUS, n.g.

Head small, partially concealed. *Eyes* small, rather finely faceted, distant. *Rostrum* curved, moderately thin, slightly shorter than prothorax, parallel-sided. *Scape* inserted about middle of rostrum, stout, shorter than funicle; basal joint of funicle elongate; club ovate. *Prothorax* feebly convex, not longitudinally sulcate, apex tubular but more than half the width of base, base truncate. *Scutellum* moderately distinct. *Elytra* feebly convex, slightly wider than prothorax, sides subparallel to near apex, posterior declivity gently rounded. *Pectoral canal* deep and wide, terminated between four anterior coxæ. *Mesosternal receptacle* rather large, raised in front, emargination strongly transverse; cavernous. *Metasternum* flat, considerably longer than basal segment of abdomen; episterna distinct. Sutures of *abdomen* distinct, 1st segment once and one-half the length of 2nd, 2nd slightly longer than 3rd, 3rd noticeably longer than 4th and but slightly shorter than 5th. *Legs* moderately short; femora stout, edentate, not grooved, posterior extending to apical segment; tibiæ feebly compressed, feebly bisinuate beneath;

tarsi narrow, 3rd joint not twice the width of 2nd, claw-joint long, thin and setose. Depressed, elongate-elliptic, punctate, squamose, winged.

The facets of the eyes are small, but in proportion to the eyes themselves are comparatively large. The length of the 4th abdominal segment in comparison with that of the 3rd is remarkable, considering that these segments are almost invariably coequal. In general appearance the genus is close to *Ephrycus*, but is at once distinguished therefrom by the cavernous mesosternal receptacle.

Ephrycinus pilistriatus, n.sp.

Antennæ and tarsi dull red; derm concealed. Densely clothed with soft scales closely applied to derm and varying from pale stramineous to brown, or almost black, the dark patches in blotches; a distinct rounded patch on each side of prothorax at base; under surface with almost uniformly coloured scales; legs feebly mottled; pectoral canal clothed. In addition to the soft ones with long thin erect setose scales: on the elytra on suture, 3rd, 5th and 7th interstices, on prothorax very distinct at sides and apex; under surface and legs with finer setæ, those on rostrum slightly curved.

Rostrum clothed almost to apex and punctures almost entirely concealed. Scape inserted slightly nearer apex than base of rostrum, more than half the length of funicle and club combined. *Prothorax* scarcely longer than wide; densely punctate, punctures entirely concealed. *Elytra* not much wider than prothorax, base feebly trisinuate, shoulders rounded; striate-punctate, striæ feeble, punctures large, round, deep, partially concealed; interstices gently convex, not alternately raised. *Metasternum* and two basal segments of abdomen with large and partially visible punctures or foveæ. *Tibiæ*, especially the posterior, stouter near apex than in middle. Length 4, rostrum 1; width $1\frac{3}{5}$ mm.

Hab.—Lord Howe Island (Macleay and Australian Museums).

ACHOPERINUS, n.g.

Eyes moderately large. *Scape* thin, almost the length of funicle. *Pectoral canal* terminated between four front coxæ. *Femora* dentate. All else as in *Achopera.*

This genus is erected to receive *Cryptorhynchus infulatus* Er., a species supposed by Mr. Pascoe to belong to *Ephrycus;* that genus, however, has the mesosternal receptacle decidedly open and the eyes finely faceted.

ACHOPERINUS INFULATUS Er.; Mast. Cat. Sp. No.5545.

Cryptorhynchus infulatus Er.

Elliptic-ovate, gently convex. Rostrum piceous, antennæ and tarsi red; derm elsewhere concealed. Densely clothed with soft, loose, dark brown scales feebly variegated at apex and sides of prothorax; a patch of ochreous scales on median line at base, a patch of similar scales at the side beyond middle of each elytron; each of these with a very distinct spot of white scales on disc just before middle; head and base of rostrum with dingy scales, but a white trilobed patch on vertex. Under surface and legs with brown and dingy white scales; pectoral canal densely clothed. Prothorax with six fascicles: two at apex and four across middle; elytra with obscure fascicles, except for a very distinct one of black scales on each side at summit of posterior declivity close to suture.

Eyes almost round, separation slightly less than width of rostrum at base. Rostrum not very long, moderately curved, very feebly increasing in width to apex; rather finely punctate. Scape inserted two-fifths from apex, slightly curved; 1st joint of funicle noticeably longer than 2nd; club almost the length of six preceding joints. *Prothorax* feebly transverse, apex narrowed, base bisinuate, punctures entirely concealed. *Scutellum* small. *Elytra* about once and one-third the width of prothorax, base trisinuate, shoulders rounded; striate-punctate, striæ almost, the punctures entirely concealed. Punctures of *under surface* entirely concealed; 3rd and 4th abdominal segments combined the length of 2nd or 5th. *Femora* almost equally dentate, posterior terminating before apical segment of abdomen; tibiæ compressed, almost straight, wider at base than near apex. Length $4\frac{1}{2}$, rostrum 1; width 2 mm.

Hab.—Tasmania and Victoria.

The prothoracic fascicles, though of moderate size, are scarcely defined on account of the looseness of the scales by which they are surrounded.

ACROTYCHREUS, n.g.

Head small, much depressed between eyes. *Eyes* prominent, round, rather coarsely faceted, distant. *Rostrum* moderately long, not cylindrical, curved, sides feebly incurved to middle. *Antennæ* rather thin; scape inserted nearer apex than base of rostrum, slightly shorter than funicle; two basal joints of funicle elongate; club rather large, elongate-elliptic, the length of six apical joints of funicle. *Prothorax* transversely subtriangular, apex produced, base bisinuate; ocular lobes almost rectangular. *Scutellum* distinct. *Elytra* wider and less than thrice the length of prothorax, convex, strongly raised in middle. *Pectoral canal* moderately wide and deep, terminated between middle coxæ. *Mesosternal receptacle* raised, walls thin and U-shaped, slightly cavernous. *Metasternum* decidedly shorter than basal segment of abdomen; episterna large. Sutures of *abdomen* distinct, 1st segment almost twice the length of 2nd, 2nd not much longer than 3rd or 4th, these conjointly considerably longer than 5th. *Femora* stout, clavate, grooved and largely and angularly dentate; tibiæ long, thin, compressed, strongly curved; tarsi long and thin, 3rd joint deeply bilobed but not very wide. Short, outline angular, convex, densely squamose, fasciculate, tuberculate, winged.

This genus is erected to receive *Tychreus fasciculatus*, wrongly referred to *Tychreus*. The shape of the head, granulation of eyes, shape of abdominal segments, shape and dentition of femora, and shape of tibiæ are at variance with *Tychreus*. The fascicles and general shape present a very misleading resemblance to *T. camelus*.

Acrotychreus fasciculatus Lea, Proc. Linn. Soc. N. S. Wales, 1895, p.307.

Tychreus fasciculatus Lea.

The type is from Sydney. There are now under observation two specimens from Cairns which are rather smaller (4 mm.); in both there is a distinct white elongate spot behind each of the large elytral tubercles; in the type these spots or stripes are scarcely traceable.

Ephrycus Pascoe.

Trans. Ent. Soc. 1870, p. 471.

Head convex, almost concealed by prothorax; ocular fovea absent or concealed. *Eyes* moderately large, round, finely faceted, distant. *Rostrum* the length of prothorax, curved, moderately wide, slightly incurved to middle. *Antennæ* moderately stout; scape short, insertion variable; funicle with basal joint elongate, 3rd-7th transverse, club ovate, elliptic, or elliptic-ovate, rather large, subadnate to funicle. *Prothorax* transverse, convex, sides rounded, apex narrower than base, base truncate; ocular lobes almost rectangular. *Scutellum* small, distinct. *Elytra* considerably wider than prothorax, feebly convex, sides subparallel to near apex, apex rounded. *Pectoral canal* wide and moderately deep, terminated at metasternum. *Mesosternal receptacle* slightly transverse, sides feebly raised and very narrow; open. *Metasternum* slightly shorter than basal segment of abdomen; episterna rather large. *Abdomen* lightly convex, sutures distinct; two basal segments large, 1st lightly incurved at apex, 3rd and 4th not depressed, their combined length equal to that of 2nd and slightly less or more than that of 5th. *Legs* moderately long; femora somewhat thickened, indistinctly grooved, the middle pair dentate, or all edentate, hind pair terminated before apex of abdomen; tibiæ compressed, almost straight; tarsi narrow, 3rd joint rather wide and short, deeply bilobed, claw-joint elongate, glabrous; claws feeble. Elliptic, slightly convex, squamose, winged.

This genus may be at once distinguished from *Chætectetorus* and *Achopera* by the open mesosternal receptacle and the finely faceted eyes. The species are all of small size and may be obtained under bark. *E. brachystylus* and *E. erythræus* differ considerably from *E. obliquus* in the insertion and shape of antennæ, but I have not considered it necessary to separate them generically on that account.

Antennæ inserted nearer apex than base of rostrum.... *obliquus* Pasc.
Antennæ inserted nearer base than apex.
  More than 2 mm. in length.
    Scape scarcely longer than 1st joint of funicle *brachystylus*, n.sp.
    Scape twice the length of 1st joint............... *erythræus*, n.sp.
  Less than 2 mm in length................................ *parvus* Lea

Ephrycus obliquus Pasc.; Mast. Cat. Sp. No. 5514.

Brownish-red;* rostrum piceous, its apex and the antennæ and tarsi red. Densely clothed with large soft scales of various colours. Head and base of rostrum with more or less ochreous scales, rostrum elsewhere naked. Prothorax with a rather large subquadrate basal patch of black scales, apex with semierect scales varying from white to brown and subfasciculate, each side of middle with a distinct black fascicle, the sides with smaller ones. Scutellum with black scales. Elytra with a rather large patch of blackish scales, extending along suture to about middle, and containing four fascicles; on each side towards apex a distinct oblique white stripe, not (or very rarely) extending to suture, a less distinct stripe commencing at each shoulder and terminating behind the first fascicle; scales elsewhere more or less ochreous; interstices each with a row of long suberect scales. Under surface (including front of pectoral canal) with greyish-white scales; metasternum in the ♂ with a very distinct patch of moderately elongate ochreous scales between four posterior coxæ. Femora with white scales and a black (speckled with white) ring, tibiæ with black scales, the base and apex white.

* The colour of the derm can be seen only when the scales have been abraded.

Rostrum curved towards apex, slightly increasing in width from near base to near apex; very finely punctate; shorter, wider, and darker in ♂ than in ♀. Scape moderately thin, inserted nearer apex than base of rostrum; in ♂ distinctly, in ♀ scarcely passing apex; funicle the length of scape; club subovate. *Prothorax* convex, apex much narrower than base; densely and strongly punctate, punctures concealed. *Scutellum* longer than wide, punctate. *Elytra* about once and one-half the width of prothorax; base almost straight, shoulders square, sides almost parallel to near apex; striate-punctate, striæ rather feeble, punctures deep, suboblong, moderately large, more or less concealed. *Under surface* moderately strongly punctate. Third and 4th segments of abdomen lightly raised posteriorly, their combined length equal to that of 2nd and less than that of 5th. Middle *femora* dentate, the others edentate. Length 4, rostrum $\frac{2}{3}$; width $1\frac{2}{5}$; variation in length $2\frac{1}{2}$-4 mm.

Hab.—Queensland, Victoria, N. S.Wales and Tasmania

I have described what appears to be the normal clothing of the species; it is, however, subject to great variation. On some specimens the four median prothoracic fascicles are almost equal in size, and the apex is adorned with two or more small but distinct ones; on several the whole of the fascicles are traceable with difficulty. On the head there are frequently two small black spots. The basal dark patch on the prothorax is always visible, but the other scales vary from almost white to dark ochreous. The dark patch on the elytra is often much interrupted and the apical and basal patches of paler scales are sometimes scarcely traceable, whilst on others they are sharply defined. On an occasional specimen the scales on the head and base of rostrum are almost uniformly white. The legs are usually, but not always, prettily variegated.

EPHRYCUS BRACHYSTYLUS, n.sp.

Dull brownish-red; head brown, rostrum more or less piceous or tinged with piceous, femora darker than tibiæ. Head and extreme base of rostrum with pale scales, rostrum elsewhere shining. Prothorax and elytra with ochreous-brown scales, the former with moderately elongate and slightly darker scales not condensed into fascicles, base speckled with white scales. Scutellum with whitish or ochreous scales. Elytra with a distinct but not sharply defined patch of whitish or pale ochreous scales, commencing at the scutellum (where it is very narrow) and suddenly dilated and terminated at about the basal third; four very ill-defined patches of darker scales bordering its sides; interstices with suberect and longer scales, frequently of a whitish colour and causing the surface to appear speckled. Under surface almost uniformly clothed with whitish scales. Legs obscurely variegated.

Rostrum feebly curved, noticeably increasing in width from near base to near apex; scarcely visibly punctate. Scape stout, inserted close to base of rostrum and terminated slightly beyond its middle; funicle almost twice the length of scape, its first joint but little shorter; club elliptic, almost the length of scape. *Prothorax* convex, apex much narrower than base, sides dilated to near base; punctures as in preceding species. *Elytra* convex, not once and one-half the width of prothorax, base straight, shoulders square, sides parallel to near apex; striate-punctate, punctures rather large, quadrate, suffused with piceous, more or less concealed; interstices regularly convex. *Under surface* moderately strongly punctate. Third and 4th segments of abdomen flat, their combined length equal to that of 2nd and slightly more than that of 5th. *Femora* edentate. Length $2\frac{1}{2}$, rostrum $\frac{1}{2}$; width 1 mm.

Hab.—N. S. W.: Forest Reefs.

The somewhat triangular patch of pale scales on the elytra is nearly always traceable, but on several specimens the clothing consists of alternate and very ill-defined zones of dingy ochreous and dingy brown scales.

EPHRYCUS ERYTHRÆUS, n.sp.

Dull red, rostrum shining and of a paler red. Upper surface obscurely mottled with ochreous and dark scales, a few whitish elongate scales sprinkled about, and on several specimens the elytra with very indistinct bands of pale scales; scutellum with whitish scales. Under surface and legs with dingy white scales.

Rostrum almost straight, increasing in width from near base almost to extreme apex, very minutely punctate. Scape stout, inserted moderately close to base of rostrum and terminated at about one-fifth from apex; funicle about once and one-half the length of scape, its basal joint about one-half as long; club elliptic-ovate. *Prothorax* convex, increasing in width from apex to near base; densely punctate, punctures concealed. *Scutellum* slightly transverse. *Elytra* not much wider than prothorax at its widest, base almost straight, shoulders square, sides scarcely visibly increasing in width to beyond the middle; striate-punctate, punctures of moderate size, subquadrate and almost concealed; interstices feebly convex. *Under surface* moderately strongly punctate. Pectoral canal rather wider than in either of the preceding species. Third and 4th segments of abdomen as in the preceding species. *Femora* edentate. Length $2\frac{1}{2}$, rostrum $\frac{1}{2}$ (vix); width 1 mm.

Hab.—W.A.: Swan River.

Differs from the preceding species (besides clothing) in having a longer scape, broader and more conical prothorax, smaller punctures, rostrum of an uniform red and elytral interstices less convex.

EPHRYCUS PARVUS Lea, Proc. Roy. Soc. Vic. 1908, p.192.

Hab.—Tasmania and King Island.

METACYMIA Pascoe.

Trans. Ent. Soc. 1870, p.472.

Head convex, not concealed by prothorax; ocular fovea obsolete. *Eyes* finely faceted, distant. *Rostrum* lightly curved, somewhat flattened, shorter than prothorax. *Antennæ* moderately stout; scape short, inserted nearer base than apex of rostrum; two basal joints of funicle elongate, the others transverse; club small, ovate, subadnate to funicle. *Prothorax* scarcely transverse, flat, sides lightly rounded and strongly coarctate towards apex, base bisinuate; ocular lobes almost rectangular. *Scutellum* small, distinct. *Elytra* somewhat flattened, base trisinuate, shoulders feebly produced, sides parallel to near apex. *Pectoral canal* not very deep or wide, terminated just behind anterior coxæ. *Mesosternal receptacle* feebly raised in front, sides rounded and decreasing to base, emargination strongly transverse; cavernous. *Metasternum* large, longer than 1st segment of abdomen; episterna very distinct. *Abdomen* large, sutures distinct; basal segment slightly larger than 2nd, intercoxal process rounded, apex lightly incurved; three apical segments flat, the 3rd and 4th combined slightly shorter than 2nd and longer than 5th. *Legs* short; femora stout, edentate, not grooved, posterior only extending to apex of 2nd abdominal segment; tibiæ compressed, short and deep, lightly bisinuate beneath; tarsi short, 3rd joint large, wide, deeply bilobed, 4th short, the length of 3rd only, squamose and feebly setose; claws widely separated. Depressed, oblong-elliptic, not fasciculate or tuberculate, winged.

Mr. Pascoe describes the claw-joint as "haud setoso," but in this he was certainly mistaken. The genus is close to *Ephrycus*, from which it is separated by the shape of the mesosternal receptacle.

METACYMIA MARMOREA Pasc.; Mast. Cat. Sp. No.5515.

♂. Piceous-red, antennæ dull red. Densely clothed all over with round, soft, overlapping scales, which entirely conceal the colour and punctures. Prothorax with a few semierect scales and setose scales at apex and sides. Scales of upper surface either ochreous and black, or ochreous-grey and brown, and very variable in pattern; head with two dark spots. Under surface with cream-coloured or leaden-grey scales, interspersed with a few setæ; the metasternal episterna usually brown. Legs with ochreous or ochreous-grey scales; femora and tibiæ each with a blotch of brown or black scales.

Head densely and strongly punctate. Rostrum with sides lightly incurved to middle; densely punctate, the punctures decreasing in size to apex. Scape terminated considerably before apex of rostrum. *Prothorax* densely and moderately strongly punctate, disc with a distinct rounded impression on each side of middle. *Elytra* about once and one-fourth the width of prothorax; striate-punctate, punctures suboblong; interstices flat, regular, considerably wider than punctures, finely punctate. *Under surface* densely and moderately strongly punctate, the 3rd and 4th segments of abdomen finely punctate. Length $8\frac{1}{2}$, rostrum $1\frac{1}{2}$; width $3\frac{1}{3}$; variation in length 7-$9\frac{1}{2}$ mm.

♀. Differs in having the rostrum glabrous except at extreme base, the scape inserted nearer the base of rostrum, prothorax less transverse, its sides towards apex less suddenly arcuate and the median impressions shallower.

Hab.—S.-W. Australia.

Specimens may frequently be obtained on several species of *Xanthorrhoea*, in the flowering-stems of which the larvæ may sometimes be found. The dark scales sometimes occupy the greater part of the surface, sometimes scarcely one-third, and frequently appear as more or less conjoined spots; there are always two spots on the middle of the prothorax, and these are sometimes continued to base and occasionally even to apex, so that a median line of paler scales is left; the sides are often spotted. On the elytra they are frequently condensed so as to form two very irregular fasciæ, one before the middle and the other on the posterior declivity; these fasciæ are always interrupted by spots of paler scales, and are very variable in extent; on one specimen there is a fascia about the middle and a few spots towards base, but the rest of the surface with paler scales. The scutellum is usually clothed with pale scales, but on two specimens they are black.

WEDNESDAY, OCTOBER 28th, 1908.

A Special General Meeting, together with the Ordinary Monthly Meeting of the Society were held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, October 28th, 1908.

SPECIAL GENERAL MEETING.

Mr. A. H. S. Lucas, M.A., B.Sc., President, in the Chair.

Business: to consider the advisability of amending Rules xlv., xlvi., and lix., so as to allow of the annual audit of the Society's accounts being carried out by a Public Accountant, not a Member of the Society, actively practising his profession.

Before proposing a Resolution, at the request of the Council, Mr. J. H. Campbell referred to the Society's indebtedness to the Members who at different times had acted as Honorary Auditors, whose courtesy and readiness to serve the Society, often at personal inconvenience, had been unfailing. But the number of qualified Members available for selection was limited; and the change proposed was brought forward as a matter of convenience, and one likely to result in the saving of time, and in the simplification of the arrangements for carrying out the annual audit.

On the motion of Mr. J. H. Campbell, Hon. Treasurer, seconded by Mr. T. Steel, it was resolved to amend Rule xlv., so as to read

xlv. The accounts of the Treasurer shall be audited annually, a short time before each Annual Meeting, by an Auditor, not a Member of the Society, who shall be a Public Accountant, actively practising his profession, and who shall have been elected at the previous Annual or a Special General Meeting, and the accounts so audited, with the report of the Auditor, shall be laid before the Society at each Annual Meeting.

And in Rules xlvi. and lix. to substitute the word "Auditor" for "Auditors."

ORDINARY MONTHLY MEETING.

Mr. A. H. S. Lucas, M.A., B.Sc., President, in the Chair.

The President announced that the Council was prepared to receive applications for three Linnean Macleay Fellowships, tenable for one year from April 1st, 1909, from qualified Candidates. Applications should be in the hands of the Secretary on or before 30th November, 1908. In the meantime intending Candidates were recommended to put themselves in communication with the Secretary, who would afford all necessary information.

A letter from the West Australian Natural History Society at Perth was read, asking the Society's support in approaching the Government, with the object of having Barrow Island, 60 miles off the North-West Coast, set apart as a Fauna Reserve. The island, which is remarkable for its Kangaroo (*Macropus isabellinus*), Bandicoot (*Perameles barrowensis*), Rat (*Mus furculinus*), and Wren (*Malurus edouardi*), none of which occur on the mainland, is likely to be leased for sheep-farming, to the detriment of the fauna. The President stated that, with the object of saving time, the Council had responded to the appeal, by sending a communication to the Premier strongly supporting the movement. The wise policy of the Crown's retention of islands as sanctuaries for wild life was being amply justified by the experiences of New Zealand and the United States; and the Barrow Island fauna was worth effort to save. After a copy of the Council's communication had been read, it was unanimously resolved, on the motion of Mr. Kesteven, seconded by Mr. Clunies Ross: That this Meeting heartily endorses the action of the Council, and hopes that the movement will be completely successful.

The attention of Members was called to a circular announcing the arrangements for the projected meeting of the Australasian Association for the Advancement of Science, in Brisbane, in

January, 1909. The Acting Permanent Secretary (Mr. J. H. Maiden, 5 Elizabeth-street, N.) will furnish full particulars on application.

The President gave notice of a Special General Meeting to be held on Wednesday, 25th November, at 8 o'clock, before the appointed Ordinary Monthly Meeting on the same date. *Business*: to confirm the alterations in Rules xlv , xlvi., and lix., and, if necessary, to elect an Auditor.

The Donations and Exchanges received since the previous Monthly Meeting, amounting to 9 Vols, 72 Parts or Nos., 19 Bulletins, 18 Reports, 5 Maps, and 12 Pamphlets, received from 60 Societies and one Individual, &c., were laid upon the table.

NOTES AND EXHIBITS.

Mr. North remarked that in the first edition of "Nests and Eggs of Australian Birds" (p.44, 1889) he had recorded that the late Mr. George Barnard of Coomooboolaroo, Duaringa, Queensland, had on one occasion found the adult male of *Artamus superciliosus* paired with the adult female of *A. personatus*. Mr. North then exhibited a specimen of unusual interest, an hybrid adult male, *Artamus superciliosus* × *A. personatus*, obtained by Mr. H. Greensill Barnard, of Bimbi, Duaringa, Queensland, on the 9th September, 1908. Also, for comparison, adult males of *A. superciliosus* and *A. personatus*. Mr. Barnard came across a flock of *A. superciliosus* nesting about five miles away from home, and among them was the hybrid which was mated with a female of *A. superciliosus* engaged in building a nest. It resembles *A. superciliosus* on the upper parts, has the forehead, lores, cheeks, ear-coverts and throat black, passing into blackish-grey on the fore-neck; remainder of under surface ashy-grey with a slight vinous wash; under tail-coverts pale ashy-grey; over and behind the eye a distinct white eyebrow, but not extending so far on to the sides of the crown of the head as in *A. superciliosus*. Total length 7, wing 4·85 inches.

Mr. Froggatt showed a very complete named series of Fruit-flies, representing sixteen different species of *Dacus* (Fam. *Trypetidæ*), including examples of the new species bred from larvæ in oranges at Tuggerah Lakes, N.S.W., described in Mr. Coquillet's paper.

Mr. Cheel exhibited, and offered observations upon, a very interesting collection of fungi, comprising examples of *Puccinia hypochœridis* Oud., on *Hypochœris glabra* L., from Penshurst (E. Cheel; October, 1908), a species which is common in Victoria upon *H. radicata* L., and is known from Wagga, N.S.W., on the same host, but whose association with *H. glabra* had been recorded previously only from Dimboola, Vic., and Brisbane, Q: *Mycenastrum corium* Guersent, from Goulburn (E. Cheel; on the ground, April, 1908) and Ryde (D. S. North; May, 1908): *Puccinia distincta* McAlp., "Daisy-Rust," very common this year on *Bellis perennis* L., at Sydney (E. Cheel; 1908), and Leichhardt (J. L. Boorman; August, 1908): and an undetermined Rust upon the leaves of Rhubarb (*Rheum rhaponticum* L.), apparently not previously noticed.

Mr. Hedley, on behalf of Mr. A. MacCulloch, exhibited an admirable series of stereoscopic views, illustrating the vegetation of Lord Howe Island.

Mr. Fletcher exhibited photographs, specimens, and seedlings illustrating the germination and growth-stages of *Atkinsonia ligustrina* F.v.M., and *Nuytsia floribunda* R.Br., (N.O. *Loranthaceæ*); and, by the kindness of Dr. J. B. Cleland and Mr. B. H. Woodward, Perth, W.A., on behalf of the Committee of the West Australian Museum, an attractive series of photographs of flowering-branches, individual trees (up to 9 feet 6 inches in girth, at 4 feet above ground) and groups of trees of *Nuytsia*, the Christmas-Tree, Cabbage-Tree, or Fire-Tree of West Australia.

ON SOME REMARKABLE AUSTRALIAN *CORDULIINÆ*, WITH DESCRIPTIONS OF NEW SPECIES.

By R. J. Tillyard, M.A., F.E.S.

(Plates xxi.-xxii.)

In comparison with their rarity in other parts of the world, one is struck with the number and remarkable variety of the Australian *Corduliinæ*. In his work on the *Corduliinæ* of the de Selys' Collection,* René Martin gives 136 species as the total number so far discovered in the whole world. If we add to these three new species of *Synthemis*† which I have since described, and the five new species described in this paper, we obtain a total of 144 species, of which 28, or approximately one-fifth, are Australian. But of the total number of species of Odonata known to inhabit the world (roughly 2,500), Australia possesses only 160, or approximately one-sixteenth of the total.

During my last visit to North Queensland I was very fortunate in obtaining the remarkable species described in this paper. Owing to the continuous tropical rains, my material is but scanty; in two cases I have only the unique male type; in one the female only, in another two males; and in another two males and a female. The species are, however, so remarkable and distinct that I hasten to put them on record, and hope to add further specimens and to supply the missing sexes on a future occasion. Besides the five new species, I was fortunate in obtain-

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* Coll. Zool. du baron Ed. de Selys-Longchamps, Fasc. xvii., Cordulines, Brussels, Hayez, 1906.

† *S. nigra* ("New Australian Species of the Family Libellulidæ," these Proceedings, 1906, xxxi., p.488); *S. Martini*, *S. cyanitincta* ("Dragonflies of S.W. Australia," these Proceedings, 1907, xxxii. pp.724, 726).

ing the hitherto unknown male of the beautiful *Macromia Tillyardi* Martin, and two males of the exceedingly rare *Hemicordulia intermedia* Selys, of which only one other specimen, the type-male, is known to exist. These are also described in this paper.

AUSTROPHYA, n g.

Allied to *Neophya* Selys, and to *Cordulephya* Selys. Upper side of triangle of forewings broken, so as to form a quadrilateral, the proximal segment of the upper side being about twice as long as the distal. All the triangles free; forewings with a quadrilateral subtriangle, free. Arculus of hindwing arising very close to the internal angle of the triangle. Triangle of hindwing rather broad. Basilar spaces free; one cross-nervule in submedian space of forewing, two in that of hindwing, the second being placed directly under the arculus, so as to form a small subtriangle. Sectors of arculus united at base. One row of cells in the discoidal area following the triangle of the forewings. Forewings narrow; hindwings very broad. Nodus of forewings placed twice as far from base as from pterostigma. Head rather small; thorax remarkably small, the distance from the interalar ridge to the prothorax, measured dorsally, being under 3 mm. Tibiæ with long slender spines.

Type *Austrophya mystica*, n.sp.*

The differences in venation between the three allied genera *Neophya*, *Cordulephya* and *Austrophya* are best seen by the following comparative summary:—

NEOPHYA Selys (*N. Rutherfordi* Selys, type).

Triangle of forewings with the upper side broken, forming a quadrilateral, the two segments being approximately equal. All

* I have elsewhere condemned the practice of proposing new genera from female characters only, and am still of opinion that it is extremely undesirable. In the present instance, however, the new species is far removed from any known species, and the female possesses all the necessary characters for the formation of the genus, so that I hasten to put it upon record and to assign to it its proper, if somewhat isolated, position in the subfamily of *Corduliinæ*.

triangles very small. Hindwing very broad at base, narrowing rapidly to tip. Inner angle of triangle of hindwings *at* level of arculus. One cross-nervule (and hence no subtriangle), in submedian space of hindwings. One discontinuous postnodal in forewings, two in hindwings. Discoidal area of forewings narrowed at tip of wing.

CORDULEPHYA Selys (*C. pygmæa* Selys, type).

Triangle of forewings with the upper side broken, forming a quadrilateral, the proximal segment twice or thrice as long as the distal. All triangles very small. Hindwing very narrow. Inner angle of triangle of hindwings *well beyond* level of arculus. Two cross-nervules (and hence a small simple subtriangle) in submedian space of hindwings. Only one discontinuous postnodal in all wings. Discoidal area of forewings same as in *Neophya.*

AUSTROPHYA, n.g. (*A. mystica*, n.sp., type).

Triangle of forewings with the upper side broken, forming a quadrilateral, the proximal segment twice as long as the distal. Triangles twice as large as in the other two genera, that of hindwing very wide. Hindwing very broad from base to near tip. Inner angle of triangle of hindwings *only just beyond* (0·2 mm.) level of arculus. Cross-nervules as in *Cordulephya*, but second placed *under* the arculus and not beyond it. Two discontinuous postnodals in all wings. Discoidal area of forewings widened at tip of wing.

1. AUSTROPHYA MYSTICA, n.sp. (Plate xxi., fig.1).

♂. Unknown.

♀. Unique. Total length 37 mm.; abdomen 29 mm.; forewing 26 mm., hindwing 25 mm.

Wings: *neuration* thin, black; base of forewing saffroned deeply for 6 mm. along subcostal space, and also throughout the submedian space; base of hindwing less saffroned, deeply for 2 mm. only along subcostal space. *Pterostigma* 1·4 mm., black, only moderately broad. *Membranule* very small, greyish-brown.

Nodal Indicator ‖ 8-9 5-6 / 6 7 | small, tubercled, Head: *eyes* dark brown; *vertex* shiny black; *front* deeply cleft medially, hairy, dark metallic greenish-black; *clypeus*, *labrum* and *labium* dark shiny brown. Thorax very short and stumpy (*prothorax* not visible), glaucous brown with metallic greenish reflections, dorsum darker than sides. *Legs* brown, tibiæ with very long slender bristles. Abdomen narrow, practically cylindrical, base of abdomen *not* swollen. Colour: 1, brownish or yellowish; rest black, rather shiny, a large brownish patch on each side of 2. [The specimen is an aged one, somewhat damaged, and if there are other markings they have been obliterated.] A brown line along ventral carina from base to 6. Appendages wide apart, almost straight, 1 mm., tips very slightly curved, pointed; black, with brownish hairs; between them there is a distinct black projection or tubercle on seg. 10, also somewhat hairy.

Hab.—Kuranda, N.Q. (F. P. Dodd; January, 1908).

2. Hemicordulia intermedia Selys. (Plate xxi., fig.2).

Two males, one in very bad condition, but the other perfect, were taken by me at Cooktown, January, 1908. I have not seen the unique type-male in Hagen's collection, nor have I seen his description of it. In M. René Martin's work, cited above, he says of it—"Comme celui de *H. australiæ*, le mâle porte une dent inférieure aux appendices supérieurs; comme *H. tau*, il porte sur le front un T enfoncé et bien net, ce qui le distingue de toutes les autres espèces. Il diffère par la bande médiane brune du devant du thorax, et par une bande jaune *en demi-anneau* au 2e segment de l'abdomen. Si les accouplements utiles entre espèces différentes d'Odonates étaient prouvés, on pourrait dire que le type en question est le produit de l'accouplement des *H. tau* et *australiæ*."

With these words before me, I hesitate to describe my specimens as new, for they agree with M. Martin's remarks on the type *H. intermedia* in the following points:—a distinct tooth or spine on the underside of the superior appendages, a very clear black T on the front, and a narrow median dorsal band on the thorax. The ring of yellow on segment 2 is *almost complete*, being first divided by a fine black dorsal line, so that the expression "*en demi-anneau*" could only doubtfully be applied to it. But it is remarkable that M. Martin says nothing of the colouration of the seventh and eighth segments, which, instead of possessing the usual metallic greenish-black clepsydrate markings on an orange ground, (as in *H. tau* and *australiæ*) is as follows:—7, basal half entirely lemon-yellow, anal half black, the division between the two colours practically straight; 8, basal two-fifths lemon-yellow, a fine black dorsal line; rest black.

My specimens bear not the slightest resemblance to either *H. tau* or *H. australiæ*, being very much smaller than either, and considerably smaller even than *H. continentalis* Martin. The measurements are: total length 41 mm.; abdomen 31 mm.; forewing 28 mm.; hindwing 27 mm. The body is very slender, the broadest portion, seg. 7, being only 1·6 mm. wide, and not appreciably enlarged; whereas in the males of the two common species the abdomen is distinctly enlarged and much wider than this. Hence it appears impossible to me to think that under any circumstances the specimens I possess could have been a hybrid production of *H. tau* and *H. australiæ;* in fact, they appear to me to be an absolutely distinct species, as far removed from *H. tau* or *H. australiæ* as, if not farther than, these two species are from one another. I have, however, decided to leave them under the name of *H. intermedia*, until I have an opportunity of comparing them with the type.

Owing to the continuous rain, I saw very few examples of *Hemicordulia* on the wing at Cooktown, not even *H. tau*, though it is certain to be abundant there in fine weather; and of *H. australiæ* I took only two females. This species swarms around Cairns and Atherton in fine weather, so doubtless it is also common at Cooktown; and in that case *H. intermedia* may also prove to be fairly abundant if one could be fortunate enough to find one day's sunshine there in January. Both my specimens were taken hovering high up among the eucalypts in the open forest, near water. (The shape of the appendages of the male is shewn in Plate xxi., figs. 3 and 4).

3. Hemicordulia continentalis Martin.

A single male of this rare species was taken by me on the railway line near Kuranda, N.Q., in January, 1905. It is somewhat smaller and darker than the types in M. Martin's collection.

Pseudocordulia, n.g.

Closely allied to *Gomphomacromia* Br., (Chili). Triangles normal, free. Inner angle of triangle of hindwings placed well beyond the level of the arculus. Sectors of the arculus united at their base. Only one row of discoidal cells following the triangle of the forewings. Basilar space of all wings free; one cross-nervule in submedian space of forewings, two in that of hindwings, the second being placed *between* the level of the arculus and the inner angle of the triangle. Second antenodal of all wings exactly above and in line with arculus. Superior appendages of male short and excessively curved, inferior about the same length, triangular. No tubercle or spine on segment 10 of male.

The following table will shew the points of difference from *Gomphomacromia* :—

Gomphomacromia Br. [*G. paradoxa* Br., type].	Pseudocordulia, n.g. [*P. circularis*, n.sp., type].
First two antenodals separated by a wide space; no antenodal continuous with the arculus.	First two antenodals no wider apart than the others; second antenodal continuous with the arculus.
Six antenodals only in forewing.*	Nine antenodals in forewing.
Second submedian cross-nervure of hindwing placed *before* the level of the arculus.	Second submedian cross-nervure of hindwing placed *after* the level of the arculus.
Inferior appendage of male quadrilateral, forked.	Inferior appendage of male triangular, bluntly pointed.

* *G. Volxemi* Selys, which possesses 10 antenodals, is not a true *Gomphomacromia*, differing from the type in several important respects.

This genus comes closest to *Syncordulia* Selys, of the Australian Corduline genera, but may be easily distinguished from it by the fact that *Syncordulia* has the sectors of the arculus separated at their base, while the appendages of the male are very long.

Type: *Pseudocordulia circularis*, n.sp.

4. Pseudocordulia circularis,* n.sp. (Plate xxii., fig. 1).

♂ unique. Total length 44 mm.; abdomen 33 mm.; forewing 30 mm., hindwing 29 mm.

Wings: *neuration* black; bases, especially in hindwing, slightly suffused with pale yellow. *Pterostigma* very short (1·7 mm. in forewing, 2 mm. in hindwing), covering 1-1½ cellules, black, rather narrow. First two postnodals of all wings not continuous. *Membranule*, fore, small and narrow; hind, narrow, 2 mm., dull smoky-grey. *Anal triangle* of hindwing broad, with one cross-nervure very low down; *anal margin* much angulated. A conspicuous cream-coloured spot on the bases of the forewings only. *Nodal Indicator* $\left|\begin{matrix}9 & 7\\ 6 & 7\text{-}8\end{matrix}\right|$. Head: *eyes* black, *vertex* black; *front* deeply cleft medially, hairy, reddish-brown, shading to dull black above, and to brown at sides; *clypeus* dark brown; *labrum* pale reddish-brown, narrow; *labium* broad, rich brown. Thorax: *prothorax* very small, black. *Meso-* and *metathorax* hairy, dark metallic-green. *Legs* short, black, coxæ and bases of femora russet-brown. Abdomen: 1-2 rather narrow, 3-4 pinched, 5 gradually widening, 7-10 cylindrical. Colour: 1, black with long brown hairs; 2, with conspicuous russet-brown spurs; 2-10 jet-black. Appendages: *superior* 1·6 mm., black, excessively curved, the two together forming practically a complete circle; bases well separated, a few hairs on basal half of inner margin. *Inferior* same length (all three meeting at tips), subtriangular, slightly hollow above, slightly upcurved, bluntly pointed; very dark reddish-brown. (See Plate xxi., figs. 5 and 6).

Hab.—Kuranda, N.Q. (F. P. Dodd; December, 1907).

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* Named from the exceedingly forcipate appendages, forming almost a complete circle.

Austrocordulia, n.g.

Allied to *Oxygastra* Selys (Europe), and *Syncordulia* Selys (Australia). Triangles, hypertrigonal and basilar spaces of all wings free. Inner angle of triangle of hindwing placed just beyond level of nodus. Sectors of arculus arising separately on all four wings. Two rows of discoidal cells following the triangle of the forewings. Only one cross-nervule in submedian space of all four wings; hence no small subtriangle in hindwings. Triangle of hindwings remarkably long (shaped as in the *Aeschnidæ*, but free). Anal triangle of hindwings of male crossed by one nervule, low down. Thorax very short. Superior appendages of male very long, inferior long and triangular.

Type: *Austrocordulia refracta*, n.sp.

This remarkable genus can be at once distinguished from both *Oxygastra* and *Syncordulia* by the following points:—the remarkable shape of the hindwing triangle, the lack of a second cross-nervule, and hence of a subtriangle, in the submedian space of the hindwing, and the possession of a small cross-nervule low down in the anal triangle of the hindwing of the male.

It resembles *Oxygastra* in possessing two rows of post-triangular cells in the forewing, while *Syncordulia* has only one row.

5. Austrocordulia refracta*, n.sp. (Plate xxii., fig. 2).

♂. Total length 49 mm.; abdomen 38 mm.; forewing 30 mm., hindwing 29 mm.

Wings: *neuration* blackish, costal and subcostal spaces slightly suffused with brown, especially at base and nodus, *Pterostigma* 2·5mm., orange-brown between black nervures. *Membranule*, fore, very small; hind, 2·2 mm., white. *Nodal Indicator*

9	6
6	6·7

first two or three postnodals of all wings not continuous. Head: *eyes* and *vertex* dark brown; central *ocellus* large, transparent reddish; *front* and *clypeus* hairy, shining brown; *labrum* brown touched with fulvous; *labium* shiny brownish. Thorax: *prothorax* small, brown. *Meso*- and

* Named from the peculiarly bent or broken appearance of the appendages.

metathorax downy, shiny brownish-black above, dorsal ridge bright yellowish-brown; on each side a semi-obsolete brown ray; sides of thorax glaucous olive-brown. *Legs* brown, elbows and tarsi black. Abdomen cylindrical, not constricted at 3; 2 with very small dark brown spurs. Colour dark brown, glaucous. Appendages: *superior* very remarkable; long, 4 mm., separated at bases, basal two-fifths slightly divergent, rest narrower, bent suddenly inwards so as nearly to meet at tips, and tapering to a blunt point; hairy, semitransparent brown. *Inferior* 2·4 mm., narrow, subtriangular, upcurved, pale transparent brown. (See Plate xxi., figs. 7, 8).

♀. Unique (immature), similar to ♂; wings slightly larger and much more suffused with brown; abdomen flabby, cylindrical, wider than in ♂; end of 10 forming a rounded hairy tubercle separating the short (1 mm.) conical dark brown appendages.

Hab.—Endeavour River, near Cooktown, N.Q. Two males and one female; January, 1908.

I found this species invariably settled in trees, from 10 to 20 feet from the ground. When disturbed it flies off and makes for another tree. It is easily captured, unless too high up to be reached. I never saw it indulging in continuous flight, but the specimens I took were not fully matured, and the weather was unfavourable.

6. Macromia Tillyardi Martin. (Plate xxii., fig.3).

♂. Total length 69 mm.; abdomen 50 mm.; forewing 46 mm., hindwing 44 mm.

Wings: *neuration* open but thick and strong, costa dull brown, rest black. *Pterostigma* 2·7 mm., black; *membranule*, fore 2 mm., broad; hind 4 mm., very broad, dull greyish; *anal angle* much incurved, *anal triangle* two-celled; *hypertrigonal space* with three cross-nervules in forewing, one in hindwing; *triangle* free, that of forewing followed by two rows of discoidal cells. *Nodal Indicator* ‖ 13-14 7-8 | 9 8-9 | Head: *eyes* brown, *occipital triangle* small, black; *vertex* tubercled, black, hairy; *front* hairy, large, wide and flat above, slightly hollowed out medially, steely black, with a pair of large round yellow spots above, separated by a broad black band in the median depression; *postclypeus* overlapping anteclypeus at sides and fringed with stiff brown hairs; *anteclypeus* jet black; *labrum* jet black with an irregular yellow basal band widest in the middle, bordering the anteclypeus; *labium* huge, yellow, with a very large central semicircular area of dull blackish; *genæ* small, yellow. Thorax: *prothorax* small, hairy, brown. *Meso-* and *metathorax* metallic steely black, with long brown hairs above, a broad straight humeral yellow band on each side, and lower down another broad lateral yellow band, crossing notum between wing-joins. *Legs* long and thick, black; tibiæ carrying both long and short bristles. Abdomen: 1-2 swollen, 3 pinched, 4-6 gradually widening, 7-10 nearly as wide as 2. Colour black, beautifully marked with yellow as follows: 1, black; 2, basal four-sevenths yellow, rest black, the two colours meeting in a very irregular line, spurs very small, pointed backwards, yellow; 3, basal half yellow except a fine transverse basal black band enlarged dorsally into a triangular black patch, and prolonged along dorsum into a fine black line, anal half black; 4, black, with two large conjoined yellow spots taking up the second quarter of the segment, rounded in front but cut off square behind; 5-6 black, with the same spots smaller, flatter, and separated by a narrow black dorsal band; 7, basal three-fifths yellow crossed by a transverse black line about 1 mm. long on each side, in the supplementary carina, rest black; 8, basal two-fifths yellow with two slanting brown lines in the carina, rest black, the yellow shading insensibly into the black; 9-10 black, a small yellow spot at base of 9, hidden away under the projecting anal end of 8; 9 also projecting similarly over 10; 10 with a large vertical black spike 1mm. high. Appendages: *superior* rather short, scarcely 3 mm., wide apart, thick, wavy, pointed, black, some hairs on inner margin. *Inferior* large, nearly 3 mm. long, very thick, much upcurved, very hollow above, black with a very dark brown centre. (See Plate xxi., figs.9-10).

♀. Already described (Martin, "Cordulines," 1906, p. 72; see also these Proceedings, 1906, xxxi., p.491).

Hab.—Kuranda, N.Q.

The type-male above described was taken by Mr. F. P. Dodd, December, 1907, and is the only one that has so far been captured. Several females have also been taken, and are now in my collection together with the type-male. I also saw a fine male near Cooktown last January, and my friend, Mr. Allen, of Cairns, has seen the insect at the Barron Falls.

This exceedingly fine and handsome insect is by far the largest of our Australian *Corduliinæ*. It has a swift straight flight and it is not easy to capture. It inhabits densely wooded streams and creeks. It appears to be very closely allied to the rare European *M. splendens* Pictet, both in markings and in the form of the appendages, but it can be immediately separated from that species by the conspicuous black spine on segment 10 of the male, which is not found in the male of *M. splendens*.

7. Synthemis Olivei,* n.sp. (Plate xxii., fig.4).

♂. Total length 39 mm.; abdomen 30 mm.; forewing 28·5 mm., hindwing 27 mm.

W i n g s : rather slack; *neuration* fine, black; two, or sometimes three, cross-nervules in basilar space, four in submedian; *pterostigma* short, 1·7 mm., black; *membranule* nil, outer side of anal triangle convex, a tiny cross-nervule very low down; one row of discoidal cells following triangle of forewings; one cross-nervule in hypertrigonal spaces of all wings; first two or three postnodals of all wings not continuous. *Nodal Indicator*

10-11	6-7
8	7

H e a d : *eyes* brown behind, black in front; *occipital triangle* very small, black; *vertex* small, hairy, tubercled, black, the black extending on to the base of the front; *antennæ* small, fine, black, central *ocellus* transparent, larger than the other two, which are black; *front* dull white; a black mark in the clypeal suture; *postclypeus* dull white, *anteclypeus* grey; *labrum* white,

* Dedicated to my friend, Mr. E. A. C. Olive, of Cooktown.

crossed medially by a black line; *labium* pale dirty brownish white, large; *genæ* black; *mouth* strongly edged with black. Thorax: *prothorax* hairy, brown, a white mark on the collar, and two pale dorsal spots not very distinct. *Meso-* and *metathorax* rich black, a creamy line along dorsal ridge; on each side of it a humeral line, cream-coloured, about 1·5 mm. long, followed behind by a creamy spot; sides marked with a large dull irregular creamy blotch something like the letter "*n*" slightly flattened; lower parts of sides and underside marked irregularly with dull grey; *notum* brownish-black, a conspicuous white spot on mesoscutellum. *Legs* brownish, underside of femora black, tibiæ black. Abdomen *very* slender, cylindrical, black, marked with straw-colour as follows:—2, a pair of dorsal marks, slightly slanting, nearly touching; spurs very small, a tiny white point on each; genital appendages dirty brownish with a grey basal lateral spot touching them on each side; 3-6, a pair of basal marks nearly touching above, and running down on the underside, also a pair of rounder central spots, very narrow on 5-6, separated by the dorsal carina; 7 with very small basal marks, and flat central spots placed one-third from base of segment; 8, a pair of spots one-third from base; 9-10 black. Appendages: *superior* short, 1·8 mm., well separated, straight, pointed, carrying a number of long stiff black hairs, two or three of which protrude from the tips. *Inferior* nearly as long, narrow, upcurved, hairy, black. (See Plate xxi., figs. 13, 14).

♀. Unknown.

Hab.—Cooktown, N.Q.; January, 1908. Very rare.

Two males taken in a sequestered spot on the mountains, where it inhabits a small boggy stream. It has an easy soaring flight, usually keeping high up round the trees, and often settling on them.

This species is by far the smallest member of the genus *Synthemis* yet discovered, and exhibits some striking differences from the more typical members of this large and complicated genus. In its thin cylindrical abdomen and in the form of its appendages it shows a close relationship to *S. flavoterminata* Martin. One should also notice the peculiar anal triangle of the male, in which all signs of a supplementary membranule have disappeared; the outer side, forming the anal margin of the wing, has been strengthened by assuming a convex shape, making the triangle itself small but comparatively broad, while the cross-nervule usually present in this genus here appears as a tiny veinlet quite close up to the lower angle of the triangle.

8. Synthemis claviculata,* n.sp. (Plate xxii., fig.5).

♂. (Unique). Total length 48 mm.; abdomen 37 mm.; forewing 31·5 mm.; hindwing 30 mm.

Wings: *neuration* fine, black, costa pale brown at base; bases of all wings slightly saffroned; *pterostigma* short, 2 mm., black; *membranule*, fore, very small; hind, narrow, 2 mm., pale greyish touched with brown; one cross-nervule in basilar space, three or four in submedian; a conspicuous yellow spot on each wing-base; first two or three postnodals of all wings not continuous; one cross-nervule in hypertrigonal space of forewings, those of hindwings free. *Nodal Indicator* $\left\| \begin{array}{cc} 11 & 7\text{-}8 \\ 7\text{-}8 & 8 \end{array} \right|$ Head: *eyes* brown; *occiput* small, black; *vertex* steely black with a round yellow spot; *front* hairy, deeply cleft medially, steely-black, with two very large yellow spots reaching to the eyes and separated by a narrow black band in the median cleft; *clypeus* steely-black; *labrum* with two large yellow spots separated and surrounded by a narrow black band; *labium* black. Thorax: *prothorax* very small, dull brownish. *Meso-* and *metathorax* with long brown hairs in front; colour black above with a broad short humeral yellow band on each side, placed well forward, and cut short suddenly behind at a distance of nearly 2 mm. from the fore wing-join; a tiny yellow spot near latter; dorsal ridge with a yellow line, enlarged on meeting the interalar ridge, on each side a very broad steel-coloured band, then a complete lateral

* Named from the peculiar form of the appendages.

yellow band, crossing the notum also, then a narrow band of steel colour; rest of sides and underside yellowish. *Legs* black, except underside of profemora yellowish-brown. Abdomen: 1-2 swollen, rest very slender, gradually widening to 10. Colour: 1, black; 2, basal half yellow with a narrow black dorsal portion, anal half black, spurs dark brownish; 3-7, black, with a pair of central oval yellow spots largest in 3, then gradually getting smaller and rounder from 4 to 6, larger again in 7, each pair crossed near anal ends by a black line in the transverse carina; 8, black with two very large yellow spots, elongate-oval and pointed anally, reaching from base to two-thirds of the length of the segment, and crossed at their middle by a fine black line; 9-10 black. Appendages: *superior* long, 3 mm., hairy, black, wide apart and slightly swollen at bases, then undulating and swelling out into a rather rounded and somewhat clubbed tip (see Plate xxi., figs. 11, 12). *Inferior* short, 1·2 mm., subtriangular, upcurved, black.

♀. Unknown.

Hab.—Kuranda, N Q. Very rare; January, 1908. A unique male taken by my friend, Mr. E. Allen, of Cairns.

This interesting species shows great similarity in its general markings to *S. virgula* Selys, a fairly common southern species, from which it is readily distinguished by its long and peculiarly formed appendages.

In conclusion, it may be remarked that the genus *Synthemis*, of which fifteen species are now known, stands in great need of careful revision and systematic treatment. The two species just described are widely separated, and should certainly be placed in different genera, if a clear point of separation could be found between the members of the group. But while it seems so probable that new species will continue to be found as long as new Australian localities can be visited by collectors, it is perhaps advisable to leave this typically Australian group in its present condition, and to wait until further knowledge of it is made available.

EXPLANATION OF PLATES.

Plate xxi.

Fig. 1.—*Austrophya mystica*, n.sp., ♀ (natural size).
Fig. 2.—*Hemicordulia intermedia* Selys, ♂ (natural size).
Fig. 3.— ,, ,, appendages of ♂, seen from above.
Fig. 4.— ,, ,, ,, ,, seen sideways.
Fig. 5.—*Pseudocordulia circularis*, n.sp., appendages of ♂, seen from above.
Fig. 6.— ,, ,, ,, ,, ,, seen sideways.
Fig. 7.—*Austrocordulia refracta*, n.sp., ,, ,, seen from above.
Fig. 8.— ,, ,, ,, ,, ,, seen sideways.
Fig. 9.—*Macromia Tillyardi* Martin ,, ,, seen from above.
Fig. 10.— ,, ,, ,, ,, ,, seen sideways.
Fig. 11.—*Synthemis claviculata*, n.sp. ,, ,, seen from above.
Fig. 12.— ,, ,, ,, ,, ,, seen sideways.
Fig. 13.—*Synthemis Olivei*, n.sp. ,, ,, seen from above.
Fig. 14.— ,, ,, ,, ,, ,, seen sideways.

Plate xxii.

Fig. 1.—*Pseudocordulia circularis*, n.sp., ♂ (natural size).
Fig. 2.—*Austrocordulia refracta*, n.sp., ♂ ,,
Fig. 3.—*Macromia Tillyardi* Martin, ♂ ,,
Fig. 4.—*Synthemis Olivei*, n.sp., ♂ ,,
Fig. 5.—*Synthemis claviculata*, n.sp., ♂ ,,

NOTES ON THE GEOLOGY OF THE NORTH-WEST COAST OF TASMANIA FROM THE RIVER TAMAR TO CIRCULAR HEAD.

By T. Stephens, M.A., F.G.S.

(Plates xxiv.-xxviii.)

The following descriptive sketch is based upon notes made many years ago during a series of journeys along the North-West Coast of Tasmania. These were undertaken by the writer, in the first instance, for the purpose of reporting on the prospects of settlement in the districts traversed, and the possibility of extending the means of education to the families of the few selectors who were beginning to occupy the Crown lands on and near the coast. At that time there were no roads worthy of the name; the only possible route, where it left the beach, was an imperfectly blazed trail; the numerous rivers were unbridged and fordable only at low tide, if at all; and for long distances, as between the Forth and Emu Bay, and between Table Cape and Circular Head, there was no shelter for man or horse, while the difficulties of the route made rapid travelling impracticable. Under these conditions, with the aid of an outline chart on a scale of one inch to the mile, the traveller's only guide, there was ample opportunity for noting the position and general character of the ancient rocks cropping out on beach or headland with a general northerly strike. Though they constitute what may be termed the bed rocks of Western Tasmania, their geological age and mutual relations are still unknown to science, and this circumstance coupled with the fact, that, with the exception of Mr. Gould's chart of a small portion of it and the sketch-plans in the reports of Mr. Twelvetrees on some of the mineral deposits, no map of the geology of the North-West Coast on a sufficiently large scale has yet been published, may be offered as an excuse for bringing to light these old Notes, with a few supplementary observations.

River Tamar to River Forth. (Plate xxviii.).

The West Head of the Tamar estuary is the terminal point of a low range of the typical diabase of Eastern Tasmania. It is flanked on the south and west by low sand dunes, and recent or post-Tertiary drift, indicating probably the original outfall of the River Tamar before it had excavated its present channel. West of this is Badger Head, the most northerly point of the so-called Asbestos Range, which derived its name from its erroneously supposed connection with the serpentine country on Anderson's Creek in which veins of chrysolite occur. The rocks of the Badger Head country extend for about four miles westerly and consist of micaceous schists, clay slates, and hard altered sandstones with laminations of white quartz, all highly inclined, with numerous anticlinals. There is much foliation on the line of strike, but the mean direction is about N. 30° West. Traces of copper have been found on the western flank of the range.

The Badger Head country is succeeded by low sand dunes and drift extending to Port Sorell, with an outcrop of diabase, not hitherto recorded, at the entrance of the Port. This is an outlier from the ridge on the western shore of Port Sorell, which is the most prominent feature in this part of the district. Drift gravels overlie parts of this ridge at an elevation up to 200 feet, and are probably of Tertiary age. Isolated masses of a flat-bedded sandstone showing signs of contact-metamorphism are occasionally met with on exposed patches of the diabase, and may possibly represent portions of the original covering when the magma was intruded in the form of a sill or laccolite.

The coast-line westward from Port Sorell Point for a distance of some seven miles is fringed by sand dunes protecting a strip of alluvial land formerly a marsh but now drained. This is for the most part backed by basaltic country extending to and across the River Mersey, except where it is interrupted by a low ridge of diabase running southerly from the beach near Pardoe. On the beach opposite the Northdown sluice may be seen at low water mark an outcropping mass of quartzite, the only instance of the occurrence of any of the ancient rocks between Badger Head and the Clayton Rivulet, a distance of twenty-three miles. The limestone of the River Don and Railton, with *Orthoceratidæ* and corals, and the Caroline Creek sandstones, with *Dikelocephalus* and other trilobites, do not approach the coast-line. The basaltic country already described extends across the Mersey to within a short distance of the Mersey Bluff, and the low-lying part of it is covered more or less thickly up to a height of about twenty feet above high-water mark with wide-stretching beds of shingle derived from the old altered sandstones, which no longer crop out above sea-level. The diabase of which the Mersey Bluff is the terminal point almost encircles the basalt of East and West Devonport, crossing the river in a south-easterly direction. On a saddle of this ridge, between Devonport and the River Don, at an elevation of about 200 feet, are drift gravels corresponding to those noted near Port Sorell. They are older than the basalt, and presumably of Tertiary age. The Mersey Bluff (Plate xxiv., fig. 1) is the most westerly exposure along the coast of this holocrystalline igneous rock which, over the whole of Eastern Tasmania, is never out of sight. Its structure is of the common rudely prismatic type, and a noticeable feature is a regular system of joints showing on the tops of exposed and weathered columns four feet or more in diameter, and radiating from the centre to the circumference as if they subdivided the mass into a series of thin plates. In one instance where long weathering had affected the structure it was possible to detach plates of the size of "Duchess" roofing slates, and tapering from a feather edge to a thickness of less than a quarter inch on the outside of the column.

The bluff west of the Don is a mass of the ordinary olivine basalt of the North-West Coast showing the typical columnar structure. About a mile south of the bluff, patches of shale and sandstone may be seen cropping out under the basalt, which probably belong to the Mersey coal measures. Farther south on the plateau between the Don and the Forth a gorge has been excavated through the basalt disclosing an underlying bed of shingle which from its position is evidently of Tertiary age. This basaltic country extends with little interruption to the Forth, and is fringed on the north by a strip of alluvial land, and, near the river, by wide stretches of shingle exactly corresponding to that at the mouth of the Mersey.

River Forth to Emu Bay. (Plate xxviii.).

The country near the coast between the Rivers Forth and Leven, and for nearly three miles beyond the Leven, is occupied by low sand dunes, beds of shingle, and patches of alluvial land, backed on the south by basalt capping and sometimes interrupted by ridges of the ancient sedimentary rocks. The latter make their first appearance on the beach at Clayton Rivulet, where dark micaceous schists crop out below high-water mark. They are highly inclined with a mean strike a little to the east of north. Next comes a patch of basalt succeeded by bands of quartz schist, black and grey slate, and quartzite. The next mile along the beach is occupied by basalt succeeded by micaceous schists, quartz schists, and quartz conglomerates dipping westerly at high angles and re-appearing on the other side of the Leven. The same rocks interspersed with bands of black and brown slate crop out at intervals for the next two miles along the beach. They are much foliated on the line of strike, which ranges from about N. 10° E , to N. 20° W. At Goat Island, a small peninsula trending northward from the beach, is an interesting development of quartz conglomerate (Plate xxiv., fig. 2), which is interbedded and mixed up with bands of fine-grained quartz schist, some of it showing a peculiar silky lustre on the bedding planes. The separate bands of schist, not seen in the photograph, have an easterly and westerly dip of about 75°, and the whole mass appears to represent an anticlinal axis striking west of north.

At the end of the beach a lofty bluff of hard dense basalt comes down nearly to sea-level, the schists, sandstones, and conglomerates cropping out from under it. At their junction was exposed a small mass of flat-bedded breccia containing fragments of fossil wood. A little west of Lodder's Point the ancient rocks are hidden for about three-quarters of a mile by an overflow of basalt, and then continue with occasional interruptions to Penguin Creek. For the last two miles or thereabouts the schists and altered sandstones are so much folded, jointed, and contorted, and so interspersed with massive bands of conglomerate and breccia that their mutual relations are not easily discoverable. The conglomerate, or some of it, is certainly interbedded, but a band of rather fine-grained breccia appears to lie unconformably on the other rocks of the series. Strings of iron pyrites, and galena, with some copper pyrites, and stains of blue and green carbonates, occur here and there in the schists. There is a narrow belt of, probably, post-Tertiary drift between the beach, and the rising ground to the south which is mostly occupied by basalt. Still farther south are massive deposits of red and brown hæmatite, and a small band of bright specular iron was noticed a little to the west of Penguin Creek. Here the old rocks rise in rugged ridges, with a general northerly strike, until they disappear westerly under the basalt, which extends to and behind the sandy beach of Preservation Bay, and also shows itself between outcrops of the old rocks near Sulphur Creek, and the small sandy beaches farther west. The next mile is occupied by grey and dark-coloured slates and grits, with interbedded bands of conglomerate, all highly inclined, striking about N.N.E., and rising steeply to the south. The coast-line from the River Blythe to Wivenhoe is bounded by lofty rugged ridges showing on the seaward face grey grits, conglomerates, slates, sandstones intersected by veins of white quartz, and strong bands of quartzite, which continue with little intermission to the River Emu, where the entrance is protected on the east by masses of intensely hard brecciated conglomerate. On both banks of the Blythe, and at Wivenhoe, are drift gravels and sands reaching to a height of not less than 30 feet above high-water mark.

From near the Blythe, south of Heybridge, some promising specimens of red hæmatite and copper pyrites have been obtained.

There is also an outcrop of granite which does not occur elsewhere so near the coast.

[For information as to the occurrence and exploitation of ore bodies south of the coast-line between Ulverstone and Emu Bay, reference must be made to the Report of Mr. Twelvetrees, Government Geologist, "On North-West Coast Mineral Deposits," dated 26th July, 1905, which gives in full detail all that is known of the present and prospective development of the mineral industry in this part of Tasmania.]

Emu Bay to Table Cape. (Plate xxviii.).

The shore-line above high-water mark between the River Emu and Burnie is occupied by sands and gravels backed, for the most part, by steep basaltic rises. In one place about 100 feet above sea-level an exposed gravelly patch showed waterworn boulders of quartzite which might possibly be of glacial origin. At low tide may be seen a series of alternating bands of hard sandstone much jointed, clay slate, and quartzite, striking east of north, and disappearing under the town of Burnie, and the low basaltic ridge of Blackman's Point (Plate xxv., fig.1), where are large exposures showing the typical columnar structure of the rock. At the farther end of the next beach, half a mile west of the Point, the old rocks again crop out. They comprise hard flaggy sandstones and grits with softer schistose bands. They have a general strike to N.N.E., and are highly inclined, showing here and there very symmetrical anticlinal folds, but the crown of the arch is continuously being removed in most instances by the wash of the sea. Interbedded with these bands all the way from West Beach to Cooey Creek are massive dykes of an igneous rock of a gabbroid character. They are distinctly intrusive, and, besides the usual alterations which are seen in such cases on lines of contact with sedimentary rocks, the latter have sometimes been contorted into most fantastic folds.

From Parish's Boat Harbour to the River Cam the outcropping rocks are mostly hard altered sandstones and slates greatly foliated on the line of strike, and so much jointed that the lines of bedding planes are much obscured. The country fronting on the beach is mostly backed by basaltic rises from Burnie to Messenger's Creek, where the altered sandstones and slates take their place. These continue on both sides of the Cam and up to the flanks of Woody Hill in high rugged ridges with wide stretches of sand and shingle to the north of them. They show on the beach at intervals for some two miles westward, passing under the basalt of Woody Hill, which comes down to sea-level. They crop out again for about half a mile and then almost entirely disappear from the coast-line for a distance of ten or twelve miles. Here is the first appearance of the so-called "conglomerate" which, though hidden at two points by flows of basalt, continues westward without a break to Table Cape, and occupies the basin of the River Inglis southward for many miles. Embedded mostly in a fine-grained mudstone resembling consolidated *till*, but sometimes in a coarser matrix, are waterworn and angular pebbles and boulders in infinite variety, and all derived from rocks which are not now found *in situ* within many miles of the coast. Among the boulders are occasional massive blocks of red granite, and sandstone and limestone with fossil brachiopods of Silurian type, all of great size, which, apart from the testimony of scratched pebbles that any one with sufficient leisure might probably discover, are unmistakable evidence of the glacial origin of the whole formation. East of the mouth of the River Inglis, at low-water mark, there is an outcrop of dark crystalline limestone strongly veined with quartz. The exposure is not sufficient to enable one to decide whether the rock is *in situ*, or is merely one of the massive transported boulders. There are other outcrops along this part of the coast which may represent slates and sandstones of the ancient rocks, but it would require close and careful examination to separate them from the glacial drift which is very variable in character.

On the beach near the Inglis were found waterworn pieces of a hard black shale resembling in character the kerosene shale of New South Wales, which are probably waifs from coal measures far inland that have been brought down in recent times by the Inglis or its tributaries.

[Some years after these notes were originally written, specimens of this shale were submitted to Mr. Cosmo Newbery, of Melbourne, for analysis. His report is as follows :—

Kerosene Mineral from North Coast of Tasmania.

Burns freely with a yellow smoky flame, leaving a reddish-brown ash. Contains iron-pyrites. When heated in a closed vessel it melts, forming a fragile coke. A sample dried at 212° F. gives the following results :—

Water driven off at 230° F	1·59
Volatile matter	67·36
Fixed carbon	25·83
Ash	5·22
	100·00

About ten years ago coal measures containing seams of this shale were discovered 14 miles south of Wynyard, and were reported on by Mr. G. A. Waller, late Assistant Government Geologist.*]

The geological age of this accumulation of moraine-material is a matter of speculation, but it seems probable that it formed the base of the Permo-Carboniferous marine beds and coal measures which are still extant in the Mersey district, and that they approached the present coast-line. These after long periods of successive subsidence and elevation were eventually removed by denudation, leaving the consolidated *till* as the floor of a shallow estuary bounded on the east by the slate ridges near Woody Hill, and on the west by a similar formation at or near the meridian of Table Cape. Such a theory implies that on this foundation, after a further period of subsidence, were deposited the Tertiary marine beds originally extending from Table Cape to Woody Hill, where detached masses of the fossiliferous sandstone were noticed cropping out from under the basalt, and it also shows itself on the banks of the Inglis some distance

*Report on the Recent Discovery of Caunel Coal in the Parish of Preolenna. By George A. Waller, 9th November, 1901.

south of Wynyard. These beds after the eruption of basalt were also extensively denuded, and the coast-line elevated to its present position. But before these beds were laid down, the glacial drift had been much wasted, and much of its material redeposited as a loosely compacted conglomerate, which is seen in places underlying and partly mixed up with the lower strata of the Tertiary formation.

Half a mile west of the mouth of the Inglis is Freestone Bluff glacial (Plate xxvi., fig. 1), a partly isolated mass of rock based on the drift and the conglomerate derived from it. Its height may be roughly estimated at about 150 feet, the greater part consisting of bedded sandstone containing fossil shells and corals, and dipping at a low angle to the west of north. This is capped by basalt, which evidently was at one time continuous with the great sheet abutting against the Cape. The upper portion of the sandstone shows numerous small shells of a species of *Turritella*, with some leaves of trees not now existing in Tasmania, and was probably a wind-blown dune. Lower down are fossil shells in great variety, the larger and heavier species, such as *Crassatella*, a large *Pectunculus*, and the larger species of *Voluta*, increasing in number towards the base. Some of the shells closely resemble existing species, but the majority are of a quite distinct type. Among the latter were obtained during a somewhat hurried visit a specimen of *Trigonia semiundulata*, and a large but not quite perfect *Cypræa eximia* which is identical with that figured in Strzelecki's "New South Wales and Van Diemen's Land." Other smaller species intermediate between *C. eximia* and the existing *C. umbilicata* were also noticed. This Tertiary formation passing from fine-grained sandstone into coarser beds with small water-worn gravel continues westward to Table Cape, and is capped by basalt except where the latter has been denuded off it. The volcanic rock forming the conspicuous headland of the Cape, 583 feet in height, differs in many respects from the basalt adjoining it, as may be seen from a comparison of the pebbles of the two rocks which line the beach of Freestone Cove. Their junction is inaccessible from the east at sea-level, and access from above through the dense uncleared bush is barred by the matted vegetation which clothes the almost precipitous face of the hillside. At a little bay west of the Cape the junction of the two rocks and the difference between them is more clearly seen. Whether the Tertiary beds abut against or pass under the Cape is an open question.

[Since the occurrence of this Tertiary formation was reported by the writer, its fossil contents and surroundings have been more or less fully described or examined by Messrs. R. M. Johnston, R. A. Montgomery, A. E. Kitson of Melbourne, and the late Professor Tate of Adelaide, and probably by others; and the general conclusion appears to be that the fossils are of Eocene, or at any rate of early Tertiary type. With reference to the *Cypræa eximia* described by Sowerby, and figured in Count Strzelecki's book, the fossil is there stated, on information supplied to the author, to have been found "in a muddy sand in sinking a well at Franklin's Village, about fifteen miles from the sea." As Franklin Village, on the main road between Launceston and Perth, is at least forty miles from the sea, and there is no trace of any marine formation anywhere in the neighbourhood, it is pretty clear that the information supplied as to the history of the fossil was incorrect. No other locality is known up to the present time where such a fossil could have been found but the Freestone Bluff beds, and the probability is that, some time in the early forties, both this *Cypræa*, and the fossil marsupial recently described by Professor Baldwin Spencer under the name of *Wynyardia bassiana*, were brought from there by one of the officers of the Van Diemen's Land Company, who alone at that time had access to this part of the coast.

All uncertainty as to the true character of the coarsely crystalline igneous rock which forms the headland of Table Cape, and occurs in a similar position at Circular Head, has been removed by the result of an examination of specimens from both places by Professor Rosenbusch. This is recorded in a paper read before the Royal Society of Tasmania on 1st December, 1902, by Mr. Twelvetrees,* who quotes Rosenbusch's definition of the rock as trachydolerite, and notes it as being quite distinct from the ordinary olivine basalt of the coast, and the product of a different magma.]

TABLE CAPE TO RIVER DETENTION. (Plate xxviii.).

From Table Cape westward the rough bridle track, the only land route to Circular Head, keeps along the edge of a great basaltic sheet for the next five miles at an elevation of from 200 to 400 feet above the shore-line. It is much obstructed by scrub and fallen timber, being very seldom travelled by any one. Whether there are outcrops of the ancient rocks below the basalt it is hard to say, the steep descent clothed with dense scrub preventing access to the beach. Approaching Jacob's Boat Harbour the track descends abruptly to a sandy beach. Here are bands of quartzite with adherent conglomerate of waterworn and subangular pebbles, both rocks being traversed by small quartz veins. The low point half-a-mile farther west, which protects a landing place, is also of quartzite dipping at 25° N.N.E. At the junction of the point with the shore are strong bands of quartzite nearly vertical and striking east and west, and there is a patch of a dark-coloured flat-bedded conglomerate of small pebbles. From Boat Harbour the track climbs steeply towards Sisters Hills, a lofty range of massive quartzite, passing near some thin patches of outlying basalt. This quartzite occupies the whole of the rugged country westward for the next seven miles except near the mouth of Sisters Creek. The coast-line at Sisters Hills is bounded by steep cliffs rising abruptly from the water's edge. The descent to the Sisters beach is very steep, the so-called track being encumbered with loose sliding rocks, and the ups and downs for the next few miles over the Rocky Cape Range are much of the same description. The Sisters Creek emerging from a rocky gorge crosses a belt of low sand dunes and quartz gravel, and for about a mile east and the same distance west of

*"Trachydolerite in Tasmania." By W. H. Twelvetrees, F.G.S., Government Geologist.

its mouth the ancient rocks that have already been mentioned show themselves at intervals on the beach at low tide. Near the eastern end, on an outcrop of quartzite, are masses of conglomerate with large subangular boulders of that rock. West of the creek are grey schists and hard shaly sandstones alternating with dark-coloured and micaceous slates and bands of quartzite. The bedding of the former is somewhat obscure. They appear to strike a little east of north, but a band of quartzite crops out farther on, the strike of which is nearly east and west, and the dip northerly. The whole country of the Rocky Cape Range shows as a confused mass of lofty peaks and ridges of quartzite with intervening gorges suggesting a series of anticlinal and synclinal folds with a general E. and W. strike, but these folds appear to have been disturbed and faulted by subsequent earth-movements. The profile of the range as seen from a distance E. or W., seems to confirm this theory. There is, however, much foliation on the line of strike (Plate xxv., fig.2), and nothing short of a lengthy and elaborate geological survey could discriminate between the massive quartzite and the comparatively thin bands of the same rock with their associated slates and schists, or determine the stratigraphical relations of the whole series.

In the exposed cliff faces of the Rocky Cape Range are several small caves on the lines of nearly vertical faults in the highly inclined bedding planes, which have so dislocated the rock that great angular flakes were easily detachable by human agency or by the wash of the sea when it was at a higher level. All these caves show signs of having been occupied by the aborigines. The most noticeable of them is near the north point of the cape (Plate xxvii., fig.1), in the face of a cliff about 160 feet high. It rises at the entrance to a height of about 40 feet, widening downwards to a breadth of 15 feet, and runs in easterly about 25 yards, narrowing to 3 feet at the inner end. The floor of the cave is covered to a depth of some yards with the comminuted fragments of shells, among which are bones of marsupials, suggesting its occupation as a winter shelter for, probably, hundreds of years.

In a bight a little to the north of this cave is a massive dyke of the same type as those noted between Burnie and Cooey Creek. Seen at half-tide it is 15 yards wide and lies between walls of quartzite, striking a little north of east, and with a northerly dip of about 60°.

On the coast, near where the track strikes the Detention beach, are outcrops of quartz schist with a northerly strike, and hard flaggy sandstones so traversed by a rude cleavage and jointing that the directions of dip and strike are much obscured. The lower parts of the western slopes of the range are covered with thick sheets of drift sand and quartz gravel, succeeded by marshes fringed on the coast-line by sand dunes. Half-a-mile up the River Detention is a patch of basalt partly covered with recent drift, and extending southward. Here the river is fordable at half-tide if the traveller is too late to cross at the bar.

This is not the place to discuss the question of the intimate relationship between the flora of a country and the character of its rock-formations, but it may be noted that the large-coned Banksia, *B. serrata*, which is common on the slopes of the Blue Mountains and elsewhere in N. S. Wales, is found in Tasmania only on the barren and otherwise almost treeless uplands of Sisters Hills and the Rocky Cape Range. Here it is associated with the dwarf grass-tree (*Xanthorrhœa minor*). On the rocky headlands of the coast which has been described, but never far above high-water mark, may be found the rare so-called "Native Sandalwood" (*Alyxia buxifolia*), with the delicate scent of the Tonquin bean. In the gorges and low down on the western slopes of the range are belts and wide stretches of the Wire Scrub (*Bauera rubioides*), the terror of West Country explorers, which nowhere else in Northern Tasmania approaches so near to the coast. The same may be said of the Button-grass (*Gymnoschœnus sphærocephalus*), which occupies marshy flats among the hills.

River Detention to Circular Head. (Plate xxviii.).

On the west bank of the river are dark-coloured flaggy slates striking about N.E. For the next eight miles the country is practically level, being fringed along the coast-line by sand dunes, except where low rocky rises intervene. From the Detention to Crayfish Creek the rocks exposed along the beach are altered slates, schists, and flaggy sandstones, the last-named being thickly traversed by joints crossing the bedding planes at all angles (Plate xxvi., fig.2). There is much foliation on the line of strike, the mean of which is about N.E. and S.W. The dip is northerly. For the next three miles the same rocks show themselves at frequent intervals, but the strike is more nearly E. and W., and the dip southerly, suggesting the neighbourhood of a low anticlinal fold. Near Brickmakers' Bay there are small veins and pockets of iron pyrites in the slates, which are noted on an old map of Tasmania as "copper ore." Near the mouth of the Black River are the same slates and sandstones with a northerly dip, and strong bands of quartzite crop out here and there on the east bank for about a mile southerly. From the mouth of the river westerly for the next three miles is a sandspit crowned with dunes and flanking East Bay or Inlet. The original track followed the beach to the wide mouth of the Inlet, the bar of which was at one time easily fordable at low tide. Some changes in the tidal currents have deepened the channel, and a traveller who has survived the crossing of it will in future prefer to strike inland after fording the Black River, and lengthen his journey by a mile or two. On the west bank of the river, a mile from the sea, is a rocky ridge, the lowest exposed member of which is a strong band of quartzite on which lies a band of quartzose conglomerate, and on this again a band of light-coloured altered limestone, which is occasionally used by limeburners. The coast-line here has a northerly trend and the old rocks are almost entirely covered by a wide expanse of drift sand and gravel, except at a point about three miles from the river, where a sheet of basalt is exposed. This probably extends under the drift to Green Hills at the narrowest part of the peninsula, being continuous from there to the north point some four miles distant. There are occasional outcrops of the ancient rocks from under the basalt along the shore line of the Western Plains. The junction of this basalt with the trachydolerite of the lofty bluff of Circular Head (Plate xxvii., fig 2) is concealed by sand dunes and drift, but the relations of these two distinct types of volcanic rock appear to be identical with those at Table Cape.

Conclusion.

The route or track described in this paper between the River Mersey and Table Cape was not far distant from the line of the present main road. From Table Cape to Circular Head it has long since been abandoned, is practically unknown to travellers along the coast, and in many places is impassable.

The annexed plan and section (Plate xxviii.) constructed from drawings made more than forty years ago on a horizontal scale of one inch to the mile will sufficiently explain the relations between the sedimentary and volcanic rocks along the coast-line described in the Notes. The section, as regards the vertical scale, is based on observation alone, the several altitudes having never been surveyed, except that of the Circular Head bluff, which is 487 feet high.

It seems probable that the great basaltic sheets rising gradually from the coast had their origin in fissure-eruptions along anticlinal axes, the intervening folds being subsequently hollowed out by the erosion of rivers of much greater magnitude than those of the present day, or by glaciers slowly moving northward along the lines of the present river-valleys. As to the geological age of the ancient sediments which have been roughly described in the Notes, there is no evidence forthcoming. With the exception of the fossils of the Tertiary beds near Table Cape, and the fossil wood from a breccia west of the River Leven, no evidence of any trace of organic remains in the rocks of the North-West Coast has yet been placed on record. In the absence of any positive evidence on the subject it still seems safe to conclude that the massive quartzite of Sisters Hills and Rocky Cape is the oldest rock-formation of the series, and that it may be classed as Archean, or at any rate Pre-Cambrian.

In his admirable reports on the North-West Coast mineral deposits Mr. Twelvetrees has suggested a probable alliance between the rocks in which they occur and some of the formations in other parts of Tasmania which are provisionally classified as Upper Silurian, Lower Silurian or Ordovician, and Upper Cambrian. In the absence of any positive evidence, this is as far as any speculation on the subject can go. Nothing short of a systematic geological survey of the whole coast could determine even the stratigraphical relations of the rocks which have been described, nor could they be correlated with other geological formations in the Commonwealth of Australia, or elsewhere, without an exhaustive and successful search for the fossil evidence which is undoubtedly contained in some of them. It is in the hope of giving some stimulus to exploration and research with this object in view that the present paper has been written.

EXPLANATION OF PLATES XXIV.-XXX.

Plate xxiv.

Fig.1.—Mersey Bluff.
Fig.2.—Goat Island, looking south.

Plate xxv.

Fig.1.—Blackman's Point, Burnie.
Fig.2.—Rocky Cape East, looking north-east.

Plate xxvi.

Fig.1.—Freestone Bluff and continuation of Tertiary beds capped by basalt on the left; Table Cape on the right; in the foreground glacial drift.
Fig.2.—Near Crayfish Creek, looking east.

Plate xxvii.

Fig.1.—Rocky Cape North, looking east-south-east.
Fig.2.—Circular Head, with basalt in the foreground.

Plate xxviii.

Geological Sketch Map of the North Coast of Tasmania from the River Tamar to Circular Head, and Longitudinal Section of same along the line marked on the Map. Reduced from a horizontal scale of one mile to one inch.

CONTRIBUTION TO A FURTHER KNOWLEDGE OF AUSTRALASIAN OLIGOCHÆTA.

PART I. DESCRIPTIONS OF TWO SPECIES OF A NEW GENUS OF PHREODRILIDÆ.

BY E. J. GODDARD, B.A., B.SC., LINNEAN MACLEAY FELLOW OF THE SOCIETY IN ZOOLOGY.

(Plates xxix.-xxxi.)

The present paper deals with a new genus (including two species) of freshwater Oligochæta belonging to the family *Phreodrilidæ.* The specimens were found in association with the large crayfish (*Astacopsis serratus* Shaw), and I am led to regard their occurrence in that particular way not as a mere accidental one, but rather as one of constant association. These Oligochæta are evidently not readily visible on the surface of the crayfish, and very probably occur in association with the eggs of *Temnocephala* which is found so abundantly on Astacopsis. The first evidence of the presence of these minute Annulates in association with the crayfish is usually afforded by the detection of small worms among the eggs of *Temnocephala* when these structures have been removed from the crayfish after the latter has been subjected to the action of some killing-fluid.

The specimens of one species were obtained in the Bulli district, and were labelled " surface of Astacopsis." For these I am much indebted to Professor Haswell. The second species I obtained when on a collecting tour in the Gosford district. Some large specimens of crayfish which I obtained, when placed in 10% formalin, yielded numerous individuals.

This accentuates my opinion that the genus which I have instituted is very probably to be found in constant association with *Astacopsis serratus*—an occurrence somewhat analogous to that of *Temnocephala* on that Crustacean genus. This, I believe, is the only known case of such an association as regards the Oligochæta except in the family *Discodrilidæ*, in which we find *Branchiobdella* on the gills, etc., of *Astacus fluviatilis*, and *Bdellodrilus* on *Cambarus*; but in these genera there is a state of true parasitism accompanied by special modifications in accordance with it, so much so in fact that these forms were once regarded as belonging to the Hirudinea. The peculiar manner of occurrence of this new genus lends some interest to it, inasmuch as one reasonably expects the possibility of the existence of some features of special significance in an organism which has adapted itself to such conditions.

At first I imagined cursorily I had an Enchytræid genus, on account of the position of the essential genital organs and their pores; but the character of the setæ, on detailed examination, and the posteriorly situated spermathecæ, place it certainly among the *Phreodrilidæ*.

ASTACOPSIDRILUS, gen.nov.

Resembling *Phreodrilus* Beddard, and *Phreodriloides* Benham, in general as regards external characters and anatomy, but differing from them in having spermathecal structures in segment xiv., almost devoid of musculature, without direct openings to the exterior but communicating with ovisacal structures in segment xiii.

ASTACOPSIDRILUS NOTABILIS, sp.nov.

The specimens were fixed in picro-nitric solution. The results of my investigations were obtained by the examination of entire specimens stained with hæmatoxylin and mounted in canada balsam, together with transverse and longitudinal series of sections similarly treated and counter-stained with eosin.

Body.—The body consists of fifty-three segments, and measures 5·5 mm. in length; and 0·65 in breadth in the middle region of the body, 0·30 at the anterior extremity, and 0·23 at the posterior end. The greatest body-thickness is to be found in the region of segments x.-xiv., these metameres increasing in diameter as they approach segment xii. The area of segments xii.-xiii. constitutes a well marked girdle, the clitellar region being confined to these segments. The line of division between these two segments is not distinct, and even in longitudinal sections the septum sometimes appears to be absent, although the ganglionic aggregations in the ventral nerve-cord make the distinction clear enough. In the region of the body anterior to segment x., the lines of division between the various metameres are marked by perfect grooves, but in the postclitellar region the lines of division become less and less important as they approach the posterior extremity of the body. The prostomium is semicircular in contour, measuring 0·12 mm. in the killed specimen from the anterior extremity to the groove separating it from the buccal segment.

Setæ.—Ventral setæ are absent in the first or buccal segment as in Oligochæta in general. No traces of them could be found in the clitellar region (segments xii.-xiii.) after careful examination of specimens treated in various ways. In all the other segments there are present two fascicles, which are situated in the latero-ventral regions of the body, each containing a pair of setæ. The setæ are exceedingly small in the anterior region, but gradually increase in importance, so that behind the clitellum they become very well developed.

The paired setæ of the latero-ventral fascicles are sigmoid in shape, with no feebly expressed nodulus, those in the posterior regions being more strongly curved than the setæ of the anterior regions of the body. In each bundle one of the setæ exceeds the other in length, the respective measurements being 0·08 mm. and 0·07 in the middle region of the body, the shorter one being slightly more strongly curved at its free extremity. In the anterior region of the body the setæ become shorter and shorter as they approach the buccal segment. One seta in each bundle has a simple extremity, the other possessing a notch on the convex side of the curved portion near the free extremity.

The dorsally situated setæ occur in segments xxxi.-xliii., are long and slender, and for some time escaped detection in the examination of an entire specimen, whereas the ventral setæ were easily and readily made out. They measure 0·13 mm. in length, but vary much in shape in different segments, some being in the form of a much elongated S, or rather resembling the curved capilliform setæ of *Phreodrilus subterraneus;* others being straight, but all gradually becoming strongly attenuated from the base towards the very fine free extremity. The portion of each seta hidden in the body is straight and of uniform thickness. The region of the body in which dorsal setæ are seen in entire specimens does not actually mark out the limit of the area of occurrence of such, inasmuch as I have found dorsally situated setæ completely enclosed in setigerous sacs, even in the anterior region of the body, but they do not project beyond the surface, and, judging from their strength of development, are possibly disappearing.

The male pores are situated in the anterior region of segment xii., immediately behind the septum forming the anterior boundary of that segment. The cells in the neighbourhood of the pores are of a glandular nature, certain of them being pyriform and taking a deeper stain than contiguous cells. The pores cannot be made out in the entire specimen, but by means of longitudinal sections they are made readily visible.

The female pores are situated at the anterior extremity of segment xiii., immediately behind the septum separating segments xii.-xiii.

The spermathecal pores have disappeared, but in the position in which one would expect to find them, viz., on the ventral surface of segment xiii., there is present, on the right side of the body, a solid strand of glandular cells with deeply stained nuclei, connecting the lower spermathecal sac with the ventral body-wall in the posterior region of that segment. In the immediate vicinity of this structure there is present a pair of setæ which differ in nowise from the other latero-ventral setæ.

The clitellum is in the form of a cingulum round segments xii. and xiii., as mentioned previously, the ventral region being much thicker than the dorsal.

Digestive system.—The pharynx is a thick-walled chamber extending from the buccal cavity in the first segment to the posterior region of the fourth segment. It is somewhat compressed laterally, and the antero-dorsal portion of its cavity is produced into a pocket which is sent off anteriorly and obliquely towards the dorsal surface. The formation of this pouch is due to the presence, in the middle of the anterior boundary of the pharynx, of a mass containing an abundance of nerve-cells which become continuous with the posterior portion of the brain. Judging from its constitution one would be inclined to regard this structure as a sensory or tasting organ. The wall of the pharynx consists of very tall columnar cells provided with very long cilia. External to this epithelium is a layer of longitudinal muscle-fibres connected with the body-wall above and below, and with the prostomium.

The œsophagus extends from segments iv.-xiv., in the form of a sinuous tube whose contour shows only a very slight constriction in the region of the septa. On entering segment xi., it becomes displaced from the central position which it has occupied so far in the body, towards the ventral body-wall owing to the great mass of developing spermatozoa which are present in that segment. It maintains this position throughout its further extent, and, in segment xiv., rises to a more central position in the body-cavity, and passes into the intestine which commences in segment xv. The portion of the intestine situated in segments xv.-xviii., inclusive, is constricted so as to form a well pronounced pouch in each of those segments. Behind this, the pouches become less and less distinct. The intestine contains an abundance of foreign material, diatom valves, etc. The digestive canal is provided throughout with exceedingly long cilia. The wall of the œsophagus differs from that of the intestine in being much folded, and in having an epithelium of slightly taller cells. The intestine has its wall covered by a plexus of bloodvessels, and this no doubt is connected with the digestive function.

Vascular system.—The attempt to make an entire reconstruction of the blood-vascular system is attended with great difficulties, and the assistance gained from the study of an entire specimen has been of little use in making the following brief notes. One finds that this system suffers much damage when the sections are injured in the process of cutting, on account of the presence of siliceous material in the digestive tube, and especially so as the vessels appear to have in their walls something of a chitinous nature, and the tortuous nature of the vessels increases the difficulties attendant on a detailed reconstruction of the system, the investigation of which would no doubt be much facilitated by observations made on living specimens.

There are present throughout the body a dorsal and a ventral longitudinal vessel, the former much the larger and pursuing an undulating course along the mid-dorsal line of the digestive canal; the latter lying immediately above the ventral nerve-cord, and pursuing a straight course. The dorsal trunk is locally dilated in each of segments v.-x., and is constricted at each of the septa separating these segments, so that, in an entire specimen, it appears as a linear series of swollen loops, one in each of these segments, above the digestive tube. In the first three segments it is much narrower and pursues a straight course, but behind these it follows a tortuous path, turning on itself in a sigmoid fashion in each segment. In segment x., it turns towards the ventral vessel in association with the deflection of the œsophagus in this region, so as to lie in the centre of the body-cavity in segment xi. In segment xii., it rises again to a more dorsal situation as before. Immediately in front of the septum separating segments i. and ii., it turns downwards to run under the brain between that structure and the antero-dorsal wall of the pharynx, emerging again in the midline on the antero-ventral aspect of the brain between the œsophageal connectives, and immediately bifurcates. The branches thus formed run off at right angles to the stem, each in company with an œsophageal nerve-connective; eventually they unite to form the ventral vessel in segment iii., that is the segment behind that in which lies the subœsophageal ganglion formed by the junction of the œsophageal connectives.

Commissural vessels of an undulating character connecting the dorsal and ventral bloodvessels were made out in segments iv.-x., inclusive, and from segment xv., backwards. In the postclitellar region commencing in segment xv., the pouches of the intestine are found to be covered by a network of fine vessels in connection with the commissural vessel; and this is specially interesting as no such plexuses are to be found on the portion of the digestive tube anterior to this. Hence an additional character is found as an assistance in the differentiation between the œsophagus and intestine which is thus clearly seen to commence in segment xv.

In segment xii., there is found, occupying the greater portion of the body-cavity, a mass of a granular nature which takes a stain with eosin similar to that of the bloodvessels and which, in the unstained state, has the same appearance as the bloodvessels. The thought occurs to one that this mass of granules represents a glomerular structure; but I am at a loss to understand its significance, since, both in transverse and longitudinal sections, the granules under high powers of the microscope appear to be quite free and separate, no mutual connection being made out between them. Further, I have observed that the granular nature of the epithelial cells lining the spermathecal sac is due to the presence, in their cytoplasm, of granules similar to those above-mentioned; and as the ducts from these sacs run forwards to the posterior wall of segment xii., it is quite possible that some relation exists between these granules, and that the mass of material present in segment xii. has been derived from the epithelial lining of the spermathecal sacs.

A reconstruction of the blood-system made from a study of transverse and longitudinal sections is to be seen in Pl.xxx., fig.15.

Excretory system.—Nephridia occur in pairs, as very complex coiled tubes similar to those of the *Tubificidæ* in general, in most of the segments. No traces of them can be found in the first six segments, nor in segments xi., xii., xiii., in which latter lie the essential reproductive organs and their ducts. No distinct internal funnel or external pores were made out. In examining transverse sections one would be inclined to regard the nephridia of segments vii.-x., as being in the form of one much-coiled, continuous tube as is found to be the condition of the pregenital nephridia in species of *Phreodrilus.* On examining longitudinal sections, however, it is found that each of these segments has a pair of nephridia quite distinct from those in the segments anterior and posterior to it; but the nephridia on each side occupy nearly the whole distance between the anterior and posterior septa of a segment, so that the coils of any one nephridium on each side lie in close proximity to the funnel-region of the nephridium which passes through the septum from the next posterior segment. The almost unavoidable obliquity of transverse sections (however slight it may be) is enough to show, in one section, traces of the nephridia of at least two adjacent segments, but there is certainly no continuity as regards the nephridia of segments vii.-x.

In his description of *Phreodriloides*, Benham remarks of the nephridia that "they seem to be asymmetrically disposed, for the first organ lies on the left side of segment vi. Those of the following segments are also confined to the left side; that in segment x. is on the right side; and further back I see only one in a segment" (*l.c.* p.262).

This asymmetry in *Phreodriloides* finds its parallel in *Astacopsidrilus* in a corresponding complete disappearance of the rudimentary spermathecal duct of one side, and not in the disappearance of the nephridia of any one side.

It is rather an interesting fact that the pregenital nephridia in *Phreodriloides* Benham, and *Astacopsidrilus* mihi—two genera belonging to New South Wales—are apparently not united to form a continuous tube, whereas such is the case in *Phreodrilus albus*, *P. Kerguelenensis*, *P. niger*, and probably also, Benham thinks, in *P. lacustris.*

Again, *Phreodriloides* shows an asymmetry in regard to the pregenital nephridia, and these are quite absent, apparently, in *Phreodrilus subterraneus.* *Astacopsidrilus* agrees with *Phreodrilus Kerguelenensis* in that the pregenital nephridia occupy segments vii.-x., and Benham describes pregenital nephridia as being present in segments vii. and x. in *P. lacustris.*

Nervous system.—The brain lies in the cavity of the buccal segment in close apposition with the antero-dorsal wall of the pharynx, being directed obliquely so that its ventral portion projects slightly into the prostomium. It is in the form of a biconvex mass, the anterior boundary being strongly convex, the posterior surface only slightly so. From the ventral extremity there pass round the buccal chamber, on each side, two stout strands of neural material—the œsophageal connectives—which unite in the second segment to form, together with the mass of nerve-cells, the subœsophageal ganglia of the ventral nerve-cord. These connectives of neural cords lie in close apposition with the anterior wall of the pharynx, enclosing between them the narrow buccal cavity; and each is accompanied by one of the blood-vessels formed by the bifurcation of the dorsal vessel. A massive structure containing an abundance of nerve-cells arises from the posterior surface of the brain, and projects into the cavity of the pharynx, as mentioned previously. Neurocordal substance is sent off, in the form of two strands, to supply the prostomium and what corresponds to an upper lip.

Reproductive system.—Male organs: the testes are paired structures attached to the anterior wall of segment xi. The cavity of this segment is filled with a mass of developing spermatozoa formed by the breaking up of the testes. This mass consists of ripe spermatozoa together with aggregations of rounded cells representing developing spermatozoa, and resembling closely similar aggregations in the *Enchytræidæ.* Outside this segment no spermatozoa are visible. In an examination by transmitted light of an entire individual, this mass of spermatozoa is very evident as giving rise to an opacity which occupies a great part of the body-cavity lying dorsal and lateral to the digestive tube, which is thereby displaced towards the ventral body-wall, and practically surrounded by the mass, except on the ventral aspect. Among this mass of developing spermatozoa are pear-shaped bodies, probably sporozoa(?).

The funnel of the spermiduct projects from the anterior side of the septum between segments xi. and xii., for a considerable distance into the cavity of the former segment. The funnel is provided with exceedingly long cilia, and is readily detected in longitudinal and transverse sections by the very deep stain it takes after treatment with hæmatoxylin. This deep colouration, one is inclined at first to regard as being due to masses of long cilia in connection with the funnel. No similarly stained masses can be seen among the aggregation of developing spermatozoa in segment xi., beyond that connected with the mouth of the funnel. Further, one can readily distinguish the cilia in connection with the funnel under a high power, and these are not affected by the stain. For these reasons I am rather inclined to attribute the deep stain to the presence of something of a glandular nature in the mouth of the funnel, as is to be found in the *Enchytræidæ* (?). Professor Benham found the same appearance in *Phreodrilus lacustris*, but attributes it to masses of developing spermatozoa, which may possibly be the case in my specimens, although I have been unable to make out under high powers anything of the nature of spermatozoa in appearance. The spermiduct is a coiled structure of the nature of a nephridial tubule, which, after leaving the funnel, passes back from the septum separating segments xi. and xii., upwards into the cavity of the latter segment for a short distance, and then turns on itself to run eventually towards the posterior region of that segment, whence it returns on itself to open into the atrium.

The spermiducal gland is confined to the same segment, and consists of a simple dorsal moiety running vertically, parallel to the anterior wall of that segment, its free distal end being in close proximity to the dorsally situated ovary. At about the level of the spermiduct it joins the ventral moiety, which is thrown into a flat vertical spiral lying posteriorly to the vertical dorsal or anterior half. After one complete turn of the spiral is completed, the gland is joined by the spermiduct; and the common chamber or atrium thus constituted is continued in the spiral as a gradually attenuating tube to open into the penial canal. The wall of the spermiducal gland consists of large truncately cuneate cells, with granular cytoplasm, each with a large spherical nucleus situated in its outer portion. No traces of musculature investing these glandular cells can be detected. The sections through this gland constitute the most prominent structures to be seen in sections through this region with the exception of the ovary. The penis consists of a pyriform body enclosed in a penial sac, which is continuous with the organ itself on the dorsal aspect in the region where the atrial canal passes into the penial canal. The cavity of the penial sac is pear-shaped, its neck-like portion opening on the exterior in segment xii., immediately behind the anterior septum of that segment. The sac is lined by a flat epithelium with spherical nuclei, and this is invested by circular muscle-fibres external to which is a peritoneal epithelium.

The wall of the penis itself is differentiated into three portions.

(1) An internal epithelium surrounding the very minute lumen. The cells of this layer much resemble those of the spermiducal glands, but are much smaller. They are squarish in shape, with spherical nuclei, and non-ciliated. They secrete externally a cuticular substance which stands out distinctly as a bright, highly refractive band investing the epithelium.

(2) A spongy mass consisting of a matrix in which are scattered muscle-fibres circularly or obliquely arranged, and external to this again isolated strands of longitudinal fibres.

(3) Columnar epithelial cells with centrally placed spherical nuclei.

Although the penis was not found protruded in any specimens, one may safely say, I think, that it can be.

In Pl. xxix, fig. 4, is shown the male efferent apparatus reconstructed from longitudinal sections.

In examining an entire specimen, one notices two large spermathecal chambers, circular in optical section, lying in segment xiv., one dorsal to, and slightly overlapping the other. In longitudinal sections it is seen that the ventral chamber is connected with the ventral body-wall, as stated previously, by a strand of cells with spherical nuclei and granular cytoplasm. This strand passes from the antero-ventral margin of the chamber through the septum separating segments xiii. and xiv., into the cavity of the first of these, to be attached to the ventral body-wall of the posterior portion of that segment in the region of the posterior margin of the clitellum. Traces can be seen of a cavity extending into this mass of cells from the exterior for some distance, but the cells become confluent with the ventral spermathecal chamber without any extension of that cavity into that of the chamber. The nature of their cytoplasm, their arrangement in an epithelial fashion along the sides of a cavity corresponding to a lumen, and the attenuation of the epithelium of the spermathecal chamber in the vicinity of the junction of the cells with that chamber, make it quite clear that we have here a spermathecal duct which is tending towards disappearance. Further, the position of the duct, lying as it does in segment xiii., corresponds exactly with the position of the spermathecal aperture in those other members of the *Phreodrilidæ* which are provided with spermathecæ. The spermathecæ are lined by a single layer of large squarish cells whose outlines are very distinct. These cells somewhat resemble those lining the spermiducal glands, but differ in shape, and in the much more granular nature of their cytoplasm. External to this epithelium is a very scant and indistinct trace of delicate longitudinal muscle-fibres.

In an examination of an entire specimen, there is seen in the dorsal region of the much abbreviated segment xiii., in close proximity to the septum separating it from segment xii., a pair of funnel-like structures in which one can make out a central lumen separated by an epithelium. Each of these is continuous with a duct which runs downwards and obliquely backwards. Beyond this no further traces can be made out in the entire specimen.

In longitudinal sections it is found that each of these funnel-like structures opens into the dorsal side of a thin-walled sac attached to the anterior wall of segment xiii. These sacs are paired structures, each of which passes ventrally into an oviduct, one on each side of the body. Following the course of the funnel-structures, it is seen that they pass into tubes which run towards the postero-ventral region of segment xiii., and eventually through the posterior wall of that segment to reach the spermathecal chambers. That which joins the ventral chamber passes into a wide tube, which is found to run vertically upwards, and become confluent with the postero-ventral portion of that chamber. The wall of the tube consists of epithelium of tightly packed, cuneate cells with a ventrally placed nucleus, this epithelium being surrounded by circular muscle-fibres much more strongly developed than in the case of the spermatheca itself. The spermathecal tube connected with the other funnel, after reaching segment xiv., in company with that connected with the ventral spermathecal chamber, passes round the posterior border of the lower spermathecal chamber, between the œsophagus and the anterior extremity of the intestine, to open into the postero-ventral margin of the upper spermathecal chamber. The spermathecal chambers each contain a fusiform mass, consisting of a linear aggregation of spherical bodies, and apparently representing spermatophores. At first one feels inclined to ascribe to these chambers the function of egg-sacs, and to interpret the masses of spermatophores as aggregations of ova. Sections, however, show clearly that they are not ova, and this evidence is assisted by the presence of a disappearing duct connected with the ventral chamber, and corresponding in position with the spermathecal duct of the *Phreodrilidæ*. Further, so narrow is the duct leading from these chambers to the funnel in segment xiii., that the passage of ova along them would be as impossible as that of the ova of *Nereis* through the nephridia. We have, then, in *Astacopsidrilus*, a unique character in connection with the spermathecal chambers, inasmuch as (1) they are tending towards fusion and the formation of a medial unpaired sac, due to the moving upwards of the spermatheca of the left side, and connected by a wide duct-like passage with the dorsal side of the spermatheca of the right side; (2) the absence of a passage communicating directly between these chambers and the exterior, and the entire absence of any traces of a representative of the same in connection with the dorsally situated chamber of the left side.

Female organs.—The ovaries are present in segment xii., as a pair of pyriform structures attached by the broad end to the anterior wall of that segment in its dorsal region, and in close proximity to the free distal extremity of the spermiducal gland. Numerous masses of maturing ova are found floating freely in the cavity of that segment, and these show, in their development, a great similarity to those of the *Enchytræidæ*.

In segment xiii., there is, in attachment to the anterior wall on each side of the body, a sac, mentioned previously, into which open the funnels of the spermathecal ducts. No communication between these sacs and the cavity of segment xii., could be detected, although it seems evident that it represents the egg-sac. Each sac passes ventrally into an oviduct, to open at the anterior end of segment xiii. The structure of the wall of the oviduct is essentially the same as that of the ovisacs, consisting of a flattened epithelium, external to which is a layer of longitudinal fibres.

As in *Phreodrilus subterraneus*, etc., it is evident that the spermatozoa and ova do not mature at the same time. One finds spermatophores present in the spermathecæ, and evidently derived as a result of copulation, inasmuch as the organism is provided with what must be a protrusible penis. No ripe ova, however, were found in segment xii., nor any trace of the same in the egg-sacs. As it appears that copulation does take place, the spermatozoa must be transferred from another individual to the oviducts, thence passing up through the egg-sac to the funnels of the spermathecal ducts, and thence backwards to the spermathecal sac, from which they are later transferred again to the egg-sac, when the ova are matured, so that fertilisation would readily take place in the egg-sacs.

Astacopsidrilus fusiformis, sp.nov.

This species is to be found very abundantly on the surface of *Astacopsis serratus*, occurring in the grooves of the carapace. It shows affinities sufficiently close to *Astacopsidrilus notabilis*, and equally well those characteristic features which distinguish that new genus from *Phreodrilus* and *Phreodriloides*, so that I deem it worthy of specific rank only.

External characters.—The colouration is white. The body is spindle-shaped and in general outline not unlike a cigar. It reaches its greatest diameter in segments xii. and xiii., the region of the body between segments ix. and xv. being swollen so as to give rise to a bulging area which is of greatest importance in the clitellar region. Behind segment xv., the body gradually diminishes in diameter. In the anteclitellar region the body is slightly flexed so that the dorsal margin is convex from before backwards. Length 2·8 mm.; greatest breadth 0·6 mm.

The total number of segments is 46; the anteclitellar segments, as in *A. notabilis*, are longer than those of the postclitellar region, and the grooves separating them much more strongly pronounced.

The prostomium is obtuse, its anterior margin crescentic and separated from the buccal segment by a groove. The posterior third of the prostomium appears to be marked off from the anterior portion by a feebly expressed groove.

The clitellum surrounds the body as a cingulum in segments xii. and xiii.; and, although not by any means as readily visible in an examination of entire specimens as in the case of *A. notabilis*, yet it can be easily made out with the naked eye, especially with the assistance of more dense stain, and consequent differentiation of this part obtained by the use of hæmatoxylin or borax-carmine.

Setæ.—There are in all the segments, except the buccal, segment xii., and the last three segments, two fascicles of latero-ventrally situated setæ. Those of segment xiii., (absent in *A. notabilis*) differ in no wise from the corresponding setæ of other segments. These setæ are very minute in the anterior region of the body, but gradually become more important as they approach the clitellar region, behind which they show no marked further or stronger development until they reach the posterior third of the body. In this posterior region they become very strongly developed as in *A. notabilis.* Each latero-ventral bundle contains two setæ which differ slightly from each other. Each is sigmoid, but in the one case the S is much more elongate (/), and the extremity faintly bifid or quite simple; in the other case the curve-contour is more typically S-like, and the extremity shows a distinctly bifid character due to the presence of a small tooth, and the consequent appearance of a notch on the convex side of the free end of the seta.

Dorsal setæ are present in all the segments, except the first two, segments xii. and xiii., and the last few segments, as a single row on each side of the body. They are capilliform, but show a faint sigmoid contour. The portion of each seta within the body-wall is of uniform importance, but beyond this the seta becomes attenuated strongly towards the fine free extremity, and this free portion of the seta shows the sigmoid character feebly. As in the case of the ventral setæ, the dorsal setæ are most strongly developed in the postclitellar region, and especially so in that portion which is comprised in the posterior half of the body.

Pores.—The male genital apertures are paired openings situated in the lateral region of the ventral surface of the anterior region of segment xii. The female apertures are paired, and open in the lateral region of the ventral surface of the anterior region of segment xiii., exactly in the middle of the clitellar region.

No traces of spermathecal apertures are to be seen, this condition representing the extreme shown by the tendency towards disappearance of traces of the same in *A. notabilis.*

Alimentary canal.—The buccal cavity extends upwards and backwards to the middle portion of the body in the posterior region of the buccal segment as a wide passage, sending off backwards a pouch (V-shaped in vertical longitudinal section) into the ventral region of that segment, ventral to the nerve-cord. It is lined by a nonciliated, flattened, stratified epithelium with spherical nuclei.

The pharynx extends from the anterior region of segment ii., to the posterior portion of segment v. The lumen of the portion lying in segments ii.-iv. is much wider than that in segment v., appearing in sections as squarish in outline. The anterodorsal region of the pharynx shows an extra thickening due to the development, or rather presence, of several layers of cells, the pharynx in general being lined by a single layer of cells This thickening corresponds to the region of the pocket-like continuation of the pharyngeal cavity in *A. notabilis*. The buccal epithelium passes into that of the pharynx at the ventral extremity of the brain, which lies in close apposition to the pharynx. The epithelium consists of very tall ciliated cells, with slightly elongate nuclei. The cilia are much shorter than those of the corresponding cells in *A. notabilis*; they appear as a hazy unstained layer internal to the epithelium, so as to readily mark off the pharynx from the posterior portions of the alimentary canal. As the pharynx passes towards the œsophagus in segment v., it becomes suddenly much narrowed so that its lumen is reduced in diameter to about that of the œsophagus, or to one-third of that of the anterior portion of the pharynx.

The œsophagus is a sinuous tube slightly constricted at each septum and extending as far backwards as segment xiii. It lies in the central portion of the cœlome as far as segment viii., in which it is forced towards the ventral body-wall and so as to pass beneath the mass of developing spermatozoa in segment xi., rising again to its former central position in the posterior region of segment xiii.

The intestine, like that of *Plagiochæta* and *Pontoscolex corethrurus*, instead of being in the form of a straight tube, constricted to form a distinct pouch in each segment, as is the case in *A. notabilis* and other Oligochæta in general, is arranged in a spiral fashion. Its anterior portion has the form of a large U-shaped mass extending through segments xiv.-xviii. Thence it proceeds as a gradually attenuated spiral tube as far as segment xxxv., behind which it assumes the form of a straight tube showing a slight constriction at each septum.

Unlike that of *A. notabilis*, the ciliated region of the digestive tube is restricted apparently to the pharyngeal portion. The cells of the intestinal epithelium differ from those of the gullet in being much flatter, and, further, the epithelium itself is less folded. In sections, also, the presence of the plexus-like arrangement of bloodvessels on the wall of the intestine is another distinguishing feature between these two regions.

In the œsophagus are found great numbers of large uninucleate masses, fusiform and vase-shaped, produced into a long flagellate thread. Similar masses are to be found in the cœlome in the region of the middle portion of the œsophagus, and a few examples were noticed as far back as segment xii. These masses I have identified as a Dicystid Gregarinidaceous Sporozoon, and in every probability a member of the genus *Stylorhynchus*. All the individuals noticed conformed to the spermatozoon type. No traces of Sporozoa were to be found in this species in the mass of developing spermatozoa, but I noted in that mass, in *A. notabilis*, pyriform masses representing the psorosperms of a Myxosporidian.

Cœlome.—The septa are extremely thin and indistinct, so much so that, in certain regions, one has to rely on the ventral nerve-ganglia in fixing the position and limits of organs in the study of longitudinal sections.

Nephridia.—Pregenital nephridia occur in segments vii., viii., ix., and x. They are extensive structures, occupying a great part of the cœlomic space. No nephridial structures are present in segments xi., xii., and xiii. The first pair of postgenital nephridia occurs in segment xiv. The arrangement of the pregenital nephridia is similar to that of species of *Phreodrilus*, those of each side being united to form a continuous tube extending from segments vii. to x. The extreme tenuity of these organs in the present species renders the tracing of the same very difficult, and I was unable to detect either pore or funnel. The arrangement of pregenital nephridia in segments vii.-x., resembles that of *Phreodrilus Kerguelenensis*.

Blood-system.—I have but few notes on the blood-system in this species, owing to the imperfect manner in which one can trace the vessels by sections alone. Traces of commissural vessels were found in all the segments, and in the postclitellar region, connected with these in each segment, is a plexus of vessels in association with the intestinal pouch. No marked "heart"-dilatations of the dorsal vessel could be seen.

Male organs.—No testes comparable with those of other Oligochæta could be seen, but the body-cavity of segment xi. is filled with a mass of spermatozoa. This mass is contained within a thin-walled sac, the presence of which is denoted by the regular appearance of the mass, in examining an entire specimen in canada balsam, and resembling exactly that seen in *A. notabilis*—that of a large unpaired sperm-sac.

The funnel of the spermiduct projects for some considerable distance into the cavity of segment xi., and is attached to the posterior wall of that segment. In longitudinal sections it appears as an elongated horseshoe-shaped structure, directed obliquely towards the dorsal body-wall. Its wall consists of a single layer of squarish cells, with deeply stained spherical nuclei, and is provided with very long cilia which project for some considerable distance into the cavity of segment xi., beyond the mouth of the funnel. This bunched mass of cilia is comparable to that in the funnel of *A. notabilis*, but, unlike that in the latter species, it does not take such a deep stain, which colouration I noted in the description of that species as being due to something of a glandular nature. The mass in this case is certainly true cilia, and not spermatozoa, filling the funnel, as they can be clearly seen to be continuous with its epithelial cells; and, under the highest powers, show none of the characteristics of spermatozoa.

The spermiduct is a fine intracellular nephridial-like tubule, which, after leaving the funnel, passes backwards and ventrally as a much coiled structure to join the spermiducal gland. The duct is much shorter than that of *A. notabilis*, and does not extend, in a horizontal direction, posteriorly to the spermiducal gland. In transverse sections passing through the region of the anterior part of the spermiducal gland, one sees the spermiduct cut across a great many times, and appearing as a complex nephridial tubule, in section.

The spermiducal gland is much simpler than that of *A. notabilis*, but is arranged in general on the same plan. It is in the form of an "*l*," the vertical portion being short and most posterior in position, leaning in the direction of the anterior wall of the segment but not projecting for any great distance beyond the base of the penis. The spermiducal gland, as a whole, lies on the inner side of the penis. After the junction of the spermiduct with the gland, the atrium consequently formed shows no great diminution in size or change in structure. This common chamber runs from the junction with the spermiduct, upwards for a short distance, and then turns posteriorly to the inner side of the penial sac, and passes into a tubule which enters the penis.

The spermathecæ, which were found in the paired condition in *A. notabilis*, are here represented by a single structure which passes transversely across the body, dorsally to the alimentary canal, and consists of a dilated chamber at each lateral extremity, connected by a narrow passage. The fusion, which was indicated in *A. notabilis*, is here complete, but, unlike the former species, no asymmetry is indicated. The spermatheca passes, at the latero-ventral portion of each lateral dilated chamber, into a duct which runs down towards the ventral surface of segment xiv., and, after turning on itself in a short coil, passes through the septum separating segments xiii. and xiv. It then turns on itself to run obliquely upwards to a thin-walled sac, which is situated in the antero-dorsal region of segment xiii.—the ovisac—into which it opens. The general course of the duct agrees exactly with that of *A. notabilis*. The wall of the spermatheca consists of a single layer of cubical cells, with centrally placed nuclei and granular protoplasm. The wall of the duct consists of a single layer of cells, about eight completing the investment of the very minute lumen. There is probably a very faint circular musculature round this epithelium, but it is very indistinct.

Female organs.—The ovaries are situated in segment xii., but no organ could be seen *in situ*. Masses of detached ova were seen in the cavity of this segment. The oviduct agrees in character with that of *A. notabilis*.

Remarks.—Until the last few years, the genus *Phreodrilus*, founded by Beddard in 1891, was represented by a single species, *P. subterraneus*, and was regarded as an appendix to the family *Tubificidæ*. As quoted by Benham, "Michaelsen gave an extended interpretation to that genus so as to include the four species of South American worms originally placed by Beddard in a distinct genus, *Hesperodrilus*; this enlargement of the genus has been rendered necessary by the discovery of a freshwater worm in Kerguelen, which, in certain respects, bridges over the anatomical gap between the two genera as formulated by Beddard, just as it serves as a stepping-stone in the geographical distribution of the genus as now extended."

In 1904, Benham described three new species of *Phreodrilus* from the New Zealand lakes, and, in 1907, he instituted a new genus, *Phreodriloides* of the same family, on a single specimen obtained from the Blue Lake, Mt. Kosciusko, by Prof. David and Mr. Hedley.

This extension of the area of distribution of the *Phreodrilidæ* is very interesting, and more so now, in the further extension of the same into more temperate regions and conditions in the Australian area. In connection with this family, the conditions of habitat of the various genera are of some value from a phylogenetic standpoint. *Phreodrilus subterraneus* was obtained in subterranean wells; *P. lacustris* was obtained in Lake Wakatipu, at a depth of 300 to 1,000 feet; and *P. mauiensis* in Lake Manapouri, at a depth of 150 to 500 feet. The locality of occurrence of the South American and Kerguelen Island forms is also of interest. *Phreodriloides* was obtained in the Blue Lake, Mt. Kosciusko, at a height of 6,000 feet above sea-level, in a depth of 35 feet, the temperature being 44° Fah. These facts, in conjunction with the peculiar condition under which *Astacopsidrilus* (gen.nov.) is found, would seem to indicate that the family is constituted by a number of forms which have had to migrate from the field of competition into surroundings and conditions more favourable for the preservation of forms which have found it impossible to carry on the struggle for existence under more arduous demands. The conditions of habitat, the small number of forms constituting the family, together with the geographical distribution of the various genera and species, would seem to indicate that the *Phreodrilidæ* are the remnants of an old Antarctic stock, the representatives of which are now to be found under conditions comparable with those of the stalked crinoids of the deep sea. The family is generally regarded, phylogenetically, as an offshoot of the Tubificid stem; and, in many ways, as being intermediate between the *Tubificidæ* and *Lumbriculidæ*. "In Phreodrilus," according to Beddard, in his description of *Phreodrilus subterraneus*, "we get the first stage in the development of capilliform setæ, and the commencing reduction of one pair of spermiducts." In *P. subterraneus*, the sigmoid, unnotched, ventral setæ are quite different from those of Tubificids, and the same applies in the case of *Phreodriloides*, and *Phreodrilus Kerguelenensis* and *P. beddardi*. But in all other species of *Phreodrilus*, and in *Astacopsidrilus* species, the bifid type of the Tubificid seta is foreshadowed. The *Lumbriculidæ* have all setæ of the Lumbricid type, and these are, in some forms, of the bifid pattern definitely established in the *Tubificidæ*.

The posteriorly situated spermathecæ indicate also a connection between the *Lumbriculidæ* and the *Phreodrilidæ*.

Again, the position of the genital aperture in *Phreodrilidæ*, and the apparent glandular nature of the spermiducal funnel epithelium in *Astacopsidrilus*, may possibly signify a reversion towards earlier characters of some lower members of the group, *e.g.*, *Enchytræidæ*. However, much assistance in this question might be very probably obtained by a study of the development of the forms.

In connection with the question of distribution, it is interesting to note that the *Lumbriculidæ* are, I believe, restricted to the Northern Hemisphere, and the *Phreodrilidæ* to the southern portion of the Southern Hemisphere.

In regard to the spermathecal structures, the new genus, *Astacopsidrilus*, is of special interest, inasmuch as it is intermediate between *Phreodrilus* and *Phreodriloides* in that connection. In *Phreodriloides*, no spermathecæ or spermathecal pores are to be found, but the male efferent apparatus is peculiar. In his description of that genus, Benham remarks :—" In all species of *Phreodrilus*, the spermatheca exists in the form of a long sac which extends through two or more segments, and opens near the anterior margin of segment xiii."

In *Phreodriloides*, the spermduct passes into the neck of a large muscular sac into which it opens. There is nothing of a glandular nature in the structure of the sac itself, or in association with it. The neck of this muscular sac opens into a penial chamber which, according to Benham, "appears to be an invagination of the epidermis, being lined by an epithelium which, over the greater part of the outer hemisphere, is similar to the epidermis; but the whole of the mesial surface of the wall, as well as the apex and part of the outer wall, is lined by a layer of tall glandular cells. . . . . The idea occurs to one that, in *Phreodriloides*, the spermatheca has passed forwards into segment xii., and has become coincident with the male pore. But there is nothing analogous to such a fusion throughout the Oligochæta, and a more reasonable explanation is, that the atrium has become a reservoir for the spermatozoa, and that copulation does not occur and that the muscular sac (or 'autospermatheca') discharges its own spermatozoa on its own ova, during the formation of the cocoon."

The nature of the spermathecæ, with their ducts devoid of any direct communication with the exterior through spermathecal pores, and entering into connection with the ovisac-structures, would seem to render more possible the moving forwards of the spermathecal structures; or, at all events, to argue that the spermathecæ, as such, have really disappeared in *Phreodriloides* and an "autospermatheca" developed. In *Astacopsidrilus fusiformis*, the spermathecal ducts are exceedingly fine tubes; and the musculature, readily noticeable as a constituent of the wall of the same ducts in *A. notabilis*, is practically absent. Traces of what evidently was a spermathecal pore, comparable with those of species of *Phreodrilus*, were noted in sections of the latter species; and the spermathecal duct in this region is much more strongly developed, as regards size and musculature, than the portion continued forwards from this region to reach the ovisac-structure. From this it seems certain that *Astacopsidrilus* has been derived from a Phreodrilan stock; and that, judging from the fact that *A. notabilis* shows, in the case of its spermathecæ, a tendency towards fusion, and that this fusion is complete, and no traces of any spermathecal pore can be seen in *A. fusiformis*, the former is the older species.

It is noteworthy that in the two Australian genera of the family, *Phreodriloides* Benham, and *Astacopsidrilus* gen. nov., the variation of most significance with regard to *Phreodrilus* Beddard, is in connection with the spermathecæ—structures which are of the greatest importance in connection with the family from the point of view of classification and also phylogeny. It would really seem that these structures have already disappeared in *Phreodriloides*, and that the muscular sac is not the representative of a spermatheca which has moved forwards, but has been evolved independently; further, that the posteriorly situated spermathecæ in *Astacopsidrilus* are very unstable.

The *Phreodrilidæ*, occupying the position usually assigned to them in the phylogenetic table, namely, as intermediate between the *Lumbriculidæ* and *Tubificidæ*, had possibly been derived from the Lumbriculid stem (or from the Tubificid stem) after the evolution of posteriorly situated spermathecæ in that group; and one of the lines of variation along the Tubificid stem may have already been opened up before the *Phreodrilidæ* left that stem, in the way indicated by the disappearance of these posteriorly situated spermathecæ, as foreshadowed in *Astacopsidrilus*, and the evolution of new spermathecæ after the fashion of that in *Phreodriloides*.

In conclusion, I may mention that I had the privilege of examining some specimens of *Astacopsis bicarinatus* sent from Victoria by Professor Baldwin Spencer, but was unable to detect any trace of Oligochæta in association with them.

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EXPLANATION OF PLATES XXIX.-XXXI.

at., atrium—*bld.vs.*, portion of network of bloodvessels in connection with intestine—*brn.*, brain—*cil.fn.*, ciliated funnel of spermiduct—*c.mus.*, circular muscle-fibres—*cu.*, cuticle—*cl.*, clitellum—*com.vs.*, commissural bloodvessel—*d.v.*, dorsal bloodvessel—*dvpg.spz.*, developing spermatozoa—*ep.*, epidermis—*ex.ep.*, external epithelium of penis—*grn.*, granules—*int.ep.*, internal epithelium of penis-sac—*int.ep.*, internal epithelium of penis—*int.*, intestine—*l.mus.*, longitudinal muscle-fibres—*lm.*, lumen—*musc.*, muscle-fibres—*nph.*, nephridium—*nuc.*, nucleus—*nv.gn.*, nerve ganglion—*n.c.*, mass of nerve-cells in connection with posterior surface of brain—*ov.*, ova—*oe.*, œsophagus—*ov.sc.*, ovisac—*ovd.*, oviduct—*oes.con.*, œsophageal connective—*pn.*, penis—*pn.sc.*, penis-sac—*ph.*, pharynx—*prst.*, prostomium—*r.t.v.*, retiform mass of bloodvessels in association with the intestine—*spr.*, spermiduct—*spz.*, spermatozoa—*spth.dc.*, spermathecal duct—*sph.*, spermatophore—*sp.gld.*, spermiducal gland—*sp.*, septum—*spth.*, spermatheca—*sp.sc.*, sperm-sac—*sp.fn.*, ciliated funnel of spermiduct—*vent.n.cd.*, ventral nerve-cord—*v.v.*, ventral bloodvessel—v_2, divisions formed by bifurcation of dorsal bloodvessel anterior to brain.

Plate xxix.

Fig.1.—*Astacopsidrilus notabilis*, gen. et sp.nov. Two setæ from a latero-ventral bundle.

Fig.2.—Entire specimen of *A. notabilis*, as seen by transmitted light. (Drawn from a specimen stained with borax-carmine, and mounted in canada balsam).

Fig.3.—Transverse section of penis and penis-sac of *A. notabilis.*

Fig.4.—Spermiduct and spermiducal gland, etc., *A. notabilis*, reconstructed from serial sections.

Fig.5.—Transverse section of spermathecal duct of *A. notabilis.*

Fig.6.—Transverse section of spermathecal duct of *A. fusiformis*, gen. et sp. nov. N.B.—Circular musculature much exaggerated.

Fig.7.—Longitudinal vertical section through the genital region of *A. fusiformis*.

Fig.8.—Transverse section through spermiducal gland of *A. notabilis*.

Fig.9.—Entire individual of *A. fusiformis*.

Plate xxx.

Fig.10.—Spermiduct, spermiducal gland, etc., of *A. fusiformis* reconstructed from serial sections.

Fig.11.—Spermatheca of *A. fusiformis*, containing spermatophores.

Fig.12.—Horizontal section through anterior extremity of an individual of *A. notabilis*.

Fig.13.—Mass of developing ova of *A. notabilis*.

Fig.14.—Cells of the epithelium of spermatheca of *A. notabilis* showing their granular nature.

Fig.15.—Blood-vascular system of *A. notabilis*, reconstructed in part from serial sections, in part from entire specimens mounted in canada balsam.

Plate xxxi.

Figs.16, 17.—Longitudinal sections through the genital segments of *A. notabilis*.

DESCRIPTION OF A NEW FRUIT-FLY OF THE GENUS *DACUS* FROM NEW SOUTH WALES.

By D. W. Coquillet, Washington, U.S.A.

(Communicated by Walter W. Froggatt.)

For the opportunity of describing specimens of this interesting fruit-fly, one of the largest species of the genus, I am indebted to Mr. Froggatt. These were collected by Mr. A. T. Hunter, one of the Orchard Inspectors, just before Mr. Froggatt left for the United States last year. The type is retained in the National Museum Collection at Washington, and the cotype is in the Entomological Collection of the Department of Agriculture of New South Wales. Another is in the collection of the Entomological Division of the Imperial Research Institute at Pusa, India.

Dacus æqualis, n.sp.

Near *D. longicornis* Wiedemann, from Java, but differing from the description in having the occiput chiefly reddish-brown, instead of yellowish, the pleura with two yellow streaks instead of black ones, the anal cell brown, etc. The evenness of the costal brown area of the wings, which is bounded by the costa and fourth vein, will serve to distinguish the present species from most of the others. Reddish-brown, front mottled with yellow, face yellow, an elongated black mark on each side; cheeks, margin of occiput, humeri, a streak extending along the mesothoracic suture each side and crossing the mesopleura, a large spot on the hypopleura, the scutellum except its base, halteres, sides and hind margin of the second segment of the abdomen, narrow hind margin of the fifth segment, also the tarsi, pale yellow; femora largely blackish-brown. Antennæ projecting about one-half the length of the third joint below the oral margin. Abdomen broadly clavate, slightly longer than the ovipositor of the female. Wings greyish-hyaline, the front margin from the costa to the fourth vein wholly dark brown, anal cell brown, the constricted outer portion and the vein beyond it broadly bordered with brown. Length (excluding the ovipositor) 8 to 9 mm.

Tuggerah Lakes, near Gosford, New South Wales. Specimens of each sex collected by Inspector Hunter, June 25, 1907; bred from larvæ in oranges.

WEDNESDAY, NOVEMBER 25TH, 1908.

A Special General Meeting, together with the concluding Ordinary Monthly Meeting of the Session, were held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, November 25th, 1908.

SPECIAL GENERAL MEETING.

Mr. Henry Deane, M.A., F.L.S., Vice-President, in the Chair.

Business: to confirm the alterations in Rules xlv., xlvi., and lix., and, if necessary, to elect an Auditor.

On the motion of Mr. J. H. Campbell, Hon. Treasurer, seconded by Mr. R. T. Baker, it was resolved that the alterations in Rules xlv., xlvi., and lix., passed at the Special General Meeting of 28th October, 1908, and published in the last Abstract, be confirmed.

The Secretary reported communications from Messrs. D. Carson and E. G. W. Palmer, Honorary Auditors, placing themselves in the hands of the Society.

On the motion of Mr. Dun it was resolved that the resignations of Messrs. Carson and Palmer be accepted, in order that the new Rules may be acted upon forthwith; and that the cordial thanks of the Society be tendered to the retiring Auditors for their valuable services in the past, and for their courteous co-operation in inaugurating the new arrangement.

Mr. E. G. W. Palmer returned thanks on behalf of the retiring Auditors.

On the motion of Mr. J. H. Campbell, it was resolved that Mr. F. H. Rayment, Public Accountant, be appointed Auditor, to act at the close of the year.

ORDINARY MONTHLY MEETING.

Mr. Henry Deane, M.A., F.L.S., Vice-President, in the Chair.

The President reminded Candidates for Fellowships that Monday, 30th inst., was the last day for sending in applications.

Mr. Theodore T. Flynn, B.Sc., Technical College, West Maitland, was elected an Ordinary Member of the Society.

The Donations and Exchanges received since the previous Monthly Meeting, amounting to 17 Vols, 49 Parts or Nos., 2 Bulletins, 1 Report, 1 Map, and 21 Pamphlets, received from 48 Societies and two Individuals, &c., were laid upon the table.

NOTES AND EXHIBITS.

Dr. Chapman, who had recently returned from a visit to West Australia, by request tendered to the Society very cordial greetings from the West Australian Natural History Society, at Perth.

Mr. D. G. Stead recorded the occurrence in the waters of New South Wales, of the great swordfish, *Xiphias gladius* Linn., an example of which, measuring 9 feet, 4 inches, in length had been captured two days previously at Kiama. This marks the first record of this species in these waters. The specimen captured—of which the sword measured 3 feet—was in pursuit of large jewfish (*Sciaena antarctica* Castelnau) at the time. Mr. Stead also exhibited two remarkable photographs of a huge sunfish, *Mola mola* (Linn.), recently brought in to Sydney on one of the propellers of the steamship "Fiona." This sunfish was the largest on record, measuring 10 feet 2 inches in length, 6 feet deep, and 2 feet thick. A living example of the beautiful osphromenid fish, *Osphromenus trichopterus* (Pallas)—a species of Gourami, of which a large number had recently been privately introduced to the State—was also exhibited.

Mr. Tillyard exhibited the cast skin of a dragonfly, *Hemicordulia australiæ*, on the back of which was a second cast skin of the smaller *Isosticta simplex.* Evidently the larger dragonfly had just emerged, and the smaller larva had afterwards climbed the same stem and affixed itself to the back of the other

Mr. Froggatt showed as exhibits (1) A quantity of the eggs of water-bugs, as sold in the market in Mexico City, and used for food by the natives. (2) A sample of water-bugs, sold in the market and used by the Mexicans to feed their caged mocking-birds. (3) "Dried Flies," really water-bugs, imported from the west coast of Africa by merchants in Liverpool, England; used for feeding pheasants. (4) Specimens of the largest Lecanid scale-insect known, received from C. P. Lounsbury, South Africa, and named by Saunders, at Washington, *Lophococcus maximus*; the insect looks like an immense *Lecanium.* (5) Wingless females of an undetermined species of *Mutilla*, which sting very sharply. This little wasp is looked on by the natives of Cyprus as more deadly than a snake, and many deaths of shepherds are attributed to the sting of this wasp, which is said to cause an eruption known as "Sflangi Face;" this complaint, however, in reality is due to blood-poisoning contracted by sleeping on the fresh skins of sheep and goats suffering from "sheep-pock."

Mr. W. S. Dun exhibited specimens of glendonite, pseudomorphs after glauberite, formerly known as thinolite, from tuffaceous sandstones of the Upper Marine Stage at Black Head, Gerringong, N.S.W.

Mr. Finckh reported that he had been successful in importing 21 common European Newts (*Molge vulgaris*, Linn.); and that ova of the Japanese Red-bellied Newt had hatched out in his aquarium in 38 days.

Mr. Cheel exhibited a series of interesting Fungi—PUCCINIACEÆ: *Puccinia bromina* Eriks.; host, *Bromus mollis* Linn.; Penshurst, (E. Cheel; November, 1908). *Melampsora lini* (Pers.) Tul.; host, *Linum marginale* A. Cunn.; Dubbo to Minore (J. L. Boorman; October, 1908), Penshurst (E. Cheel; November, 1908). MYXOGASTRES : *Arcyria punicea* Rost.; Botanic Gardens, Sydney; on a garden rake-handle and on a decaying log (E. Cheel; April, 1908).

Stemonites ferruginea Rost.; Parramatta, on a charred log (E. Cheel; March, 1908). *S. fusca* Rost.; Leura and Centennial Park (A. A. Hamilton); Botanic Gardens, Sydney (E. Cheel and W. Blakely); Mount Macedon, Victoria (E. Cheel); on decaying fence-rails, stems of Buffalo-grass (*Stenotaphrum americanum* Schrank), and trunks of *Dracæna nutans* Cunn. Recorded in these Proceedings, Vol. xxxii. p.205 (1907) as *S. ferruginea* Rost.

Mr. North exhibited the nest and eggs of Newton's Bower-bird (*Prionodura newtoniana* De Vis) and of the Tooth-billed Bower-bird (*Scenopœetes dentirostris* Ramsay), together with skins of the females shot near the nests. They were obtained through the instrumentality of Mr. Robert Grant, from Messrs. John and George Sharp, of whom the latter procured them respectively on the 9th and 7th November, 1908, on the Bellender Ker Range, after waiting near the nests for over an hour, and flushing the females from them several times, before shooting them and taking the nests and eggs. The nest of *Prionodura newtoniana* is an open cup-shaped structure formed externally of dead leaves and portions of leaves, including fragments of stag-horn ferns and a small quantity of dried mosses, and is lined inside at the bottom with thin dead twigs. Externally it measures 5½ inches in diameter by 2½ in depth, the inner cup measuring 4½ inches in diameter by 1½ in depth. It was built about the centre of an opening 4 feet long and about 6 inches wide, inside in a rotten tree, 3 feet from the ground, and contained two eggs. The eggs are oval in form, the shell being finely granulate, lustrous, and of a uniform fleshy-white. Length (A) 1·4 × 0·98 inches; (B) 1·38 × 0·97 inches. The nest of *Scenopœetes dentirostris* is a slightly concave structure, formed throughout of twigs; coarser ones below, and finer ones above, as a resting place for the eggs; it is most flimsy and loosely built, and resembles one of the smaller pigeon's, or a dove's nest, and averages 5 inches in diameter by 2 inches in depth. It was placed in a low, thickly-foliaged tree, about 17 feet from the ground and in the most dense part of the scrub. The nest contained two eggs, which are oval in form, the shell being very finely granulate, lustrous, and of a uniform creamy-brown colour, resembling very much the eggs of *Æluroedus maculosus*, but of a more distinct brownish hue. Length (A) 1·63 × 1·1 inches; (B) 1·62 × 0·9 inches. Subsequently Mr. Sharp found other nests and eggs of the same species.

Mr. Fred. Turner exhibited a specimen taken from *Ficus rubiginosa* Desf., a tree of great historic interest, growing in Hyde Park, Sydney. It was presented by his Excellency Sir George Gipps in 1841 to the Honorable Sir Alfred Stephen, who planted it in his garden, and subsequently transplanted it to its present position. He also showed a photograph of the tree taken many years ago, on the back of which is written in Sir Alfred Stephen's writing: "Tree given to me by Governor Sir G. Gipps in 1841, and planted in the Park by me."

Mr. Basset Hull exhibited the egg of the White Tern (*Gygis candida*) in position as laid on a branch of the white-wood tree, taken at Norfolk Island on the 31st October, 1908. This bird lays its single egg in a knot-hole or slight depression on the horizontally-inclined branches of the white oak, white-wood, or other large trees at Norfolk Island, at heights varying from 20 to 60 feet from the ground, and incubates it in this position. Advantage is taken of any depression in the branch, but no nest-forming material is added.

Mr. Fletcher, on behalf of Dr. Cleland, of Perth, showed sections of branches, suckers, and natural seedlings of *Nuytsia*.

THE RÔLE OF NITROGEN AND ITS COMPOUNDS IN PLANT-METABOLISM.

Part i.—Historical.

By James M. Petrie, D.Sc., F.I.C., Linnean Macleay Fellow of the Society in Bio-Chemistry.

(From the Physiological Laboratory of the University of Sydney.)

CONTENTS.

Introduction.—In the days of Liebig the aims of organic chemistry were to examine the substances comprising the structure of living things and the products of their metabolism. Liebig's great work was the building of the foundation of vegetable chemistry. In the long interval which has since elapsed chemistry has chiefly been employed in perfecting its methods, and with the new century it rises again and seeks its first love, biology, under the new name of Bio-Chemistry.

It is by the exact quantitative methods of physical science that most of the recent advances in biology have been possible, and indeed it is quite evident from a general survey of the current literature that the physiology of plants and animals is progressing along the lines of pure chemistry and physics. It is now fully recognised that the living cell as a physiological entity owes its formative material, its nourishment, growth, and even movement to chemical changes; and further, that it contains some self-regulating mechanism by which, amidst the continuous changes, an almost constant chemical composition is maintained.

The living protoplasm is constantly associated with protein, of which the characteristic element is nitrogen; we therefore find the latter in every living cell, and it is the main purpose of this review to trace the nitrogen cycle in nature through some of its many stages.

The Source of the Nitrogen of Plants.

The nitrogenous compounds which are found in every living cell are of primary importance to organic life, and have their origin in the atmospheric nitrogen, from which they are formed by many complex changes. Not from the lightning flash alone, but far more from the continuous and silent electric discharges between clouds and from cloud to earth, comes the energy by which the elements of water-vapour and air are united to form ammonia, nitric and nitrous acids. This was the discovery made by Priestley in 1774 when he recognised the oxides of nitrogen in the air. In 1804, de Saussure detected ammonia in air, and by very rough gasometric experiments showed that the free nitrogen is not utilised by plants. A few years later, Chevreul and Brandes found that ammonia was present in rain and river-water; but it was Liebig who first called attention to the great significance of ammonia in the rainfall on the growth of vegetation. He also detected nitric acid in rain water, but attached very little importance to its nitrogen. Boussingault was the first to make elaborate and exact quantitative estimations of ammonia in rain water; and Barral of Paris, in 1851, made the first series of quantitative nitric acid estimations in rain. Since then the most important results are those of Gilbert and Lawes of Rothamsted.

The quantity of ammonia in the atmosphere, as the mean of many results obtained by the best authorities in different countries, is 1 pound per 26 million cub. yards. Rain water contains—

	Rain.	Dew.	
Ammonia.....................	1 to 9	1 to 3	parts per million.
Nitrous and nitric acids.................	2·4	2 to 16	

The Rothamsted experiments have shown that there is carried down by the rain every year and added to the soil

2·4 lbs.	N per acre,	as ammonia.
1·0	,,	as nitrates and nitrites.
1·0	,,	as organic nitrogen.
4·4	,,	total combined N (average over 5 years).

Now there is removed in a crop of wheat from unmanured soil 20 lbs. of nitrogen per acre yearly, and Gilbert has said that the amount of fixed nitrogen received by the annual rainfall is approximately balanced by the loss of nitrates through drainage, it is evident that there must be other ways in which combined nitrogen is added to the soil.

In the first place (a) we know that an acre of clover will add to the ground 200 lbs of N per annum. (b) Since Winogradsky isolated the bacillus *Clostridium pasteurianum* from the soil, many other organisms have been found which can utilise the atmospheric nitrogen directly in forming their protein substances; such are the group of Clostridia, *Azotobacter*, *Radiobacter*, *B. radicicola*, *B. prodigiosum*, etc. It has been estimated that 70 lbs. of N per acre are yearly added in this way, and the organic compounds formed made available to plants. (c) Every drop of water that passes into vapour on the earth's surface is accompanied by an energy-change, which combines the atmospheric nitrogen to the water-molecules and produces ammonium nitrite [$N_2 + 2H_2O = NH_4NO_2$]. This important fact, first noticed by Schönbein, probably accounts for a large amount of the nitrogen fixed and added to the soil, since there is constant evaporation of water from the ground and even from the surface of plants. In this way, says Thorpe, the plant may indeed prepare for itself a portion of its nitrogenous food.

The Nitrogen of the Soil.—The following table shows the amount of nitrogen present in ordinary arable soil unmanured(1)

First	9 inches of soil contain			3000 lbs. N per acre.		
Second	9	,,	,,	,,	1700	,,
Third	9	,,	,,	,,	1500	,,
	27	,,	,,	,,	6200	,,

The average value is 0·1 % N.

This nitrogen exists chiefly in organic combination in the humus, which is an indefinite mass of decaying vegetation, and out of which, by slow bacterial oxidation, nitrates are formed. We find here all the intermediate stages of nitrogen-transformation—proteins,(2) amides, amino-acids, amines, ammonium salts, nitrites and nitrates. These are the materials available to plants for food, and from which they synthesise their special proteins.

The numerous stages in the conversion of the organic nitrogen to nitrates is considerably hastened by the influence of micro-organisms, and firstly, the ordinary putrefactive bacteria convert the decaying vegetable material into ammonia and carbon dioxide; secondly, the "nitrosomonas" are able only to change this ammonia into nitrites; and lastly, the "nitrobacter" complete the oxidation to nitrates. The two latter organisms are generally known as the "nitrifying organisms" of the soil, and were first isolated in pure cultures by Winogradsky in 1890.(3) This nitrification process everywhere goes on in arable soil; the nitrates, being the most highly oxidised form, are also the most stable, and the greater part of the nitrogen in the soil exists in this form.

Relation of Protein to the Non-Nitrogenous Reserve Material.

Since proteins are composed of amino-acids, and the latter are ammonia derivatives of the fatty acids, it is necessary here to briefly summarise our views on the possible sources of the fatty acids in plants.

(a) *Carbon-assimilation.* — Since the hypothesis was first suggested by Baeyer in 1870(4) that formaldehyde is the primary product of photosynthesis, much experimental work has been done,(5) most of which tends to uphold this view, though it has never yet been completely proved. The most recent view as to its formation is that, through the influence of light and chlorophyll, water is decomposed, the oxygen being evolved while the hydrogen unites to the chlorophyll. The latter then acts as a strong reducer on the carbonic acid in solution in the cell-sap, whereby it is reduced to formic acid, then to formaldehyde.

H_2CO_3 carbonic acid ... $(CO{\cdot}OH{\cdot}OH)$
H_2CO_2 formic acid...... $(CO{\cdot}OH{\cdot}H)$
H_2CO formic aldehyde $(CO{\cdot}H{\cdot}H)$

This aldehyde is the probable starting point for the higher synthesis wherein the various groups CH_2, CHOH, COOH, become linked together into long chains forming the carbohydrates and fats. In the first stage of the mechanism of this change the formaldehyde has ever proved elusive and difficult of detection in the living plant. The only important facts on which we have to depend are those established by Curtius, Reinke,(6) and later by Pollacci,(7) who have certainly proved that formaldehyde occurs in green leaves growing in light and air. The fact that chemists were for a long time unable to reduce carbonic acid to formaldehyde *in vitro* was used as an argument against Baeyer's hypothesis, but now this has been accomplished by Fenton,(8) who used magnesium as a reducing agent, at the ordinary temperature. The formaldehyde radicle exists in combination with phosphoric acid as "phytin," discovered independently by Winterstein and Posternack. The latter author states that phytin is formed from the inorganic phosphates during the actual process of the reduction of carbonic acid by chlorophyll.

The second stage, the synthesis of sugars and their conversion into starch and fat, is more easy to comprehend, since it is possible to perform these apart from the living cell, as for example, the aldol condensation from formaldehyde to glucose. Then it is possible to conceive the hydrolysis of starch into sugar as a reversible enzyme-reaction, and that enzymes are directive agents in building up both starch and oils, even cellulose and glucosides.

(b) *Relation of Carbohydrates to Fats.*—The rôle of fats in the plant has been shown to be similar to that of the carbohydrates; both are reserve-materials found together, and serve the same purpose in metabolism. They are capable of being transformed into one another by the protoplasm(9)—*carbohydrate* $\rightleftharpoons$ *fat.* It has been observed in certain plants that inulin, starch, glucose, and fat are formed in succession from the same food-substances.(9) Again, Sachs observed that fat was formed from glucose in the ripening seeds of Ricinus, and Pfeffer that the starch in the endosperm of Pæonia was converted into fats. All oily seeds, when unripe, contain much starch, and as they ripen the formation of oil may be observed; when the seeds are ripe the starch may be wholly replaced by fatty oil.(9)

Conversely, in germinating seeds fat is changed into carbohydrate. A. Fischer(10) has pointed out that temperature is an important factor in these changes; he has noted, for example, the change of starch into fat in trees in the winter, and the reverse taking place in the spring. That these changes take place in the plant there is little doubt, though the evidence rests entirely on physiological experiments, and the exact chemical course which is followed has not yet been explained. The conversion of carbohydrate into fat was first suggested by Liebig, and afterwards proved by the historic experiments of Gilbert and Lawes at Rothamsted.

It is of interest here to glance briefly at the mechanism of certain processes whereby this end is achieved in synthetic chemistry. Sugars are readily converted into lactic acid by weak alkalies,(11) and by the enzymes of micro-organisms and yeast,(12). $C_6H_{12}O_6 = 2C_3H_6O_3$. One of the general properties of lactic acid is its decomposition to aldehyde and formic acid; aldehyde is exceedingly liable to condense into aldol, and aldol reacts with water to yield fatty acids.(13) Hoppe-Seyler considered that these reactions represent the simplest form in which carbohydrates are converted into fats. True it is that only the lower acids (to caproic, C_6) were obtained in the above way, but, as Leathes puts it, the formation of even caproic acid from lactic acid must involve just such a synthesis as that which occurs in plants and animals, which if continued must lead to the higher members of the series.

From seeds Stoklasa(14) has isolated an enzyme which produces alcoholic fermentation and lactic acid. He says that the process of anaërobic respiration in plant-cells is a fermentation directed by this lactolase.

The phytin of Posternack has been shown capable of hydrolysis by an enzyme, phytase, into phosphoric acid and the cyclic carbohydrate inosite. The former is a possible source of phosphorus-supply for the cell-nucleins, and the inosite further breaks up into lactic and other fatty acids. This phytin, which contains 80 % of the phosphorus of seeds, is built of three double formal-phosphoric ester groups, condensed as inositephosphoric ester.(15) We see in this new substance vast possibilities—how inorganic phosphates may unite with the first product of photosynthesis, and (somewhat like the acetone-mesitylene condensation) produce a cyclic compound. From the latter the phosphate radicle separates and gives rise to inosite, and from inosite a number of fatty acids have been formed.

The fats circulate in the plant as glycerol and free acids. This separation is the work of the enzyme, lipase, which is able to split the fats or recombine their products according to requirements. The presence of a hydrolytic fat enzyme in plants was first suggested by Pelouze(16) in 1855, and conclusively proved by Green(17) in 1890. Since then, a large number of seeds and other parts of plants have been examined, and the evidence points to the presence of a zymogen or dormant enzyme in the resting seed, though some resting seeds are slightly hydrolytic. When such oily seeds germinate, the enzyme is activated into lipase and the fatty oils rapidly hydrolyse; this is the first step in the utilisation of fats as food-material for the developing embryo. By determining the amount of free acid from day to day, the activity of the lipase may be found. It is possible to activate the zymogen by various mechanical or chemical means, but different methods are necessary with different kinds of seeds. This points to a probable difference in the zymogens. Again, active solutions of lipase can be prepared from germinating seeds, and from these solutions alcohol may precipitate the enzyme completely in some and not at all in others. This suggests that different lipases exist in various seeds.

Absorption of Nitrogenous Food.

Liebig considered that ammonia was the chief source of the nitrogen of plants, while Boussingault held that the nitrates of the soil were most essential. It is certain that both are valuable; some plants are found to prefer nitrates, others ammonia, while others again are indifferent. Nitrites, too, are of considerable value, and Treboux(18) states that the value of the amino-acids and amides is much less, yet these, too, form important sources of nitrogen. For some fungi the food-value of the simple amino-acids is higher than that of all other forms of nitrogen.(19)

Large amounts of nitrates are found in many plants, such as the sunflower, turnip, potato [1·5 to 2·8%], in Amaranthus [15%], in Chenopodium, Urtica, etc.;(20) the nitrates are absorbed by the roots, and when plants are grown in nitrate-free soil none is found in the tissues. We thus see that nitrates can be stored in plants as reserve-material, but nitrites and ammonium salts are poisonous and must be immediately used.

Now the nitrates and nitrites undergo reduction in green plants, and a reducing enzyme was discovered in potatoes by Abelous and Aloy(21) in 1903, and confirmed in other vegetables by Kastle and Elvolve(22) in 1904. This enzyme has recently been isolated by Irving and Hankinson(23) (1908), who found it in the roots, stems and leaves of *Vicia Faba*, in the iris, and various gramineæ. They state that the conditions necessary for nitrate-reduction are the presence of the enzyme and a suitable carbohydrate to supply the necessary energy. There is also evidence that amino-acids and amides are decomposed by enzymes setting free ammonia. All these facts suggest strongly that ammonia is the form most easily utilised by chlorophyllous plants.

Protein-Synthesis in the Plant.

From these very simple forms of food-stuff in soil and air the plant, by an expenditure of a vast amount of energy, is able to construct many different compounds increasing in complexity till at last the protein-molecule is synthesised. The actual nutrition of the organism now really commences, and so, as Green has said, the food on which plants really depend is as complex as that on which animals live. We do not know exactly by what stages the plant builds up its proteins, though we are quite familiar with the different steps in the reverse or downward grade of protein-decomposition.

Proteins, metaproteins, proteoses, polypeptides (coupled amino-acids), amino-acids, fatty acids and ammonia. Through this series the protein-molecule breaks up into a number of simpler bodies, and each of these into still smaller groups, and finally into the amino-acids, about twenty of which have been isolated. The latter readily lose ammonia, and there are left the fatty acids, or more frequently the oxy-fatty acids.

By precisely the same steps we believe the synthesis to take place—that the plant has not only the power to form all the different amino-acids and their amides, but also to link these together into polypeptides and peptones, to condense these into proteoses, and finally into proteins.

It has been already indicated that the initial substances exist in the plant, viz., the oxy-fatty acids formed from carbohydrates and fats, but just how the amino-radicle (NH_2) enters into the acid to form the amino-acid, still remains a mystery. Lang,(24) in 1904, observed that amino-acids are denitrified in the body with loss of ammonia, possibly by the action of an enzyme. It is possible that the reverse also takes place under the influence of the special enzyme.

Two distinct stages are therefore to be noted in the synthesis, (1) the conversion of nitrate, ammonia, or other simple nitrogen source into amino-acids; (2) the synthesis of amino-acids to proteins. Abderhalden has proved that Aspergillus, whether supplied with nitrate, glycocoll, or glutaminic acid, etc., builds up its proteins always in the same way; and that the proteins so formed have the same constant composition, as shown by their yielding identical cleavage-products. He therefore concludes that Aspergillus must start from the amino-group in constructing its proteins.

The amino-acids and amides were proved present in considerable quantities in green leaves by Kellner,(25) in 1879. Emmerling,(26) in 1884, discussed in detail the importance of these compounds in protein-building, and collected much experimental proof. Most of this earlier work depended on microchemical methods which in many cases have proved unreliable, but of the more recent work founded on exact chemical estimations, the following may be cited. Suzuki,(27) in 1898, found that plants fed on sugar-solution and nitrates were able to form protein in the dark, and that the same occurred in plants which contained a large amount of sugar. Hansteen,(28) in 1899, synthesised protein from ammonia and glucose in the dark; this was also quantitatively confirmed by Maliniak(29) in 1900. Zaleski,(30) in 1905, proved the formation of protein from amino-acids and amides in the dark by exact quantitative analysis, and in the case of bulbs and tubers, without any change in the amount of nitrogen. Since Pasteur, in 1851, first observed the tendency of plants to accumulate amides when grown in the dark or in air free from carbon dioxide, there is now considerable evidence to show that the synthesis of protein is greatly retarded under these conditions; and further, that when such plants are afterwards grown in the light, still without carbon dioxide,(31) they show no diminution of the amides,(32) but when fed on carbohydrates in the dark, or brought into the sunlight and air, soon show an increase in the amount of protein.

The above experimental evidence would seem to support the suggestion made as early as 1865 by Sachs, that an intimate association exists between the photosynthesis of carbohydrate and the chemosynthesis of protein, and therefore that a large part of the protein may possibly be formed in the carbon-assimilating cells of the green leaf.

In the metabolism of animals there is a highly important parallelism which Loewi(33) proved in 1902. Proteins were digested with trypsin for a prolonged period, until they no longer gave the biuret reaction. When animals were fed with the cleavage-products as their only nitrogenous food, they lived and thrived; but it was absolutely essential that a plentiful supply of carbohydrates should also be given. His results have since been confirmed by Henriques and Hansen,(34) and Abderhalden,(35) who have also shown that animals can be kept alive even by a part of the hydrolytic products; that portion soluble in alcohol and not precipitated by phosphotungstic acid, namely, the mono-amino-acids, possesses the nutritive value. This close resemblance between animals and plants in the manner of building up their proteins is very significant.

Nitrogenous Reserve-Materials.

The intermittent growth of plants necessitates a laying up of reserve-material as stores of food on which they may draw during the periods of rest. A large part of the metabolism is therefore directed towards this end. Such stores are found (*a*) in the circulating sap in the most plastic form ready for immediate use; (*b*) in reservoirs such as fleshy roots and stems, medullary rays, cells of vascular tissue, sieve-tubes, laticiferous vessels, etc., stored for short periods; (*c*) in seeds, bulbs, and tubers as the most permanent form suitable for periods of absolute rest. These stores of plastic material may be divided into nitrogenous and non-nitrogenous substances. The former will be dealt with at some length here; the latter are starch controlled by the diastatic enzymes, hemicelluloses and their enzymes, the cytases, and fats controlled by the lipases.

Concerning the nitrogenous reserves of plants, the most important chemical researches have been done on seeds. In these we find the substances more permanent and definite, while in other parts of the plant the various compounds are constantly changing, though they try to retain equilibrium between the anabolic and katabolic processes.

The Nitrogen Compounds in Seeds.—The nitrogenous material in seeds may be considered first as proteins and non-protein compounds. The *Proteins* are classed as follows :—

1. Phyto-albumins—soluble in water.

2. Phyto-globulins—soluble in salt sols., insol. in 1.

3. Phyto-gliadins—soluble in alcohol, insol. in 1 and 2.

4. Phyto-glutelins—sol. in dil. acids or alkalies, insol. in 1, 2, 3.

5. Conjugated proteins—nucleo-proteins, lecitho-proteins (though it is not yet known whether these are true chemical compounds, adsorbed substances, or aggregates), toxalbumins, etc.

6. Proximate cleavage-products—proteoses and peptones.

The non-protein nitrogen compounds are :—

1. Amides—glutamin and asparagin, and probably others.

2. Amino-acids.

3. Diamino-acids or the hexone-bases—histidin, arginin, lysin.

4. Nucleic acid and Purins—vernin and the purin bases guanidin, adenin, guanin, hypoxanthin, xanthin, allantoïn.

5. Lecithin and its decomposition-products—cholin, betaïn, amines, trimethylamine.

6. Alkaloids.

7. Glucosides and their decomposition-products, including hydrocyanic acid.

1. Our knowledge of the vegetable proteins has been greatly enhanced in recent years by the researches of Osborne and his co-workers in America. The various proteins in the seeds of most of the cereals, in a number of legumes and nuts, have been separated and examined. From wheat, Osborne and Voorhees(36)

have obtained by successive extraction with (1) dilute salt solution, (2) 70 % alcohol, (3) 0·2 % alkali, the following:—

Edestin......	0·6 %	globulin	sol. in salt solutions	separated by dialysis.
Leucosin....	0·3	albumin	sol. in salt solutions	separated by heat-coagulation.
Proteose....	0·6		sol. in salt solutions	remains in solution.
Gliadin......	4·2	sol. in 70 % alcohol		Gluten.
Glutelin.....	4·0	sol. in dil. alkali		Gluten.
	9·7 %.	Total proteins in wheat flour.		

In a similar manner they have obtained from maize three globulins, two albumins, and the alcohol-soluble protein, zein(37). From the pea (*Pisum sativum*) three proteins were isolated,(38) viz., two globulins—legumin and vicilin, and the albumin legumelin.

The legumin of peas and beans, and the gluten of wheat were the earliest known of the plant-proteins, having been discovered more than a hundred years ago. They were classed with the "sanguigenous compounds" of the early chemistry. On this heterogeneous group the first light dawned with the classical researches of Ritthausen in 1872, which are summarised in his book "Die Eiweisskörper der Getreidearten." For the extraction of proteins he used dilute acids and alkalies as solvents, but these have since been proved to alter the proteins and are now given up.

Osborne in obtaining legumin from the garden-pea, first made an extract with 10 % sodium chloride solution, from which the total proteins were precipitated by salting out with ammonium sulphate. The proteins were redissolved and dialysed free from salt, when the globulins were rendered insoluble and the albumins remained in solution. The precipitate of globulins was next dissolved in dilute salt solution and fractionally precipitated by different concentrations of ammonium sulphate. He found that up to six-tenths saturation precipitated legumin, while above this strength up to complete saturation precipitated the vicilin. The legumin thus obtained was purified, and hydrolysed by boiling with acid, the product esterified by Fischer's new method,(39) and the esters separated by fractional distillation; from the various fractions the amino-acids were obtained. A second part was then hydrolysed, and the hexone bases separated by the method of Kossel and Kutscher.(40) Since legumin is one of the best known and typical vegetable globulins, I give the results of its cleavage in full.(38)

Glycocoll	0·38 %	Serin	0·53 %
Alanin	2·08	Tyrosin	1·55
Leucin	8·00	Arginin	10·12
Prolin	3·22	Lysin	4·29
Phenylalanin	3·75	Histidin	2·42
Aspartic acid	5·30	Ammonia	1·99
Glutaminic acid	13·80	Tryptophane	present.
			57·43 %

Many individual proteins were separated from seeds by the early workers, and much controversy took place as to the identity of the products from the same group of plants. Thus we are familiar with a number of edestins from different plant-seeds, these being the proteins soluble in dilute salt solutions and which crystallise on cooling. Similarly the phosphorus-containing proteins were called vitellins. It is only since Fischer supplied us with his new method for separating the hydrolytic products, that we are able to say definitely whether any two proteins are chemically the same or different. For example, Osborne found that the globulins from the pea, bean and lentil agreed in properties and composition, but differed widely from the proteins of other legumes. Then the edestins from different plants all have the same physical properties but the hydrolytic products vary in amount.

On the other hand, a similar yield of hydrolytic products may not mean physiological identity of two proteins, for the recent results of Relander(41) show that the precipitin reactions are quite different with the proteins from the same plant-species and variety.

In plants the group of proteins which appears to be most largely represented is the globulins. Though we have long been familiar with the physical properties of these, bio-chemists are now actively engaged in examining their exact chemical nature by the new methods just mentioned. A few of the most characteristic of these globulins are the legumin of peas, phaseolin of beans, edestins of cereals and many other seeds, excelsin of the Para-nut, conglutin of lupins, amandin of almonds and peach stones, avenalin of oats, corylin of the walnut.

In the differentiation of the globulins and albumins our methods have quite recently undergone a fundamental change, chiefly through the exact experimental work of Osborne on plant-proteins, and Mellanby on animal-proteins. Hitherto we have been guided by the teaching of Hammersten, that complete saturation with magnesium sulphate precipitated globulins only, and of Hofmeister that the same result was obtained by half-saturation with ammonium sulphate, and these statements were comprehended in the definitions. Osborne and Harris(42) have now proved the utter impossibility of separating vegetable globulins from albumins by means of their ammonium sulphate precipitation-limits; in the curves there exist no definite breaks such as are necessary for the assumption that different proteins are precipitated by certain concentrations of salt. Mellanby(43) obtained 47 % of serum-protein by complete saturation with magnesium sulphate and 71 % by half-saturation with ammonium sulphate, and these were assumed by the old definitions to be interchangeable as globulin-precipitants. There is in fact only 3 % of globulin in serum-proteins. The same author has succeeded in obtaining a correct differentiation of the serum-proteins into a globulin and two albumins by fractional precipitation with various strengths of alcohol.

Albumins are distinguished from globulins by the complete absence of the glycocoll-nucleus. They are soluble in pure water, while the globulins are quite insoluble. In treating seeds with distilled water globulins also go into solution by the presence of soluble inorganic salts in the seeds; we are therefore really extracting with a dilute salt solution. The separation is made by dialysis, when, on complete removal of all salts, the globulins are rendered insoluble.

3. The group of alcohol-soluble proteins includes the gliadin of wheat, zein of maize, and hordein of barley. They contain no glycocoll or lysin nucleus in their constitution, but are rich in

glutaminic acid; hordein, for example, contains over 41 %, which is the largest amount of any hydrolytic product obtained from proteins.(44)

Rosenheim(45) states that rice contains no alcohol-soluble protein, but the chief constituent is the glutelin named by the author oryzenin.

5. The nucleo-proteins are present in all seeds. By the action of enzymes they are split into nuclein and protein; the former is further broken into nucleic acid and protein, and thus we find both of these proximate hydrolytic products in most seeds.

The phyto-toxins are a group of powerful plant-poisons closely allied in properties to certain animal-toxins such as snake-venom, spider- and bee-poisons, and, like the latter, produce solution of red blood-corpuscles. Ehrlich's first experiments on immunity were carried out with phyto-toxins. There is considerable evidence now to show that these are proteins conjugated with a toxic nucleus. They include ricin from the castor-oil plant, abrin from *Abrus precatorius*, and crotin from *Croton tiglium*. Phallin from the deadly mushroom, *Amanita phalloides*, was, until recently, classed among these as a phyto toxalbumin mainly on the results of Kobert's work, but Abel and Ford(46) have now proved that phallin is a nitrogenous glucoside. The remarkable fact may be noted that an antitoxin was prepared to the hæmolytic action of phallin, and should this be confirmed it will be the first instance of the formation of an antitoxin to a substance other than a protein and of known chemical constitution.

6. Proteoses and peptones have been found in small quantities. Frankfurt(47) found the former in the resting germs of wheat; they do not accumulate in seedlings, but decompose soon after their formation.

Non-protein Nitrogen Compounds in Seeds.—Nitrates have not been detected in any seeds yet examined, but traces of ammonia are often present in the aqueous extracts; the existence of the latter in the ungerminated seeds is, however, doubtful, as it may result from the change of unstable amino-compounds or even of proteins during the extraction.

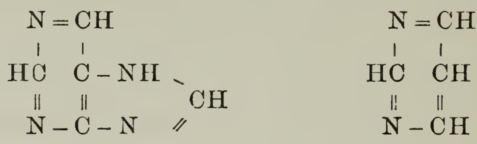
1. Amides are apparently not present in the reserve-material of seeds. Schulze and Castoro,(48) working on a kilogram of leguminous seeds, after having separated the proteins and boiled the solution with acid (to decompose amides), could not obtain any reaction with Nessler's solution, and therefore amides could not have been present. The same authors(49) were able, however, to separate a very small amount of asparagin from the embryos of wheat-grains. Acton(50) compared old wheat that had been stored for twenty-eight years with new seeds from the same field, and found no amides in the latter, while the dead seeds contained 0·8 %, probably the result of ferment-action at an earlier stage.

2. Amino-acids are the simple raw material out of which proteins are synthesised, and since the reserve-proteins are formed and secreted in the seeds during their growth it is evident that a transportation of this raw material to the seeds must take place. One would therefore expect to find amino-acids during the early stages of seed-formation, but the few investigators who have examined seeds in most cases have obtained negative results. Ritthausen searched in vain for amino-acids in those seeds richest in proteins, namely the leguminosæ; and Schulze, too, has long sought for the same with a similar result, except that a very small amount of tyrosin was obtained from 500 gms. of *Lupinus luteus* seeds(51). Tyrosin is the most insoluble of the amino-acids, and has definite colour-reactions, hence is the one most easily detected. These negative results, however, are no proof of the absence of amino-acids, as in the uncrystallisable syrups invariably obtained on evaporating the solutions our imperfect methods scarcely allow of finding small quantities, and the crystallisation is prevented by the large proportion of impurities.

3. Diamino-acids, mainly arginin, have been recognised in resting seeds by Schulze and Castoro(51). From *Lupinus luteus* they obtained 0·4 % of arginin, and from *L. albus* 0·02 %; the presence of histidin was indicated, but in quantity too small for identification.

4. Nucleic acid, a product of the hydrolysis of nuclein in cell-protoplasm and nuclei was isolated from plant-seeds first by Osborne and Harris.(52) The nucleic acids are glucosides, and yield on hydrolysis a pentose sugar, purin bases, pyrimidin bases and phosphoric acid; these vary with the different sources. From the resting embryos of wheat the above authors separated 3·5 % of tritico-nucleic acid; they also noticed that, in meal which had been stored for some time, the nucleic acid had disappeared. The hydrolytic products were identified as amino-purins—guanin and adenin, resembling the animal nucleic acids; but the pyrimidin base was represented by uracil (dioxy-pyrimidin), while in that from animal sources it is usually thymin or a mixture of thymin, cytosin and uracil (one, two, or all three); on the other hand, thymin has not yet been obtained from plant nucleic acids.

Since the pyrimidin structure is contained likewise in the purins it has long been discussed whether the former do not owe their origin to a cleavage of the purins during hydrolysis.



The nucleic acids combined with protein form the most essential part of all germ-cells, and the presence of a carbohydrate group in these is of peculiar interest. Most of our recent knowledge of the nucleic acids we owe to the classic researches of Levene.

Vernin is another peculiar body, also possessing the constitution of a purin-glucoside, discovered by Schulze(53) in 1886, in *Lupinus albus*, and so named by him. He found it in various species of Lupinus, Vicia, and clover, from the aqueous extracts of which it was precipitated by mercuric nitrate. To this substance Schulze has ascribed the formula $C_{16}H_{20}N_8O_8$; and, after hydrolysing it by boiling with acid, he obtained as cleavage-products guanin and a pentose sugar(54). The amount of vernin present in lupin seeds is very small, being about 0·025%.

The purin bases were first observed in plants by Schützenberger, who found them in yeast. Kossel(55) noticed that, by long-continued boiling with water, the nucleins of yeast break up and purins, chiefly hypoxanthin, are obtained; the latter was isolated from black mustard-seeds, wheat, lupin-seeds, and spores of Lycopodium. Chittenden,(56) too, has shown that, by boiling fibrin with water for twenty-four hours, small quantities of hypoxanthin were obtained; and, further, that protein, when warmed for several days in contact with gastric or pancreatic juice, yielded hypoxanthin. Now when seeds are extracted with cold water, the ferments accompany the proteins into the extract; and so we have all the conditions for incipient hydrolysis and formation of traces of purin. This fact has to be remembered in examining such substances for small quantities of these bodies.

Xanthin and the methyl-xanthins have been known, for well nigh a century, to be present in tea and coffee seeds, in cacao seeds, and in cola-nuts.

Hypoxanthin is present in most leguminous seeds, in seeds of cereals and a number of other plants.

Guanin has a very wide distribution; it was obtained by Schulze(57) from a large number of leguminous seeds.

Allantoïn, which is a decomposition-product of trioxypurin, was discovered in the bran of wheat by Richardson and Crampton,(58) and confirmed by Schulze(59); the amount present was about 0·5 %.

5. Lecithins.—The phosphorus-containing constituents of plants which are dissolved out by absolute alcohol and ether, are grouped together under the new name of the phosphatides(60). They include true lecithins, and also certain compounds of lecithin-like bodies with carbohydrates, etc. The most recent work on the plant-phosphatides is that of Winterstein,(61) who discovered that these complex bodies yield, on hydrolysis, hexoses and pentoses in very varying amounts; as, for example, those isolated by ether from *Triticum vulgare* contain 16 % of carbohydrate (galactose and d. glucose), from *Lupinus albus* 13 %, from *L. luteus* 1 %, and from *Vicia sativa* 3 %. It is not yet known whether these are

present originally as hexoses or polysaccharoses, but it is an interesting fact that, hitherto, we have known no carbohydrates soluble in ether and almost insoluble in water. Their presence in these complex phosphatides and in nucleic acid points to a resemblance in constitution to jecorin, which Drechsel isolated from the liver, and to the crystalline cerebrins from the brain, and forms another relation between animal- and plant-chemistry.

True lecithin, as an individual plant-constituent, was first discovered in yeast in 1866 by Hoppe-Seyler,(62) who also recorded the fact that both lecithin and cholesterin occur generally in plant-seeds.

When seeds are extracted with hot absolute alcohol, the whole of the fat goes into solution together with waxes, lecithins, and the phytosterols or plant-cholesterin. The solvent is distilled off, and the residue extracted with ether which dissolves the lecithin and leaves behind all other phosphorus-compounds. The amount of phosphorus in the ether solution is estimated, and from this is calculated the percentage of lecithin. Jacobson(63) has estimated the amount of lecithin in a number of leguminous seeds, and finds that from 6 to 30 % of the fat is lecithin. Schulze obtained from beans 1·64 %, from *Lupinus luteus* 1·5 %, and from *Vicia sativa* 1·22 % of lecithin in the dried seeds.

The hydrolysis of lecithin, and also its synthesis, is generally assumed to be brought about by the lipolytic ferments, the products of hydrolysis being chlorin, glycero-phosphoric acid, and fatty acids. Rosenheim has shown that cholin is present in all animal organs where there is great cell-activity and tissue-disintegration; it is also present in plant-tissues and seeds. The various lecithins are distinguished by the particular fatty acids in their composition, most plant-lecithins containing both saturated and unsaturated acids, viz., stearic, palmitic, oleic, and linoleic. According to Koch, the specific characters are due to the unsaturated acids, and it may be that these convey the property of linking on such organic compounds as carbohydrates, proteins, glucosides, and alkaloids, which are known to combine readily with lecithin. The first clue to the proper function of lecithin was supplied by the discovery of Preston Kyes(64) that, in snake-poisoning, lecithin is the amboceptor which links the venom to the body-cell and brings about its destruction. The opinion is now growing that the assimilation of foodstuffs by the living cells whereby the latter are nourished, is analogous to the action of those toxins. We now see that lecithin stored up in the reserve-material of seeds is destined to play a profound physiological rôle, if not the chief part, in those enormous synthetic activities incited by germination.

Among the decomposition-products Schulze obtained cholin from the ungerminated seeds of *Vicia sativa*, *Pisum sativum*(65), and wheat(66); also Maxwell has isolated it from cotton-seeds.(67) Betaïn, an oxidation-product of cholin, is also found associated with the latter in the seeds mentioned above. In the seeds of the mustard, *Sinapis nigra*, occurs the alkaloid sinapine, which is readily decomposed into sinapic acid and cholin. The latter therefore is frequently found in the seeds, with the alkaloid. Cholin has the widest distribution of all plant-bases, which is to be accounted for by the fact that it is a constant product of the decomposition of the phosphatides present in every living cell, and therefore intimately concerned in the vital processes of the plant.

Trimethylamine results from the decomposition of both cholin and betaïn, and, therefore, also, of the phosphatides. It was discovered in Chenopodium by Dessaignes(68), in 1851, and has also been found in seeds of beech, hawthorn and a few others. Wicke(69) showed that it existed as such, and accumulated in the plants, and was not formed during the distillation with alkali. Other alkylamines hardly ever occur in plants, except in decay.

6. Alkaloids.—Concerning the alkaloids, we must note their vast distribution in the vegetable kingdom; they have been found in almost every family of plants. Very often an alkaloid is characteristic of a family or even of a plant-species. Some plants contain a number of alkaloids, but then it is found that these are closely related chemically. We meet them in some of our commonest feeding-stuffs, for example, trigonelline which

Schulze(70) found in peas, oats, and flax; vicine in *Vicia sativa* and *V. Faba*; the three lupine alkaloids lupinine, lupinidine, lupanine; and many others.

The vegetable alkaloids are built upon the structures of certain well known hetero-cyclic bodies—pyridine, quinoline, and acridine. Very little is actually known of their antecedents in vegetable metabolism, but here again Latham(71) has given us some valuable suggestions of possible methods by which we can trace their relation to the proteins. By starting with acetic acid and passing through the cyanide stage, we can obtain pyruvic acid, $CH_3CO{\cdot}COOH$; the latter condenses with hydrocyanic acid, ammonia, aldehydes, etc., to form amino-acids, amides, pyridine, quinoline, pyrrol and indol. Quinoline-derivatives may also be obtained by the union of certain aldehydes with amino-benzaldehyde, which suggests that benzaldehyde may be a constituent of living protein.

7. The glucosides containing nitrogen are mainly the cyanogenetic compounds, and these have a far wider distribution than is commonly believed, if it be accepted that they are the only precursors of hydrocyanic acid in plants. The latter has been produced from considerably over a hundred different plant-species, many of which are of great economic importance, such as cassava, sorghum, vetches, maize, beans, seeds of para-rubber tree, etc. Out of the vast number of plants in which cyanogen occurs, only a very few glucosides have been isolated and their constitution made known. The chief of these are—

Amygdalin(72) from almonds and the seeds of a number of other plants.

Sambunigrin(73) from the elder-berries.

Dhurrin(74) from the sorghum or Indian millet.

These three, when hydrolysed, split off hydrocyanic acid, benzaldehyde, and sugar.

Phaseolunatin(75) from *Phaseolus lunatus* (Lima-bean), flax and cassava. This yields hydrocyanic acid, acetone and glucose.

Lotusin(76) from the lotus-plant of the Nile, and also from the *Lotus australis*. In this glucoside alone, the sugar is directly united to the cyanogen-group, the third residue being the lotoflavin dye.

Fischer(77) has shown that the glucosidoclastic enzymes may be divided into two classes according to whether they act on glucosides derived from α-glucose or β-glucose(78) respectively. The glucosides, therefore, exist in two stereo-isomeric forms, viz., α- and β-alkyl ethers of the hexoses, and the enzymes are correspondingly described as α- and β-enzymes. As a type of the first class the maltase of yeast may be taken, and of the second the emulsin of bitter-almonds. It would seem that a certain relationship must exist between the configuration of the glucoside and that of the enzyme which is capable of hydrolysing it, although the latter need not be specific in each case. Dunstan and Henry have also shown that their phaseolunatin is the only natural α-glucoside(79) so far obtained, all others yielding the β-hexoses on hydrolysis by enzymes; but the two sugar-molecules of amygdalin appear to be α and β, the former alone being liberated by maltase.

Concerning the significance of these compounds in plant-physiology, we have some interesting investigations by Treub and Soave, who discarded the old idea of protective poisons and waste-products, and raised them to a higher level. Treub(80) found both free hydrocyanic acid and glucoside existing together, and by increased assimilation there follows an increase in the amount of both. Soave(81) showed that hydrocyanic acid first appears in the seed at the commencement of germination, and that the amygdalin is a reserve-substance of the seed. The results of Weevers(82) also show that many glucosides may act as reserves. The conclusions of these investigators are, that the cyanogenetic glucosides are transitional substances assimilating the inorganic nitrogen compounds and supplying the plant with food through the medium of the cyanogen-group.

These results lend further support to the hypothesis of Latham(83), who has shown how the formaldehyde of plants and the ammonia from the roots may give rise to hydrocyanic acid, and how the latter unites with formaldehyde to form a series of cyan-alcohols, through which he has synthesised nearly all the products of protein-hydrolysis. By noting the common antecedents of the synthetic products he concludes that both hydrocyanic acid and benzaldehyde, among others, may be the earliest products formed in the synthesis of protein. It must be remembered that those reactions, which are so difficult to perform *in vitro*, take place with ease when catalysed by enzymes; for instance, the synthesis of amygdalin was accomplished by Emmerling(84) from glucose and one of the cyan-alcohols with the maltase of yeast, and salicin(85) was synthesised with emulsin.

All these are evidence that the cyanogenetic glucosides are not end-products but that they may function as reserve-material, and by their slow hydrolysis supply the active substances which are known to make the precursors of protein. When the hydrocyanic acid is liberated from these stores by enzyme-action, and is not consumed just as fast in the synthetic process, then it must accumulate, and we are enabled to detect its presence. Frequently it has been noticed that hydrocyanic acid is detected only in very young plants, and, as they grow older, that it gradually disappears. We have instances of the result of this in the poisoning of cattle when young green fodder, especially legumes, has been eaten.

A number of different nitrogenous glucosides have been isolated from various plants, but beyond the fact that the simple hydrolytic products are hydrocyanic acid and sugar, very little is known of their constitution. Among them may be mentioned vicianin(86) discovered by Bertrand in *Vicia angustifolia*, sinalbin and sinigrin of mustard-seeds, solanin in the species of Solanum, and indican from Indigofera.

The Bio-Chemistry of Germination.

When the necessary conditions of moisture and temperature exist, certain physiological and chemical changes are initiated in the seed. The hypnotic stage has ended, and a sudden activation of the zymogens or pro-ferments takes place, by which very active enzymes are rapidly formed. These bring about the hydrolytic changes in the seed-constituents, the insoluble stored material being split into simpler and soluble substances fit for translocation.

Enzymes.—The protein-splitting enzymes of plants have been divided into three groups according as they partake of the nature of the pepsin, trypsin, or erepsin of animal juices. Considerable difficulty was met with in identifying the true nature of these; it was usual to describe as peptic those enzymes which acted only in acid solution, while tryptic enzymes worked in alkaline solutions. But some are active in both, others are destroyed by both acids and alkalies, and others again act only in presence of very weak organic acids. Now all these difficulties are vanishing in the light of Fischer's work, for none of his synthetic polypeptides (conjugated amino-acids) have as yet been split by pepsin, while they are rapidly decomposed by the pancreatic enzymes. This has caused a complete revision of the classification of plant-enzymes, in which the work of Abderhalden stands out conspicuously. A specially favourable peptide for this purpose is glycyl-l-tyrosin, an optically active compound of the two amino-acids. When split, its components are easily demonstrated by the insolubility of tyrosin and the HCl-ester of glycin, while the method of proving the unchanged dipeptide is very definite and certain. Further, the strong rotation in the polariscope is rapidly negatived if cleavage takes place, as the simple amino-acids are optically inactive in water-solutions; this change of the rotation is seen immediately on commencement of hydrolysis.

Abderhalden(87) has used glycyl-glycin, glycyl-tyrosin, leucyl-glycin, etc., and has shown that the endotryptase of yeast is a tryptic ferment, so also is papaïn; while on the other hand with juice of Nepenthes, which, in its pitchers, is capable of digesting meat in a neutral solution, almost no hydrolysis took place; it is therefore not of the nature of trypsin. Abderhalden has also studied the effect of the proteoclastic ferments of germinating seeds on the polypeptides, by bruising the seeds in a mortar with sand, and expressing the juice under three hundred atmospheres pressure. All the polypeptides tried were split by the press-juice from seedlings of legumes and cereals; and, further, when racemic peptides were used, the hydrolysis took place on one-half only of the racemic body. The cleavage of these simple di-peptides gives us a clearer insight to the larger cleavage of the protein-molecule, which is really constituted by the linking of these simple units, the amino-group of one united to the carboxyl group of the next.

The investigations of Vines(88) have proved the presence in plants of distinct peptoclastic enzymes. These belong, therefore, to the group of erepsins which begin their work at the proteoses and peptones. Considerable evidence has now accumulated to show that in plants the proteoclastic enzymes are of the nature of pepsin, while the hydrolysis is completed by various peptoclastic erepsins; and what we formerly regarded as trypsin is a mixture of members of the peptic and ereptic groups of enzymes.

Protein-transformation in germination, (a) *Katabolism.*—It has been repeatedly proved by experiment that the absolute amount of nitrogen in seeds and their seedlings does not change; equivalent weights of material therefore contain the same amount of total nitrogen. The change in form of the nitrogen-compounds during germination is illustrated by the following experiments of Schulze.(89)

	Lupinus angustifolius.		*Zea Mays.*	
	Protein N	non-prot N	Protein N	non-prot. N
Resting seeds..............	92·89 %	7·11 %	97·95 %	2·05 %
3 days' seedlings..........	84·13	15·87	95·82	4·18
6 ,, ,, ...	48·31	51·69		
9 ,, ,, ...	34·73	65·27	91·62	8·38
12 ,, ,, ...	28·67	71·33	85·30	14·70
16 ,, ,, ...	22·33	77·67	66·67	33·33
18 ,, ,, ...	22·78	77·22		
	per cent. of the total N			

In these two types of germinating seeds a great difference is noticed in the rate of decomposition of the proteins. Schulze explains this by the unequal enzyme-content of each.

Let us examine the nature of the substances represented by the second column of figures, in which it is seen that non-protein nitrogen is increasing rapidly with development. Here Schulze found different amino-acids appearing at particular periods. During the first six days leucin, tyrosin and the hexone bases were present; and, on about the sixth day, the relative proportions of these was the same as that obtained by acid-hydrolysis. But gradually these decreased till, in the two or three weeks' seedlings, tyrosin had disappeared entirely, leucin and arginin were only found in traces, and often none at all. Their place was now taken by other amino-acids(90) such as phenylalanin, amino-valerianic acid, α-prolin, iso-leucin, and tryptophane.

Different plant-species produce different amino-acids; and again, even in the same species, these vary according to whether the plant has developed in light or in the dark. Therefore it is apparent that the protein-molecule in the various plant-species does not decompose in the same way, and even in the same species is this true. Most of the known hydrolytic products of protein have been isolated at various stages of germination.

The fact that considerable quantities of amino-acids exist in the early stages of growth, and that these gradually disappear to a small remainder, is explained by Schulze's experiments.(91) He says that these primary decomposition-products are further broken down, yielding a nitrogen-containing residue (perhaps ammonia) which is used up for the synthesis of asparagin and glutamin.

We may now renumerate the different compounds which have been found in germinating seedlings. (1) The proteins and their cleavage-products, viz., proteoses, polypeptides, amino-acids, and ammonia. The mono-amino-acids—leucin, iso-leucin, tyrosin, phenylalanin, valin, prolin, and tryptophane; the diamino-acids—histidin, arginin, lysin; the amides—asparagin and glutamin. Besides these we find the hydrolytic products of the other seed-constituents. (2) From nucleo-proteins the purin bases are split off by the nuclease enzyme; other enzymes then remove the (NH_2) group from the amino-purins, and adenin passes into hypo-xanthin, guanin into xanthin, and by decomposition of these we get guanidin and allantoin. (3) From the phosphatides, chiefly lecithins, result cholin and betaïn; and by the further decomposition of these, trimethylamine. (4) The glucosides yield their hydrocyanic acid, aldehydes, hexose and pentose sugars.

(b) *Anabolism.*—The decomposition of the reserve proteins in the seed is followed by the regeneration of protein from the cleavage-products, and in our experiments it would be almost impossible to distinguish the katabolic from the anabolic compounds. But since the formation of protein greatly decreases in absence of light, we are thus enabled, by etiolation of the seedling, to obtain an accumulation of the intermediate bodies, *i.e.*, of the precursors of the proteins.

Now when the amino-acids are observed to decrease gradually as stated above, there is a corresponding increase in the amount of amides—asparagin, glutamin, and others. The following example, also from Schulze's results, shows this increase.

The nitrogen of asparagin in etiolated seedlings of *Lupinus angustifolius* :—

Resting seeds.	1-week seedling.	2-weeks' seedling.	3-weeks seedling.
Nil.	27 %	54 %	60 %

per cent. of the total nitrogen present.

The amino-bodies are not always consumed at the same rate or in the same proportion; some are used up almost immediately, while others, such as arginin in *Lupinus luteus*, accumulate, the formation of the latter in hydrolysis exceeding its consumption. Then again, asparagin and glutamin often replace each other, as, for example, in Cucurbita seedlings some cultures contained large amounts of glutamin and only a little asparagin, while others contained only the latter, glutamin not being found.

When seedlings are subjected to aseptic autodigestion, there are formed, by zymolysis, mono- and di-amino-acids, and ammonia. Castoro(92) in one experiment found the amount of ammonia present to be about 0·2 % of the dry weight. Many investigators have believed that this ammonia is not the result of oxidation of protein, but of the activity of special enzymes, which Shibata(93) names amidases, acting on amides. On the other hand we have the experimental evidence of Suzuki(94), which shows that, by addition of ammonium salts to the seedling, the amount of asparagin was greatly increased. When the etiolated plants were grown in a space free from oxygen, there was no increase; while those plants grown in oxygen showed a large increase. He then concludes that oxidation-processes play a part in germination. Schulze has, in fact, found oxidation-products. During development, the organic sulphur from the decomposing proteins is oxidised to sulphate, and the latter increases with development. A second case was discovered by Bertel(95), who showed in *Lupinus luteus* the fate of tyrosin, how by an enzyme it is oxidised to homogentisic acid, and, finally, by oxidation the ring is completely destroyed. This change includes the addition of (OH) groups, and the casting out of (NH_2), the latter being equivalent to the formation of ammonia. Then by asphyxiating the seedlings with chloroform, *i.e.*, preventing oxidation, Bertel caused the tyrosin to accumulate in large quantities. A number of peroxidases have been discovered, together with the peroxides upon which they act.

Castoro(92) examined seedlings at various stages for ammonia, and found that, even after several weeks growing in the dark, the maximum was only 0·13 % of the dry material. It is very significant, therefore, that the ammonia does not accumulate in the living seedling, and that the amount present is only very small. Schulze's important conclusion(96) is that, in the metabolism, the ammonia is used up, and that, most probably, it is used in the synthetic formation of amides. These amides are, therefore, secondary products, and owe their origin to the primary compounds. He adds, further, that it is also possible for a limited quantity of amides to originate direct from the cleavage of protein, as it is well known that aspartic and glutaminic acids are always obtained by acid- or alkali-hydrolysis; and, by careful enzyme-hydrolysis, the amides may be obtained direct.

These are the views of Schulze, as proved by his experiments on the metabolism of seedlings, supported by the work of Balicka-Iwanowska(97) in 1903, and Prianischnikow(98) in 1904. The accumulation of asparagin in etiolated seedlings was first proved by Pasteur, in 1851; and Pfeffer, in 1871, proved that the cause of this accumulation was the lack of sufficient carbohydrate. The amide, glutamin, on the other hand, Schulze(99) first separated, in 1895, from the beet.

The second stage in the synthesis is shown by the disappearance of the accumulated amides when the plant is grown in the sunlight, and the simultaneous formation of protein, as if certain of the products of carbon-assimilation were necessary. All evidence points to the latter being carbohydrates, since, if these be supplied, the protein-formation proceeds in the dark. Brown and Morris(100) have shown that all foliage leaves contain diastase in varying quantities, and that leguminous leaves have an enormous diastatic activity; *Pisum sativum*, for example, contained sufficient of the enzyme to convert 24 times its own dry weight of starch into sugar in two days, while most of the non-leguminous plants had a value less than 1. It is significant that we have here an unfailing source of sugar in the particular plants which contain the largest amount of nitrogen-compounds on the upward grade.

The following table shows the distribution of amides in the seedlings of *Lupinus albus*(101) :—

Leaves	stalks	cotyledons	roots
6·6 %	21·1 %	17·6 %	10·2 % of amides

in the dry material, while the etiolated leaves of the same contained more than 17 %. The effect of carbon-assimilation is evident in the green leaves; asparagin disappears and protein is formed.

Now these facts are but a few isolated milestones on the upward track, with very long intervals between. We cannot see clearly why amides should suffice and amino-acids be insufficient in the synthetic processes. Is it that asparagin and glutamin form a halting stage, or common centre, upon which act both disintegrating and upbuilding forces, that many intermediate stages are quickly run through, that these are of infinitely labile compounds changing constantly, melting away into something else when we try to follow them with our imperfect methods, till at last we come to a stop and behold only the familiar milestones again?

Much new light has been thrown on this region by the extension of Latham's hypothesis(83) as to the synthesis of organic matter in plants. He shows methods of possible genesis of organic compounds from the first products of assimilation, and how by the well known steps of organic chemistry all the constituents can be prepared. Let us first consider the earliest stages of the synthesis. (1) Carbonic acid is reduced to formic acid, then to formaldehyde; formic acid unites with ammonia (absorbed by the roots), and the ammonium formate by dehydration yields hydrocyanic acid. (2) Then by means of aldehydes, hydrocyanic acid, and ammonia, we can obtain amino-acids,

$$\left.\begin{matrix}\text{aldehyde}\\ +\text{HCN}\end{matrix}\right\}\longrightarrow\left.\begin{matrix}\text{cyan-alcohol}\\ +NH_3\end{matrix}\right\}\longrightarrow\left.\begin{matrix}\text{amino-nitril}\\ +H_2O\end{matrix}\right\}\longrightarrow\text{amino-acid}$$

Latham regards these cyan-alcohols as the antecedents of the amino-acids in living protein. (3) By starting with acetaldehyde we can also obtain asparagin and arginin; from propionic aldehyde glutamin and lysin can be formed, and from benzaldehyde we can obtain tyrosin.

These practical methods of the laboratory are of great significance in that they show us where exist the articulations of the giant protein-molecule. They enable us to perceive how each of the small segments may be utilised as bricks for building; these may, however, not all be necessary in the living organism, for our most perfect synthetic methods are infinitely excelled by the ease with which the catalytic enzymes arrive at the same result. Protein has been decomposed by peptic and tryptic enzymes to amino-acids (not precipitable by 85 % alcohol); when these were concentrated to incipient crystallisation, and again subjected to the action of the same enzymes, it was found that the original protein was regenerated(102).

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THE RÔLE OF NITROGEN AND ITS COMPOUNDS IN PLANT-METABOLISM.

Part ii.—The Non-Protein Nitrogen in Seeds.

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(From the Physiological Laboratory of the University of Sydney.)

i. Until a few years ago the nitrogen of seeds was by many authorities looked upon as existing entirely in proteins. The total nitrogen found by analysis was multiplied by a factor, 6·3 (obtained from the average per cent. of nitrogen in protein) and the product written as proteins. We find this still not uncommon at the present time. The purpose of this paper, therefore, is to emphasise the fact that such is not the case; and also to record some remarkable results, in which it may be seen that, in some seeds, proteins account for little more than one-half of the nitrogen.

As is well known, when seeds commence to germinate, the insoluble protein-substances are changed by proteolytic ferments which suddenly appear by the activation of the pre-existing zymogens. We thus have all the soluble protein hydrolytic products, viz., proteoses, peptones, and amino-acids, etc., present in the germinating seeds. But, as to the composition of the ungerminated, resting seeds, there is scarcely any information available with regard to the distribution of their nitrogen.

The very few investigations which are available on this subject are the work of Schulze and his pupils at the Zürich Polytechnic, and published in "Die landwirtschaftlichen Versuchs-Stationen" and in "Hoppe-Seyler's Zeitschrift." In one of the first of his papers(1) dealing with this important part of plant-composition is a table of results, showing the ratio of the non-protein N to the total N in some common agricultural plants, of which the following are a few examples.

	Non-prot. N in the seeds.		Of the total N.
Legumes—Peas	0·543 %	=	11·4 %
Vicia Faba	0·562		11·4
Lupinus albus	0·790		10·3
Soy beans	0·668		10·1
Vetches	0·504		10·0
Lupinus luteus	0·628		8·8
L. angustifolius	0·410		7·7
Cereals—Wheat	0·240		11·2
Oats	0·125		7·5
Maize	0·090		4·9

We note that the *highest* figure was obtained for peas, 11·4 % of the total nitrogen existing in some form other than protein. Again, in coniferous seeds Schulze(2) found in

Abies pectinata	0 05 % of the seed	= 3·1 %	of the total N.
Picea excelsa	0·04 ,,	1·2	,,
Pinus sylvestris	0 03 ,,	0·5	,,

From the above it is also apparent that those seeds richest in nitrogen, viz., leguminous seeds, contain the largest proportion of non-protein nitrogen-compounds.

ii. Discussion of Methods.

The majority of investigators have used Stutzer's reagent (copper hydroxide) to separate proteins from plant-extracts; all the results quoted above were so obtained. On the other hand, the proteins of animal-extracts are usually separated by the tannin-salt method. Alcohol is also known to be a valuable precipitant, but has been very seldom used.

Since the whole value of the results depends on knowing exactly what is precipitated by the reagent in each of the above methods, it is absolutely necessary to know the full details of their work before we can compare the results of various experimenters. A further difficulty is met with in the fact that authorities are not agreed as to the completeness of the separation in each case, especially of proteoses and peptones.

In choosing the most convenient and suitable method for the work in hand, the following details were carefully considered. (1) As to Stutzer's method(3) precipitating too little(4)—peptones are not thrown down, or only very slightly; Stutzer, in his original paper, states that they are carried down with the proteins and cannot be washed out by water. He also states that albumoses are completely precipitated. On the other hand, Schulze, who has had great experience with this method, says that it is not known for certain whether albumoses are precipitated or not, and at least both proteoses and peptones are very incompletely precipitated(5). Suzuki(6) came to the conclusion that only certain groups of proteoses were precipitated, and in his experiments with the Lima-bean found the method unsuitable. Mellanby's(7) experiments with serum-proteins show that precipitation with copper salts was never complete; he could not obtain more than 85% of the protein. Next as to Stutzer's method precipitating too much, various authors have stated that the purin bases are partially precipitated, and we find that Schulze precipitates amides by warming with copper hydroxide. These are two highly important groups of substances in plant-extracts, and it is essential that we know exactly how they act towards the reagents.

(2) Tannic acid and salt solution was supposed to precipitate proteins and proteoses completely, while peptones are soluble in

excess of the reagent. It was first used by Schjerning(8), and is the chief method in use for measuring the progress of digestion-experiments. Hedin(9) uses for this purpose a solution containing tannin 7, salt 10, acetic acid 5, per cent. Bigelow and Cook(10) have shown that none of the amino-compounds are precipitated except creatin and diphenylamine. Alkaloids, and possibly other plant-bases as well, are precipitated, and these are present in the majority of seeds.

(3) Alcohol precipitates proteins, proteoses and peptones completely(11), and does not precipitate any other nitrogenous compounds. Mellanby's experiments(7) show that for each different protein there is a critical temperature below which the precipitate formed remains quite soluble, and above it the proteins are chemically changed and rendered insoluble; only the proteoses and peptones are precipitated in the soluble form. The precipitation with hot alcohol certainly appears the most convenient for use with plant-extracts; the tannin-salt solutions are very difficult to decompose in the Kjeldahl process, as they require careful watching on account of the constant frothing. The precipitation by copper hydroxide, though it is the method which has been almost exclusively used by Schulze and all the early workers, is evidently too indefinite except for comparative purposes; we hardly know how it acts, especially towards those obscure plant-bases which it is necessary to keep in solution.

The following preliminary experiments were carried out in order to test the difference in the above methods and for purposes of comparison.

Stutzer's reagent was prepared by precipitating a solution of copper sulphate and glycerol with potassium hydroxide, and the green ppt. washed free from alkali. The ppt. was then suspended in water with 10 % of glycerol added. Each 1 cc. contained 0·01 gm. of copper hydroxide. The tannin solution contained 10 % of tannic acid and 10 % of sodium chloride.

An aqueous extract of the seeds of *Acacia pycnantha* was made, and equal volumes taken for comparison of the above three reagents. The proteins were precipitated, and the nitrogen in each was determined by Kjeldahl's process, using 10 cc. of sulphuric acid, 0·2 gm. copper sulphate, and boiling till charring ceased; then 10 gms. of potassium bisulphate were added, and the boiling continued for three hours after the liquid cleared; the ammonia was distilled off in the usual way into $\frac{N}{10}$ acid.

(1) 50 cc. for determination of total N.

(2) 50 cc. were boiled with 20 cc. of Stutzer's reagent and 1 gm. of alum, filtered and washed, and the N estimated.

(3) 50 cc. were treated with 15 cc. of tannin-salt solution (*i.e.*, just in slight excess), centrifuged, washed with reagent, and the N determined in the ppt.

(4) 50 cc. were evaporated down to 10 cc., and poured into 90 cc. of alcohol 94 %, making the solution of the strength of 85 % spirit, heated to boiling, allowed to stand 3 hours, and filtered. From the filtrate the alcohol was then distilled off, and the N determined in the residue.

The above were done in duplicate, and the mean results are given below.

1. Total N....................	11·8 cc. $\frac{N}{10}$ acid	= 0·0165 gm. N.
2. N in copper ppt............	4·2	0·0059
3. N in tannin ppt...........	2 65	0·0037
4. N in alcohol filtrate......	8·95	0·0125

Therefore the non-protein nitrogen is represented by—

2. N in copper filtrate....................	0·0106 gm.
3. N in tannin filtrate........................	0·0128
4. N in alcohol filtrate.......................	0·0125

We may conclude from these figures that, in a solution such as the one used above, tannin and alcohol are practically equal in precipitating power; and, further, that peptones which were known to be present in the above extract are also precipitated by the tannin-salt reagent, the filtrates being biuret-free. Copper hydroxide precipitated 13 % more nitrogen than either of the other two reagents.

On looking over Schulze's results, a few of which are quoted at the beginning of this paper, it is observed that the maximum amount of nitrogen of non-protein compounds is about 11 % of the total nitrogen in the seeds. Now on making a rough extraction of Acacia seeds with dilute salt solution and precipitating the proteins, the nitrogen in the filtrate represented over 50 % of the total. This very large figure led to further investigation, and varying results were obtained according to the degree of fineness of the meal when ground. This is probably to be accounted for partly by the different amounts of spermoderm or skin which are included in the samples after passing through different sizes of sieves. It was decided to keep the outer skins on all the seeds. First, because in many it was almost wholly impossible to remove the skins completely; and second, since the latter are rich in both soluble carbohydrates and soluble nitrogen-compounds, it seems quite possible that these take a share in the supply of nutriment during germination. The skins may therefore be looked upon, from the chemical point of view, as an essential part of the seed-sample.

That the method of preparing the sample makes a considerable difference in the result the following table shows.

(a) Acacia seeds ground and passed through 1·5 mm. sieve.

(b) Acacia seeds ground and passed through 0·5 mm. sieve.

(c) Acacia seeds, skins entirely removed, ground and passed through 0·5 mm. sieve.

———	(a) coarse whole seed.	(b) fine whole seed.	(c) fine cotyledons only.
Total N in seeds...........	4·09 %	5·04 %	5·52 %
N not pptd. by alcohol...	1·63	1·70	1·71
=% of total N...............	40·00	33·75	31·00

Now it is observed from these that the non-protein nitrogen is the same in each, but the total nitrogen of the seed varies with the treatment.

It was further observed that in making an aqueous extract of the seeds considerably more nitrogenous material was dissolved by standing in the cold for twelve hours, than when boiled and filtered a number of times in succession.

iii. The Amount of Non-Protein Nitrogen in Seeds.

The following series of experiments with seeds of thirty different plant species was carried out by the *alcohol* method of separation. I may here recall the important statement of Henriques and Hansen, referred to in Part i. (*antea* p.811) that in their feeding experiments with the products of tryptic hydrolysis, only that portion soluble in alcohol sufficed for nutrition.

The samples were air-dried and put through a grinding mill, until almost the whole passed through a 0·5 mm. sieve. Two estimations were then made on each.

(1) The total nitrogen of the seeds.

(2) The non-protein nitrogen as represented by the nitrogen not precipitable by alcohol.

For the latter, 1 gm. of the sample was extracted with 200 cc. of cold distilled water by standing over night, boiled for 2 hours on the w.b., decanted through a filter, the residue again boiled with an equal volume of water for 1 hour and filtered, and the operation repeated a third time. This of course did not perfectly exhaust the seeds of their soluble nitrogen-compounds, but the amount left was inconsiderable. The combined filtrates were evaporated to about 10 cc., and poured into 90 cc. of methylated spirit. The proteins were thereby precipitated in 85 % alcohol. Heated to the boiling point in the w.b., and then allowed to stand for at least 2 hours. The protein ppt. was then filtered off; from the clear filtrate the alcohol was removed by distillation, and the nitrogen in the residue determined.

The results are arranged in descending order of the amounts in the third column. It is seen that *Acacia pycnantha* contains the highest amount, and also the highest ratio of non-protein nitrogen; and that all the Acacias tested are high. The average for the other leguminous seeds is 19 %, the lowest result being 15·7 %. The cereals contain the smallest amount of total nitrogen, and still the non-protein ratio is about the same as in the legumes; rye and wheat have conspicuously high values.

—			Total N of Seeds.	N not pptd. by alcohol	% of the total N
Acacias ...	1	*A. pycnantha*	5·04%	1·70%	=33·75
	2	*leptoclada*	3·22	·92	28·5
	3	*elongata*	3·86	1·07	27·6
	4	*penninervis*	3·25	·81	25·0
	5	*neriifolia*	3·53	·88	25·0
	6	*accola*	3·84	·84	21·8
Other legumes	7	*Phaseolus lunatus* (lima-bean)	4·03	1·04	25·8
	8	*Lathyrus odoratus* (sweet pea) ...	4·20	·86	20·5
	9	*Medicago sativa* (lucerne)... ...	6·50	1·30	20·0
	10	*Phaseolus multiflorus* (scarlet runner)	3·22	·61	18·9
	11	*Trifolium pratense* (red clover) ...	5·66	1·06	18·7
	12	*Phaseolus lunatus* var. (Madag. bean)	3·30	·62	18·6
	13	*Vicia Faba* (broad beans) ...	4·87	·90	18·5
	14	*Phaseolus vulgaris* (French beans)	3·78	·60	15·7
	15	*Pisum sativum* (peas)	4·37	·69	15·7
Cereals ...	16	*Secale cereale* (rye)	1·63	·47	29·0
	17	*Triticum vulgare* (wheat) ...	2·58	·63	24·5
	18	*Avena sativa* (oats)	1·71	·37	21·5
	19	*Fagopyrum esculentum* (buckwheat)	1·99	·35	17·6
	20	*Zea Mays* (maize)...	1·57	·27	17·2
	21	*Chattacchloia italica* (Hungn. millet)	1·71	·26	15·5
Miscel. seeds	22	*Quercus virens* (acorn kernels) ...	·45	·11	24·0
	23	*Sinapis alba* (white mustard) ...	4·26	·91	21·5
	24	*Ricinus zanzibarensis*	3·20	·62	19·4
	25	*Daucus carota* (carrot)	3·81	·66	17·3
	26	*Allium porrum* (leek)	3·28	·56	17·1
	27	*Brassica napus* (rape)	3·16	·53	16·9
	28	*Allium Cepa* (onion)	3·42	·57	16·7
	29	*Tropæolum majus* (nasturtium)...	3·19	·45	14·2
	30	*Olea Europæa* (wild olive) ...	1·01	·13	12·4

As stated above, these results were obtained from the seeds after only three extractions with water, they are therefore *minimum values*; successive extractions continue to remove small quantities. They are, however, precisely comparable, all having had exactly the same treatment.

The following experiment was designed to determine the maximum possible amount of non-precipitable nitrogen by successive extraction with dilute salt solution till no more was dissolved.

From the same stock of *A. pycnantha*, the age of which was about two years, a sample was taken, ground in a mill, and well mixed. This contained 4·5 % of N; 20 gms. were extracted for one day in the cold, with 1 litre of 10 % salt solution, and filtered. The residue was treated in the same way four times, then ground still finer, and the extraction repeated, till at the eighth time practically no nitrogen was found in the solution. In each of the eight salt extracts the proteins were precipitated by 10 % tannin solution in slight excess; the nitrogen in the original solution and in the tannin precipitate was determined.

20 gms. seeds extracted with salt solution, and extracts precitated by tannin. Results—

	N in tannin ppt. gm. (b)	N in tannin filtrate gm. (a—b)	Total N gm. (a)
1st extraction	0·2585	0·3230	0·5815
2nd ,,	0·0375	0·0680	0·1055
3rd ,,	0·0308	0·0127	0·0435
4th ,,	0·0154	0·0014	0·0168
5th ,,	0·0066	nil	0·0066
6th ,,	0·0090	nil	0·0090
7th ,,	0·0024	nil	0·0024
8th ,,	trace	nil	trace
Total N extracted	0·3602	0·4051	0·7653
N in exhausted resd.	0·1360	——	0·1360
			0·9013
N in orig. 20 gms. seeds (4·50%)			0·9000

This series of results shows that all the non-protein nitrogen is extracted after four successive treatments, and that it amounts to 2 gms.% of the seeds, as against 1·7% obtained by alcohol in the previous series. Of the nitrogen extracted by salt solution 53% or more than half is non-protein; and finally the amount of non-protein nitrogen, as represented by the part not precipitable by tannin, is equivalent to 45% of the total nitrogen of the seeds. Throughout this paper the term "non-protein nitrogen" is used to signify only that part of the total nitrogen which is not thrown down by the protein-precipitants used.

As previously stated, I have not been able, in the limited range of literature here available, to find any record of the non-protein nitrogen in ripe seeds exceeding 12%. *Acacia pycnantha* with 45%, therefore, stands out prominently as perhaps the highest yet found; and the high values obtained in the first series of experiments with thirty seeds materially alter our views with regard to the form in which the nitrogen of seeds exists.

In conclusion, I wish to express my best thanks to Professor Anderson Stuart for the use of his laboratory with every facility for my work, and to Dr. H. G. Chapman for many kind suggestions.

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CONTRIBUTION TO A FURTHER KNOWLEDGE OF AUSTRALIAN OLIGOCHÆTA.

Part ii. Description of a Tasmanian Phreodrilid.

By E. J. Goddard, B.A., B.Sc., Linnean Macleay Fellow of the Society in Zoology.

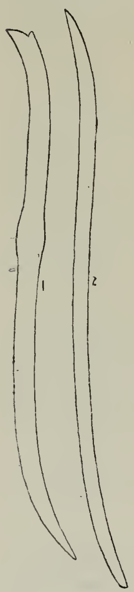
The present paper deals with the description of specimens of an immature worm obtained from small pools on the Mt. Wellington plateau, Hobart, Tasmania. In January, the month during which they were collected, the worms were abundant, moving about in the fine sediment in the small pools. Like so many of the aquatic Oligochæta, they are sexually mature at certain seasons, and in the case of the present form I am inclined to think that this condition is reached during the cold season of the year. This period of sexual maturity is, perhaps, of some interest in conjunction with the fact that the worm shows characters which should suffice to include it among the *Phreodrilidæ*, which family is so markedly Antarctic from a distributional standpoint.

The mountain regions of Tasmania, judging from the knowledge we possess of the habitats of the *Phreodrilidæ*, should offer special opportunities for the preservation of representatives of that family; so much so, indeed, that one is by no means surprised to learn of its occurrence in that island. No doubt further search will reveal the distribution of representatives of the family as being very wide in Tasmania.

The form under description may possibly represent a species of *Phreodrilus*, if what I have described as the probable remains of the spermathecal structures turn out eventually not to be such. The size of the worm and the size and nature of the setæ show a great resemblance to *Phreodrilus mauiensis*. Otherwise the worm is to be regarded as representing a new genus. This point, however, must be left over until such time as mature individuals are obtainable for examination.

The worm is not unlike *Phreodrilus mauiensis* in general external appearance and dimensions. The specimen of that species described by Benham was also unfortunately immature.

Body.—Length 17-20 mm.; breadth 0·5 mm.; consisting of 77 segments. Segments v.-xvi. are biannulate, at least on the ventral surface; and this appearance, though not quite so distinct, is again noticeable in the last thirteen segments. In the intermediate segments a faint trace of this biannulation appears at intervals. Prostomium conical, measuring 0·15 mm. from apex to base. No clitellar region can be made out, due to the immaturity of the specimen.



Figs. 1-2.*

Setæ.—No dorsal setæ can be seen in an examination of the entire individual, nor was I enabled to discern them in a study of sections. It may be that, owing to pressure, they have been broken, since their nature renders them more liable to such an accident than in the case of the ventral setæ. Ventral setæ are represented by two fascicles, one occurring on the latero-ventral region of each segment except in the case of the buccal segment, where, as in all Oligochæta, they are absent. Each fascicle contains two setæ, which differ from each other in size, shape, and the nature of the free extremity. In the case of the shorter seta the structure is stouter, more strongly curved, and approximating more nearly to a true sigmoid shape; there is a well expressed nodulus; the extremity is not simple, there being on the convex side of the curve towards the free end a well marked tooth. This form of seta measures 0·175 mm. In the case of the longer seta the structure is also sigmoid, but much more

* Figs. 1-2.—The two types of setæ in a ventral fascicle.

elongate and narrow, the curves being much less marked than in the case of the shorter seta; there is no trace of a nodulus; the extremity is simple. This form of seta measures 0·195 mm. Towards the posterior extremity the setæ are much more prominent than in the region anterior to the last dozen or so segments. In shape, size, and the character of the free extremity these setæ approximate very closely to those of *P. mauiensis.*

Digestive system.—The pharynx extends back as far as the posterior extremity of segment v. It is lined by a ciliated epithelium of tall columnar cells, outside which lies a loosely arranged mass of longitudinal muscle-fibres. The intestine is loaded with a mass of gritty material. Chloragogen cells make their appearance in the posterior region of segment vii., but are not pronouncedly developed anterior to segment viii., the region of the canal between segments v. and vii. representing the œsophagus. In segments vi.-viii., there is a paired mass of cells which take a deep stain with hæmatoxylin. These cells are pyriform in shape, the attenuated portion of each cell being directed ventrally so that the duct-like portions of the various cells tend to converge. Each cell has a nucleus of a spherical shape, with a deeply stained nucleolus. The character of these cells as regards shape, their large size, and the intensity of their staining affinity certainly suggests that they are glandular in function. No nephridia are to be made out in the three segments containing these glandular structures, so that it would seem that they are to be regarded as modified nephridia. In section a very noticeable feature is an arborescent appearance about the nephridia, the sections of the cells forming the boundaries of the intracellular portion of the nephridium appearing to be arranged alternately on either side of a central stem arranged dorso-ventrally, after the fashion of branches from the main stem of a tree. A similar arrangement is very noticeable in connection with the glandular structures described above, and which are to be regarded as peptonephridia, or nephridia which have undergone great enlargement and modification so as to act as salivary glands. A canal passes forwards from the mass of these pepto-nephridia to open into the buccal cavity.

Nephridia.—Mention of glands in connection with the alimentary canal has already been made, and these were regarded as modified nephridia. The first pair of true nephridia occurs in segment ix. No nephridia can be seen in segments x.-xiii. The nephridiopore is situated about the middle of each segment containing a nephridium, immediately anterior to the ventral chætæ between the anterior two-thirds and the posterior third of the distance separating the ventral seta from the anterior margin of the segment. The pore is very distinct, and leads into a flask-shaped bladder. The wall of this receptacle consists of polygonal cells whose limits are clearly made out, the nuclei taking a dense stain with hæmatoxylin. About eight of these cells would be cut by a section passing lengthwise through the bladder. The body of the nephridium extends up as far as the level of the ventral margin of the alimentary canal. The funnel is distinct, opening into the segment anterior to that containing the body of the nephridium. After leaving the funnel, the tube passes upwards parallel to the septum and then becomes twisted on itself spirally. This mass appears as a hump reaching as high as the alimentary canal. The first portion of the tube is intra-cellular, its wall being formed by a linear arrangement of cells with very granular protoplasm, their nuclei only representing cellular elements. Towards the top of the spiral loop or hump the cells, through which the tubule passes, have their cytoplasm not granular, but with a radial striation not unlike that of Hirudinean or Oligochæte muscle-cells. After again reaching the level at which the funnel lies, the nephridial tube passes into the bladder, to open on the exterior at the nephridiopore. The manner of folding of the nephridial tube on itself is such that, in section, the nephridium appears to have an arborescent form, nephridial cells alternating on either side of a main stem.

Reproductive organs.—There are present in the immature worms two pairs of gonads, in segments xi. and xii. respectively. Each gonad is pear-shaped, and attached to the anterior wall of the segment. They consist of a mass of spherical cells taking a deep stain with hæmatoxylin. There is no difference in the structure of the gonads of the two segments, except that those in xi. are much the larger, which would enable one on those grounds to suggest that one mass represented male and the other female

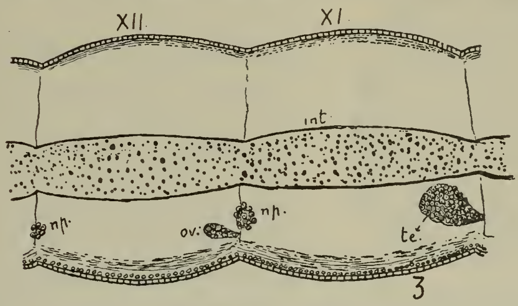


Fig.3.—Diagramatic representation of the genital segments. *int.* intestine - *np.* mass of cells which will become anterior end of gonoduct—*ov.* ovary—*te.* testis.

organs, the masses in xi. probably representing testes, and those in xii. ovaries. No gonoducts can be seen, but in association with the ventral region of the septum xi./xii., one can make out a mass of spherical cells on the anterior and posterior surfaces at what would be the level of a nephridial funnel. This mass represents the anterior end of what will eventually become the spermiduct. There are no traces of a nephridium in xii., and the spermiduct is no doubt afterwards developed by a growing backwards of a coelomo-duct from the coelomostome as in the "limicoline" Oligochæta after the disappearance of the nephridium. In association with the absence of a spermiduct in the immature worm, no trace of a spermiducal gland is present. In segments xiii., xiv., xv., xix. and xx., there is present above the digestive canal a spherical chamber, unpaired and isolated, without any connection between the members of the series. These structures I regard as the remains of spermathecæ from a fused condition as represented and initiated in *Astacopsidrilus*. These chambers measure 0·09 mm. in diameter. No traces of a spermathecal duct are visible. As to what relationship there may be between the nature of these chambers and the immaturity of the worm, I am not in a position to say, but I am inclined to regard them as representing a state of degradation of the posteriorly situated spermathecæ. The walls of the chambers consist of — (1) Inconspicuous flattened epithelium. (2) Circular musculature constituting the main portion of the wall. And (3) inconspicuous flattened epithelium. Within the chambers are present a great number of spherical or ellipsoid sacs, the mass of which are invested by a thin membrane isolated from the wall of the chamber. These sacs measure 0·008 mm. in the direction of their longest axis, and contain a mass of highly refringent granules similar, in themselves, to the granules which I have described in segment xii. in *Astacopsidrilus notabilis*, and in the epithelial cells of the spermathecal chambers of that species. In connection with some of the chambers there is a cellular mass having much the appearance of the corky tissue of plants. This, from its distribution, would seem to represent the portion which originally connected together the chambers themselves, the latter representing the swollen portion of the original spermathecal structures as the result of septation. No oviduct or female genital aperture is visible, but it is distinctly noticeable that the

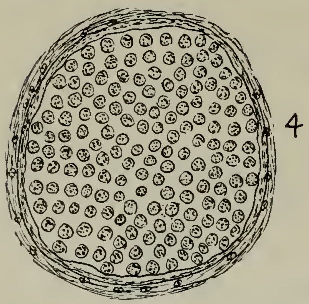
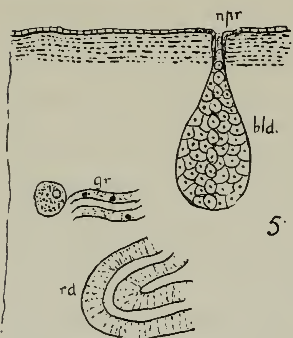


Fig. 4—A spermathecal (?) chamber, loaded with ellipsoid sacs.



* Fig. 5.

* Fig. 5.—Diagram showing different portions of a nephridium. *bld.* bladder—*gr.* portion of granular tubule—*ra.* portion showing striations —*npr.* nephridiopore

septum xii./xiii. is at the level of the mass of cells in association with xi./xii., pushed backwards so as to form a small ovisac; and in association with this are to be made out a mass of cells resembling those connected with the more anterior septum.

Remarks.—At the October Meeting of the Society I described two species of a new genus, *Astacopsidrilus*, belonging to the *Phreodrilidæ*, and was able to extend the distributional area of the family into more temperate regions in New South Wales. The present form is the first member of the family recorded from Tasmania, and its occurrence in that region is of some interest inasmuch as it completes the circuit of distribution from South America to New South Wales.

The number of genera now known definitely is three, and in all possibility the present form is to be regarded as the representative of another genus.

The known species and their regions of occurrence are as follows :—

PHREODRILUS Beddard (1891).

P. subterraneus Beddard (1891)—New Zealand; subterranean wells.

P. albus Beddard (1894)—Port Stanley, Falkland Islands.

P. pellucidus Beddard (1894)—Uschnia, South America.

P. niger Beddard (1894)—Port Stanley, Falkland Islands.

P. branchiatus Beddard (1894)—Valdivia, Chili.

P. lacustris Benham (1904)—Lakes Wakatipu, Manapouri, N.Z.

P. beddardi Benham (1904)—New Zealand.

P. mauiensis Benham (1904)—Lake Taupo, New Zealand.

P. Kerguelenensis Michaelsen (1902)—Kerguelen Island.

PHREODRILOIDES Benham (1907).

P. notabilis Benham(1907)—Blue Lake, Mt. Kosciusko, N.S.W.

ASTACOPSIDRILUS Goddard (1908).

A. fusiformis and *A. notabilis* Goddard (1908)—New South Wales; on *Astacopsis serratus* (Shaw).

Genus ?

Mt. Wellington, Hobart, Tasmania.

It is rather noteworthy that the representative species of the Phreodrilidæ occurring in Australia fall definitely into two well marked genera in distinction from the New Zealand, Kerguelen Island, and South American species which are all placed in the type-genus *Phreodrilus*. The Tasmanian form would seem, further, to show closer affinities to the Australian genera than to *Phreodrilus*, and it is of some value to note that one of the characters which stands out as distinctive of *Phreodriloides* and *Astacopsidrilus* against *Phreodrilus*, namely, the modifications in connection with the spermathecal structures, is apparently also noticeable in the Tasmanian representative.

The posteriorly situated spermathecal apparatus so characteristic of the *Phreodrilidæ* and *Lumbriculidæ*, I remarked in a previous paper as being very unstable in the former family, and this is apparently borne out in connection with that apparatus in the present form. In *Phreodriloides* the spermathecal apparatus, if represented at all, is denoted by the "autospermatheca"; in *Astacopsidrilus* there is in one species a tendency towards fusion, in another a complete fusion; and in both the ducts do not communicate with the exterior by means of a spermathecal pore; in the Tasmanian representative the same structure is represented apparently by a series of unpaired, non-connected chambers, and no signs of a duct are visible. In all known species of *Phreodrilus* the spermathecal ducts and pores are distinct; and in all probability that genus shows characters much closer to the ancestral member of the family, and closer affinities to the *Lumbriculidæ*. The Australian and Tasmanian forms are then to be regarded as specially aberrant forms, or otherwise as forms representative of conditions of structure grading into that of the *Tubificidæ*, and which have possibly undergone some degradation, that character being very probably associated with a change in the position of the spermathecal apparatus towards a condition characteristic of the earlier Oligochæta and of most existing representatives of that group. The Tasmanian form would seem to present the last phase of the spermathecæ before their disappearance, and to represent a condition intermediate between the state of affairs in *Astacopsidrilus* and *Phreodriloides*.

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CONTRIBUTION TO OUR KNOWLEDGE OF AUSTRALIAN *HIRUDINEA*.

Part ii.

By E. J. Goddard, B.A., B.Sc., Linnean Macleay Fellow of the Society in Zoology.

The single specimen of a leech, the description of which forms the subject of this paper, was obtained from a freshwater pool in the vicinity of Oberon, N.S.W. It differs sufficiently from that of any other well known member of the Hirudinea to warrant the institution of a new generic name.

This new genus finds its place in the Family *Herpobdellidæ*, one of the two divisions of the *Arhynchobdellidæ* as classified by R. Blanchard (1894), who gave as the characters of the family:—"Gula maxillis dentatis carens, quandoque tribus pseudognathis chitinosis inermibus ornata, uno medio infero, duobus lateralibus superis. Oculi 8 in duas series a pluribus annulis separatas dispositi, constantesque e duobus paribus anterioribus et duobus paribus posterioribus. Papillæ segmentariæ permultæ, non apparentes. Annuli 5-11 in somito integro, saepius dispares. Pori nephridiales in latere ventris hiantes. Intestinum caecis lateralibus carens. Ova pauca in capsulis ellipticis complanatis pellucidis lapidibusque vel herbis adhaerentibus posita. Habitant aquas dulces."

Oka, in instituting the genus *Orobdella* (1895), found that the above diagnosis, in respect of the number of eyes and the habitat, would have to be altered in order to include *Orobdella* among the *Herpobdellidæ*, to which family it undoubtedly belonged. Oka gave as an amended diagnosis :—"Hirudinea without proboscis, without jaws; eyes in less than 5 pairs, or wholly wanting; rings without external marking that distinguishes some from the rest; number of rings in a complete somite 5-11."

Had no necessity been found to amend the diagnosis as given by Blanchard, in order to include *Orobdella*, it would now have been necessary to do so in connection only with the eyes.

For this new leech I propose the name

DINETA CYLINDRICA, gen. et sp.nov.

External characters.—Body cylindrical, without any marked change in diameter in any particular part of the body, beyond a slight attenuation towards the anterior extremity. General appearance not unlike that of *Orobdella.* Length, in the contracted condition, about 25 mm.; breadth, in the contracted condition, about 2 mm. Total number of annuli 115.

The surface is exceedingly rugose, each annulus being divided up into a series of squarish tubercular areas by grooves running from the anterior to the posterior margin of each. The appearance of the surface reminds one of the rugose tubercular nature of an Actiniarian such as *Bunodes.* The grooves themselves are of relatively insignificant importance beyond that they express the rugosity. A large number of annuli are also superficially marked by a fine groove which runs round them, dividing the tubercular areas so as to give the appearance of a double row of the same in the annulus. This secondary annulation in some cases becomes so well developed in places that it is difficult to decide whether one is dealing with one or two annuli; and in such cases one has to rely on the pentannulate constitution of the somite as seen in longitudinal section, in making an exact count of the number of annuli. On the whole, however, the annulation is well marked by distinct furrows. The tubercular nature of the surface apparently is merely an expression of the rugosity and has nothing to do with a tactile or sensory function. This rugosity is most marked in the posterior half of the body. Perhaps one might most aptly describe the surface, especially in the posterior region, as tessellated. The number of annuli in an unabbreviated somite is five (5) as in *Herpobdella* and many other Arhynchobdellids.

There are present no segmental papillæ of any kind, and, as no nephridiopores could be detected in the examination of the entire animal nor any external signs of the metameric constitution, I have had to rely on sections. The separation of the male and female genital apertures by five annuli inclined me, before sectioning, to regard the somite as being pentannulate. The absence of any metameric papillæ, etc., which might serve to distinguish any one annulus from another, is a characteristic of the *Herpobdellidæ* in general.

Although one might be inclined, and reasonably so, to regard the pentannulate nature of the somite as being of generic value, still such is not invariable in some forms. For instance, the three Japanese species of *Orobdella* have, in an unabbreviated somite, four, six, and eight annuli respectively; and yet the internal structures of the three forms show such strong mutual affinities, that this variation is rightly counted as of mere specific importance. We find a similar variation in somitic constitution in species of *Trocheta*; and, in the form under description, secondary annulation reaches in places an important development.

In making out the somites, owing to the absence of papillæ and the difficulty in detecting nephridiopores in an examination of the entire animal, I have had to rely on sections cut longitudinally.

I have adopted the views put forth by Castle, that the ganglia of the ventral nerve-chain lie, not in the first annulus of a somite as stated by Whitman, but in the middle annulus of an unabbreviated segment. In addition to the proof given to his statements by Castle, this position of the ganglion, when we take into consideration the method of somitic extension and its object, if we are to consider the Hirudinea as being derived from a stock allied to the Oligochæta, fits in very well as a natural and not unexpected conclusion, the middle ring representing the stable component of a somite.

The first unabbreviated segment is v. The following table shows the constitution of the abbreviated segments anterior to v.

Somite	i.	Constitution,	Uniannulate.	Annuli	1.
,,	ii.	,,	Triannulate.	,,	2, 3, 4.
,,	iii.	,,	Triannulate.	,,	5, 6, 7.
,,	iv.	,,	Triannulate.	,,	8, 9, 10.
,,	v.	,,	Pentannulate.	,,	11,12,13,14,15.

At the posterior extremity of the body we find somites xxiv.-xxvi. abbreviated.

In *Dina* and *Herpobdella*, the two forms to which this leech bears the closest resemblance, we find that the abbreviated somites include i.-v., and i.-iv., respectively, at the anterior extremity; xxiv.-xxvi, and xxiii.-xxvi., respectively at the posterior extremity.

On close examination of the anterior portion of the body under magnification, it is noticed that the annuli are not exactly alike. The last annulus of each somite is slightly more important in size than the third and fourth, but much more so than the first two annuli. The first two are equal, and the third and fourth are of equal importance.

The diagnosis of *Dina* given by Blanchard is :—"Somitus e 5 annulis constans, tertio majore et transverso diviso. Oculi et clitellum ut in Herpobdella. Somiti i.-v., et xxiv.-xxvi. contracti."

I take it as granted that Blanchard adopted Whitman's method of determining the somites, since Castle's paper has been published much more recently.

If this is the case then the annulus which would be the third according to Whitman would be the last annulus of the somite according to Castle; and it is the corresponding annulus of the somite in the present form which is strongly developed. The anterior four annuli of the somite, however, are of equal importance among themselves in *Dina*, whereas they fall into two consecutive sets in the present form. This differentiation of the annuli composing a somite is not so well marked towards the posterior extremity as towards the anterior end.

The anterior sucker occupies dorsally six annuli, the sixth creeping across to form the posterior lip. The posterior sucker differs very slightly in diameter from the rest of the body, and is set on it obliquely.

There are three pairs of eyes situated on annuli 1, 3, and 6 respectively.

The male genital aperture lies in the midline in the posterior region of the 37th annulus, that is the 32nd postoral ring, or 2nd annulus of somite x., the usual position for it in Arhynchobdellids; its aperture is transversely elongated, and provided with prominent tumid lips. The female genital aperture lies in the midline on the 42nd annulus, that is, the 37th postoral ring, in the 2nd annulus of somite xi.

The anus is situated between the fourth and fifth annuli from the posterior end.

Digestive system.—The mouth-cavity is very wide, measuring about one-third of the body. The pharynx measures about one-third of the body. In transverse section it has the shape of an equilateral triangle with the apex in the dorsal median line. There is a slight groove at each angle, and the sides of the pharynx are convex towards the outer surface of the body. The wall has the same characters as in other Arhynchobdellids, consisting of (a) epithelium; (b) longitudinal muscle-fibres, about five fibres in each row; (c) radial muscle-fibres; (d) circular muscle-fibres, arranged so as to form a circle circumscribing the triangular pharynx, and passing through the apices so that (b) and (c) form plano-convex masses between the epithelium and the circular musculature. The portion of the pharynx between the genital apertures becomes elliptical in shape, the long axis being directed in a dorsoventral line.

In the region of the female genital aperture there appears in the pharynx a peculiar proboscis-like organ. It has a triangular shape, and extends, as such, through about one somite before passing into the œsophagus at the end of the pharynx. The wall of this structure consists of (1) an internal epithelium of columnar cells, very much folded, and sending long projections into the cavity, whose contour is thereby rendered very irregular; at the base of each of these projecting masses occurs a large capillary; (2) an irregular layer of longitudinal muscle-fibres, much stunted in size; (3) circular muscle-fibres, constituting a good portion of the wall and representing the chief muscle-elements; (4) very irregularly distributed longitudinal muscle-fibres; and (5) an external epithelium, similar in nature to the internal epithelium; immediately beneath this epithelium occur a few large capillaries. This structure, as will be shown later, has no direct relationship to a proboscis, but is, in all probability, connected with the respiratory function. One would at first glance readily imagine that here was shown a rudimentary proboscis which had undergone degeneration, especially with reference to the radial and longitudinal muscle-fibres; and that the genus in this respect represented a form intermediate between the Rhynchobdellid and Arhynchobdellid types.

The œsophagus has an elliptical lumen, the long axis being dorsiventral. The epithelium is very little folded in comparison with that of the proboscis-like structure preceding it. In the relaxed condition of the circular muscle-fibres there is present a dorsal median papilla projecting into the lumen, with a groove on either side of it. At the ventral extremity of the œsophageal wall there is a deep wide groove. Its wall consists of (1) an epithelium of columnar cells; and (2) circular muscle-fibres, well developed, and enclosing occasional longitudinal fibres. The chief points of difference between the wall of the œsophagus and that of the proboscis-like prolongation into the pharyngeal lumen are (1) the less folded epithelium in the œsophageal wall; and (2) the practical absence of capillary vessels beneath its epithelium.

The crop has an epithelium similar to that of the œsophagus, and circular muscle-fibres in its wall. In the relaxed condition it has a dorsal median papilla and an equally well developed ventral median papilla as seen in cross-section, these papillæ representing longitudinal folds. Beneath the epithelium occur numerous capillaries, and in this respect the crop agrees more with the proboscis-like structure than with the œsophagus. These capillaries are, however, by no means so abundantly or strongly developed as in connection with the former. No diverticula arise from the crop; and in this respect the genus agrees with most other aquatic Herpobdellids, and differs from the terrestrial members, such as *Orobdella* and *Lumbricobdella.*

The intestine has its epithelium folded to such an extent that it projects into the lumen as elongated villose structures. Sinuses are very strongly developed beneath the epithelium, so that in all probability ingestion takes place in this region. The canal opens at the anus between the fourth and fifth annuli from the posterior extremity.

Reproductive organs.—The testes are arranged in the form of capsules along the sides of the ventral sinus, and extending for a short distance up the sides of the digestive canal. There are about seven such capsules. Each testis contains a mass of mature spermatozoa. The male ducts call for no special remarks.

The ovaries are large hollow sacs situated midway between the dorsal and ventral surfaces, each containing a large number of ova which are apparently mature. The ova are large, and form the most prominent cellular elements in this region of the body.

Vascular system.—This system resembles that of *Nephelis* and *Trocheta,* consisting of two lateral vessels, a median ventral sinus, and numerous cœlomic spaces carrying blood.

(a) The lateral vessels are provided with an epithelium consisting of minute cells which take a deep stain with hæmatoxylin. Outside this lining layer is a well developed circular musculature. These channels in all probability are contractile in the living animal, as in the case of *Nephelis* and *Trocheta.*

(b) The ventral sinus, in the single specimen available for examination, was observed to be developed to the extent of having a lumen not many times larger than that of the lateral vessels. In its normal position it lies immediately ventral to the digestive tube; but, in the neighbourhood of the posterior region of the stomach, the digestive tube was found to be pushed towards the dorsal surface, and the ventral sinus separated considerably from it, and displaced towards the ventral side by a greatly distended blood-laden space

(c) The cœlomic spaces have the same character as those of *Trocheta* and other Herpobdellids. They are arranged in a symmetrical fashion on each side, as mostly hollow sacs of an elliptical oblong or circular shape, as seen in transverse sections. They make their first appearance some little distance behind the female genital aperture. Each sac is lined by an epithelium consisting of cells highly granular in character, the layer having a ragged and slightly disintegrated nature as regards its constituent elements. The granular nature of the cytoplasm of these cells is in all probability due to the presence of pigment granules in each cell, the whole system of these spaces being developed in connection with the botryoidal tissue as in *Trocheta* and *Nephelis.* They extend throughout the postgenital portion of the body as far back as the anal region, and reach their maximum in the middle part of the animal. In the extreme anterior region of their occurrence they appear as three hollow sacs on either side, two immediately dorsal to the ovary and the third directly ventral to that organ and on a horizontal level with the base of the pharynx which, just in this region, passes into the œsophagus. The cavities carry some metameric significance, and communicate with the lateral bloodvessel in each somite. In the first few somites in which they occur, they have the same distribution as described above. Behind this they form a linear series on each side parallel to the sides of the alimentary canal, those of one side communicating with the other side by continuations of the pouches dorsal to the alimentary canal, these connections occurring in each somite. Eventually we find the alimentary canal invested by a series of such spaces arranged so as to give the impression of a complete circle of the same in the region of their greatest development. Although these spaces approach into close association with the ventral sinus, no direct communications between these two forms of chambers were made.

In the region of the intestine enormously distended sinuses are found laden with blood, some reaching such a strong development as to measure as much as one-third of the body. These spaces, however, show no traces of the botryoidal epithelium which was described above in connection with the botryoidal sinuses.

Nephridia.—No nephridiopores could be seen in an examination of the entire animal, and unfortunately owing to the loss of some sections in the preparation for microscopic examination, I am unable to state exactly how many nephridia are present. No funnels could be detected in a careful examination of the sections, and in this respect we have a point of difference from *Herpobdella*, *Orobdella*, etc., and an approach towards the condition in *Hirudo*, etc. In the anterior region of the body where no cœlomic spaces occur, as described above, the nephridial canals appear to communicate with the lateral bloodvessels. In the region in which the botryoidal sinuses do occur, the nephridial canal-structure is much more massive, and appears as a prominent mass in section, lying on the inner side of the lateral bloodvessel, between that structure and the botryoidal sinuses. The canal-region of the nephridium runs dorsoventrally towards the evacuatory bladder ventrally, and dorsally it is continued as a complex massive structure to pass inwards between the botryoidal sinuses which follow a circular arrangement, and those which are more internally situated and surrounded by the outer ring of sinuses. The canal is continued eventually as a less massive structure, so as to come into close association with the sinus in which lies the testis. The close connection between the canal-cells and the sinuses is, no doubt, connected with the excretory function of the cells of the botryoidal tissue, which are comparable to the excretophore-cells of *Glossiphonia*. In connection with those canals, which I mentioned above as being connected with the lateral bloodvessels, I noticed a small bulging on the inner side of the vessel; and this I regarded as corresponding to a capsule. In this capsule I observed a lumen, but the details of the connection between it and the nephridial canal I cannot tell, although there seems no doubt, from the manner of their association, that such a connection does occur.

The nephridial canal-structure may be described as a sausage-shaped mass bent in the form of the letter U, the convex side directed towards the dorsal region of the body, and the outer limb longer than the inner and passing down on the inner side of the lateral vessel to join the bladder. The winding of the canal is very similar to that of *Orobdella* and *Herpobdella.* The figure of the nephridium, as reconstructed by Graf from sections of *Herpobdella octoculata* (Linné) 1758, (= *Nephelis vulgaris* Moq.-Tandon, 1827) is, as Oka has mentioned in his description of *Orobdella,* false inasmuch as he has represented the canal as running a simple course from the capsule to the bladder. As in *Orobdella* and *Herpobdella,* so in this new genus, the canal-region of the nephridium consists of a number of large granular cells placed in alignment to form a row. The row of cells is turned on itself several times, so that in transverse section the canal, which pierces the cells in a direction parallel to the length of the row, is seen three or more times. In places, owing to the apparent fusion of the cells and the impossibility of differentiating between the limits of the constituent cells, one might readily imagine that there was a single, simple row of cells, in which was present a much winding canal. That such is not the case is plainly shown in certain regions of the structure by the distinct elementary nature of the constituent cells, each permeated by a single canal when one differentiates between a transverse and a longitudinal section of such a cell.

The bladders attached to the distal extremity of the nephridial canal have the form of a flask, with a very wide venter, continued into a very narrow attenuated neck, which opens on the lateral ventral region of the body through the nephridiopore.

Remarks.—Undoubtedly the Hirudinea in general represent a group of an archaic nature. Their distribution would suggest a great antiquity for the class, and this is supported anatomically by the wide differences, in regard to various organs, in members closely allied from the point of view of classification.

Regarding the relationship of the *Rhynchobdellidæ* and *Arhynchobdellidæ,* one is forced to conclude that these two groups have been evolved from an old stock, probably closely allied to the Oligochæta, sufficiently long enough to allow of the development of characters widely divergent in connection with genera in other respects closely allied. This renders it almost impossible, with our present knowledge, to point to any one genus as being more primitive than another.

In the case of the *Glossiphoniidæ*, we have the triannulate somite, which undoubtedly is more primitive than that existing in forms with a greater number of annuli, but from this one cannot judge that the family is any older than another.

The development of a proboscis in the *Rhynchobdellidæ* is to be regarded as a character evolved after the separation of that group from the *Arhynchobdellidæ*. The primitive ancestor of these two groups was not provided with such a proboscis, as can be readily seen from a study of the embryology of the Hirudinea.

In this connection it is rather interesting to note that the Rhynchobdellids are all aquatic forms, and it seems very likely and probable that these forms have, in their proboscidean nature considered in conjunction with their habitat, some explanation of the origin of the group.

In the genus which I have described in this paper, I noted the presence of a peculiar proboscis-like outgrowth from the œsophagus or from the base of the pharynx. One would at first sight readily regard this structure as a rudimentary proboscis, but such is apparently not the case. The proboscis of the Rhynchobdellids is formed by an involution of the anterior extremity of the body, the pharyngeal sac-wall representing the modified epidermis of the involuted portion. A transverse section of the proboscis of these forms is markedly comparable with the anterior extremity of the body of an Arhynchobdellid. An examination of the structure of the proboscis-like organ which I have described in the new form shows that, in this connection, it is not comparable with the proboscis of Rhynchobdellids. I mentioned above that very possibly some relationship existed between the presence of a proboscis in the Rhynchobdellids and their aqueous habitat. Now it seems to me that it is quite probable that the same cause may have stimulated the evolution of the proboscis in the Rhynchobdellids and the organ under discussion. One marked feature in the structure of this organ is the presence of abundant large capillaries beneath its epithelium, and this would seem to indicate that, in all possibility, it functions as a respiratory organ. It has developed a good circular musculature, and, by the contraction of these muscles, water would be prevented from passing backwards into the digestive tube.

Dineta agrees with other Herpobdellids as regards internal structures, such as the peculiar sinuses formed in connection with the botryoidal tissue and blood-system.

Of the various genera in this family it approaches closest to *Dina*. Indeed, it is possible that it may have to be included in that genus; but, at present, considering the characters given for *Dina* and as I have not any anatomical literature on *Dina*, I feel that I am justified in instituting a new generic name.

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EXPLANATION OF PLATES XXXII.-XXXIII.

Dineta cylindrica, gen. et sp. nov.

Plate xxxii.

Fig. 1.—(See Plate xxxiii.).
Fig. 2.—Ventral view of anterior extremity.
Fig. 3.—Dorsal view of anterior extremity.
Fig. 4.—Lateral view of posterior extremity.

Fig.5.—Ventral view of posterior extremity.

Fig.6.—Dorsal view of posterior extremity.

Plate xxxiii.

Fig.1.—View of the entire animal.

Fig.7.—Diagrammatic view of anterior extremity, showing arrangement of annuli with reference to anterior sucker.

Fig.8.—Diagram showing position of genital apertures, with reference to the annuli of somites x. and xi.

Fig.9.—Section through proboscis-like organ, showing highly vascularised condition.

(Figs.1-6 drawn from photos.)

ILLUSTRATIONS OF POLYCOTYLEDONY IN THE GENUS *PERSOONIA*, WITH SOME REFERENCE TO *NUYTSIA*.

[N.OO. *Proteaceæ*; *Loranthaceæ*].

By J. J. Fletcher.

(Plates xxxiv.-xxxv.)

About a century ago Sir Joseph Banks gave to the younger Gärtner some botanical specimens, including portion of an Australian plant whose seeds contained embryos with five cotyledons. For this plant Gärtner fil., proposed the name *Pentadactylon angustifolium*, g. et sp. nov. [= *Persoonia linearis* Andr.]; and he included a description of it, with figures, in the Supplement to his father's great work "De Fructibus et Seminibus" published in 1807.* This is the first recorded instance of a polycotylous Protead. But seventy-five years later, Baron von Mueller was able to announce that the peculiarity recognised by C. Gärtner in *Persoonia linearis* was shared, in a varying degree, by the embryos of a substantial majority of the species of *Persoonia* whose fruits were available for examination. This genus, in fact, is without a rival among the Angiosperms for the number of species which habitually produce polycotylous embryos (in the current sense of the term); and in this respect it promises to compare not altogether unfavourably with some of the genera of the Coniferæ

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* From the synonymy given on p.159 of his paper, it appears that Robert Brown had recognised that C. Gärtner's generic name *Pentadactylon* was synonymous with the earlier described *Persoonia* of Smith; but it was left to Mr. Bentham to settle definitely, from the comparison of specimens, that *Pentadactylon angustifolium* C. Gärtn., was synonymous with the earlier name, *Persoonia linearis* of Andrews.

among the Gymnosperms. The maximum number of cotyledonary members observed in any species of *Persoonia* is eight, though this is not a common number; whereas in some species of *Pinus* as many as fifteen are produced.

The interesting peculiarity referred to, though first announced by the younger Gärtner for one species, had been noted some years earlier by Robert Brown, who had had the opportunity of studying living representatives of twenty species of the genus during his visit to Australia. As the polycotylous character of the embryo offered no special attraction from a classificatory point of view, Robert Brown did not trouble to place on record the results of his observations in detail; but he refers to them in general terms more than once, both in his renowned paper "On the Proteaceæ of Jussieu"* and in the Prodromus (1810). Thus, in the former, he says "The number of cotyledons when more than two is a circumstance of little importance. In *Persoonia*, the only genus of the order in which a plurality of cotyledons has been observed, I am not even certain that their number is constant in those species in which this anomaly occurs" (p.37). And of the Order—"Embryo dicotyledoneus (raro polycotyledoneus) rectus" (pp.46, 48); or "Embryo dicotyledoneus (quandoque polycotyledoneus) rectus" (Prodromus, p.363). And of the genus *Persoonia*—"Cotyledones sæpius plures" (Op. cit. p.160; Prod. p.372).

General statements of more or less similar import are to be found in various botanical works of reference. For example, Sir Joseph Hooker in his "Flora Tasmaniæ" says of *Persoonia* "embryone sæpe 3-5-cotyledoneo" (Vol. i. p.321), a statement possibly founded on personal observation. I have not had access to the Volume (xiv.) of Decandolle's Prodromus which contains Meissner's account of the Proteaceæ, to which the Baron makes reference.

In 1848, Duchartre published the results of his inquiry into the nature of the cotyledonary members of polycotyledonous embryos so-called. He says that he had desired to extend his

* Trans. Linn. Soc. x. pp.37, 46, 48, 160(1811). Read Jan. 17th, 1809.

observations to embryos of *Persoonia*, but the material which the resources of the Paris Museum and the Collections of Messrs. Delessert and Webb had placed at his disposal was insufficient both in quality and quantity for satisfactory examination. He then proceeds—"Quant au petit nombre de graines en bon état j'ai trouvées sur les *Persoonia ferruginea*, *salicina* et *linearis*, celles de la première avaient deux cotylédons entiers; le seul embryon que j'aie vu de la seconde avait six productions cotylédonaires très inégales, dont quatre de même longueur, une cinquième plus courte de moitié environ, et la sixième presque rudimentaire; enfin, les embryons de la troisième espèce étaient comprimés par les côtés et à six productions cotylédonaires égales. Mais je n'oserais dire si, dans ces dernières, il fallait voir deux cotylédons tripartis ou six cotylédons distincts.

Au reste, M. Rob. Brown admet qu'il y a là autant de cotylédons distincts; et certes, une pareille autorité est plus que suffisante pour faire admettre cette manière de voir jusqu'à preuve du contraire, bien qu'il puisse paraître bizarre de voir quelques espèces à cotylédons multiples disséminées au milieu d'un genre dicotylé."*

This is the first definite statement respecting the embryos of *P. ferruginea* and *P. salicina*; but, in my opinion, Duchartre's embryo of the latter was an abnormal specimen, if not wrongly determined also..

In "The Plants indigenous to the Colony of Victoria," Vol. ii. Lithograms(1864-65), Baron von Mueller included a plate(Pl.lxix.) illustrative of *Persoonia Cayleyi*(= *P. chamæpeuce* Lhotsky) of which figs.15-18 show views of two embryos with six cotyledons, entire or in transverse section.

The foregoing summary, as far as I am able to ascertain, may be fairly taken to represent the state of knowledge of polycotyledony in *Persoonia* up to the year 1882, when the Baron contributed a short paper entitled "Plurality of Cotyledons in the

* Duchartre, P., "Mémoire sur les Embryons qui ont été décrits comme polycotylés." Ann. Sci. Nat. 3e Série. T.x., p.234.

Genus Persoonia" to the New Zealand Journal of Science, in which he recorded the results of his examination of the embryos of 23 out of a total of 61 known species, in the following manner.

"*Cotyledons in Species of Persoonia.*—P. ferruginea, 2; P. confertiflora, 2; P. elliptica, 2; P. longifolia, 2; P Toro, 3, rarely 2 or 4; P. arborea, 3; P. dillwynoides, 3-4; P. nutans, 3-5; P. Gunnii, 4; P. media, 4; P. lanceolata, 4-5; P. juniperina, 4-6, rarely 3; P. linearis, 4-6; P. myrtilloides, 4-6; P. rigida, 5; P. pinifolia, 5-6; P. falcata, 5-7; P. hirsuta, 5-8; P. chamæpeuce, 6; P. tenuifolia, 7; P. brachystylis, 7; P. quinquenervis, 7-8; P. teretifolia, 7-8. Of the 61 well marked species of this genus hitherto on record, I was thus able to examine 23 as regards embryonic structure; but of P. brachystylis, P. elliptica, P. media, P. Gunnii, P. rigida, and P. tenuifolia, only single fruits were accessible to me. As out of the above mentioned 23 species only four proved dicotyledonar, it may be fairly assumed that, in the genus as a whole, the pluricotyledonar embryo by far preponderates." (*Op. cit.* i. p.116).

In his "Key to the System of Victorian Plants"(i. Text,1887-8; ii. Plates, 1885) the Baron mentions the number of cotyledons observed in embryos of eight out of eleven Victorian species of *Persoonia* (i. pp.275-277); and, in Plate 68B., he gives figures illustrating the cotyledons of embryos of *P. chamæpeuce,* entire or in transverse section. These figures, together with those in the "Plants indigenous to the Colony of Victoria," already referred to, and those given by Gärtner, comprise all the published illustrations that I am able to find any record of.

Of the species in the Baron's list six are restricted to West Australia, two to Victoria. one to Tasmania, seven to New South Wales, one to New Zealand; and the others are common to two or more of the States.

It does not seem possible to connect polycotyledony in any way, either with geographical distribution or with the grouping of the species adopted by Mr Bentham in the "Flora Australiensis," and which presumably represents natural groups of allied species. Of the four species with dicotylous embryos in the Baron's list, *P. elliptica* and *P. longifolia* are restricted to West Australia, *P. confertiflora* to Victoria, and *P. ferruginea* to New South Wales. All four species fall into Mr. Bentham's Section 3, but this, with one exception (*P. falcata* from N.A. and Q.) includes all the species which are not West Australian, and three which are.

Species with polycotylous embryos, on the other hand, are to be found in each of Mr. Bentham's Sections. Of the six West Australian species in the Baron's list, *P. teretifolia* and *P. brachystylis* fall into Section 1; *P. dillwynoides* and *P. quinquenervis* into Section 2.

The opportunity of seeing germinating seeds and seedlings of *Nuytsia floribunda* R.Br., the West Australian terrestrial member of the N.O. *Loranthaceæ*, another Australian plant which has a long-standing reputation for producing polycotylous embryos, stimulated my interest in polycotylous Geebungs. Residence in Sydney gives one a great advantage over the Baron in respect of facility of access to living plants; and I decided to turn my attention chiefly to seedlings. The embryos are delicate and fragile; and even if one succeeds in extracting them entire from the hard putamen and the double seed-coat, it is difficult to examine them satisfactorily and in detail without damage and without the expenditure of much trouble. They vary in size from about 4-7 mm. in length. The smallest I have seen are those of *P. myrtilloides* (about 4 mm.); those of *P. mollis* are slightly larger (about 5 mm.). The cotyledons are relatively broadest in the dicotyledonous embryos of *P. ferruginea*, semicircular in section, the appressed surfaces flat. In polycotylous embryos the cotyledons are proportionately narrower, according to their number, nearly triangular with a curved base (a sector of a circle, in fact) in section, and approximately equal in their dimensions.

Seedlings are very satisfactory for examination, as the cotyledons persist for a considerable time, remaining fresh and green in seedlings several months old; and they are fairly conspicuous, in individuals of some species attaining a length up to 17 mm., which are the longest I have measured. The transitional forms, too, more readily catch the eye.

My first successful attempt to collect seedlings resulted in the acquisition of ten rather advanced examples of *P. nutans.* Four of these had four cotyledons, four had five, but the other two were anomalous inasmuch as one, with four cotyledons, had one of these bipartite; and the other, also with four cotyledons, had two of them in a similar condition. This kind of aberration, resulting in transitional forms of so much significance in the aggregate, seems to have escaped the notice of the Baron, or, at least, he does not mention it; and I myself have not noticed it in embryos. The condition is one which may easily be overlooked until the cotyledons have grown, when it is usually readily observable. More that ten per cent. of the total number of seedlings which I have examined, presented some phase of a more or less incomplete division of one, sometimes two, or rarely even three of the cotyledonary members. It may vary in amount from a notch up to almost complete separation. Two seedlings illustrating the occurrence of one or more incompletely divided cotyledons of this character are shown in Plate xxxv., figs. 1-2. For the sake of brevity I shall speak of all such anomalies as bipartite cotyledons, irrespective of the amount of the separation (that is, whether the cotyledons are notched, bifid, cleft, or all but completely separated). I think it is not altogether impossible that some of these anomalies may have been entitled to be regarded as cases of partially fused, or connate cotyledons.

With the exception of the six species of which only a single fruit was available, the Baron does not state how many embryos were examined in any case; nor does he indicate, as the result of actual observation, any proportion in which the numbers quoted by him may be expected to occur.

The object of the present paper is to supplement the Baron's observations in so far as these relate to the species of *Persoonia* to be found in the neighbourhood of Sydney, and on the Blue Mountains, from a study of seedlings, and, whenever it was possible, of a considerable number of them; and likewise to furnish some photographic illustrations of a series showing the variation in the number of the cotyledons met with.

Among other matters, I particularly wished to know whether the examination of a considerable number of embryos or seedlings—say not less than 100—of any of the four species represented as dicotylous in the Baron's list would show any indications of occasional polycotylous developments. Also whether the examination of a considerable number of embryos or seedlings of the species reputed to be polycotylous, would show any obvious indications of an occasional tendency to produce dicotylous embryos. Another matter I wished to know was, whether it was possible to recognise any definite proportion in which the numbers might be expected to occur whenever a fair number of specimens were examined.

Perhaps the statistical information collected with this object in view may help to throw some light on the Baron's numerical data and also upon this statement—"Again, as in Coniferæ so also in Persoonia, the number of embryo segments ranges only within specific definite limits" (l.c. p.116).

I have examined seedlings of ten species, four of which are not in the Baron's list—*P. salicina*, *P. mollis*, *P. acerosa*, and *P. chamæpitys*. Seedlings of two species, one of which, *P. angulata*, is not in the list, were not procurable, though I spent considerable time in searching for them; consequently I had to fall back on the examination of embryos.

Persoonia ferruginea Sm.—Of the ten species available for investigation by me, this is the only one which has offered dicotylous embryos and seedlings. It is one of the Baron's four dicotyledonous species. The plant is common, but seedlings are scarce. Not only do the fruits often fall where the seeds have little or no chance of germinating, but, in my opinion, in many cases, too long exposure to desiccating conditions, notwithstanding the hard putamen and mucilaginous mesocarp, before an otherwise favourable opportunity for germination presents itself, is responsible for a large number of failures. After much searching, I had to be content with nine seedlings, the youngest of which is shown in fig. 1. Neither these, nor ten embryos examined, offered any departure from the dicotylous condition.

Among all the seedlings and embryos seen by me, these are the only typically dicotyledonous examples I have met with. Fig. 1 is slightly enlarged, the cotyledons of the seedling being about 10 × 3 mm.

P. lanceolata Andr.—The examination of the first three hundred seedlings collected, taking them as they came, gave the following results :—

With	3	cotyledons		84
,,	,,	,,	(1 bipartite)	10
,,	,,	,,	(2 bipartite)	1
,,	4	,,		186
,,	,,	,,	(1 bipartite)	7
,,	5	,,		12

For this species the Baron gives 4-5 cotyledons. Hence I conclude that he was not able to examine a very large number of embryos. In my table 4 appears as the dominant number (62%), and 3 (28%) is more numerously represented than 5 (4%). In terms of experience, this table simply means that if one takes a considerable number of seedlings as they come, without specially selecting them, and sorts them out into lots, one may expect to find that those of the largest lot will have four cotyledons, those of the next largest three, next those with five, and then the lots of transitional forms, of which 3 with 1 bipartite cotyledon will be commonest. And, *mutatis mutandis*, the Baron's numbers (within the limitations allowed by the material at his disposal) may be understood to signify something of this sort, except that the dominant numbers are not mentioned, and one cannot determine them by inspection, in the absence of statistical data. A good example of a typical seedling of this species with 4 cotyledons is shown in fig. 3 of Pl. xxxiv.; and another aspect of one with 3, which has not reproduced very well, in fig. 4 (the fourth fig. in the top row, counting from the left) of Pl. xxxv.

P. salicina Pers.—The total number of seedlings procurable was 82.

With	3	cotyledons		11
,,	,,	,,	(1 bipartite)	5
,,	4	,,		45
,,	,,	,,	(1 bipartite)	7
,,	5	,,		14

In this species again, 4 is the dominant number, while (for the number of cases examined) 5 is somewhat more common than 3. A seedling with 3 cotyledons is shown in fig.2.

P. nutans R.Br.—One hundred and ten seedlings, taken as they presented themselves, gave the following results :—

With	3	cotyledons		4
,,	,,	,,	(1 bipartite)	5
,,	4	,,		51
,,	,,	,,	(1 bipartite)	7
,,	,,	,,	(2 bipartite)	2
,,	5	,,		36
,,	,,	,,	(1 bipartite)	1
,,	6	,,		4

The range of variation in this species is wider than in either of the two preceding species. The dominant number is still 4, with 5 next, and 3 and 6 equal but considerably behind. The Baron missed an example of 6; his list gives 3-5. A young seedling with 6 cotyledons, not yet bent back, is shown in fig.5.

P. linearis Andr.—The total number of seedlings obtainable was 67.

With	3	cotyledons	(1 bipartite)	1
,,	4	,,		6
,,	,,	,,	(1 bipartite)	8
,,	,,	,,	(2 bipartite)	1
,,	,,	,,	(3 bipartite)	1
,,	5	,,		28
,,	,,	,,	(1 bipartite)	7
,,	,,	,,	(2 bipartite)	1
,,	6	,,		13
,,	,,	,,	(1 bipartite)	1

The dominant number is 5, then 6, and 4 rather behind; but the percentage of transitional forms is higher in this species than in any other I have examined. Two seedlings with bifid or bipartite cotyledons are shown in Plate xxxv., figs. 1-2 (the first and second figs. in the top row, counting from the left).

P. pinifolia R.Br.—The number of seedlings examined was 122.

With	4	cotyledons		4
,,	5	,,		52
,,	,,	,,	(1 bipartite)	2
,,	6	,,		47
,,	,,	,,	(1 bipartite)	5
,,	7	,,		12

In this species also the range of variation is wide; the dominant number is 5, with 6 well represented; the number 7 is less common, but not so rare as 4. The Baron missed examples of both 4 and 7. A rather advanced seedling with 7 cotyledons is shown in Plate xxxv., fig. 6; and another aspect of one with 6 cotyledons, in Plate xxxv., fig 3.

P. hirsuta Pers.—Only 31 seedlings were obtained.

With 5 cotyledons		6
,, 6 ,,		16
,, ,, ,,	(1 bipartite)	2
,, 7 ,,		5
,, ,, ,,	(1 bipartite)	2

The dominant number in this species is 6. The Baron's numbers are 5-8. The maximum number of cotyledons observed by the Baron was 8, in three species, of which *P. hirsuta* is one, the other two being West Australian species. I have not seen a seedling or embryo with this number. The nearest approach to it was offered by two examples of this species with 7 cotyledons, in each case one being deeply but not completely divided; so that, at a casual glance, without careful examination, they might have passed as specimens with 8.

P. acerosa Sieb.—Seedlings were very scarce. I succeeded in finding only nine, of which one had 4 cotyledons, seven had 5, and one had 5 with 1 bipartite. Of five embryos, one had 4 cotyledons and four had 5. Five seems to be the dominant number.

P. mollis R. Br.—Seedlings of this species were far from plentiful. Much searching yielded only eight, of which four had 4 cotyledons and four had 5. A young seedling with 5 cotyledons is shown in fig. 4.

P. chamæpitys A. Cunn.—This plant is common on the Blue Mountains, and fruits freely. Whether the prostrate habit of the plant is detrimental to the production of seedlings, I cannot say; but a single seedling, with 7 cotyledons, was all I could find after much searching. A few embryos examined gave 4-7.

P. angulata R. Br.—Not a single seedling could be found. Of eighteen embryos, two had 4 cotyledons, eleven had 5, four had 6, and one had 7.

The apparent scarcity of seedlings of the above four species during the past season may have been due to seasonal drawbacks; and I hope, at some future time, to be able to examine better series.

P. myrtilloides Sieb.—I failed to find a single seedling. A few embryos examined gave 4-5. In the Baron's list this species is credited with 4-6.

Of the total of 61 species of *Persoonia*, four are known habitually to produce dicotylous embryos, 24 to produce polycotylous embryos, leaving the condition in 33 still open for investigation. Experience seems to justify a doubt that all these 33 species will turn out to have dicotylous embryos.

In their very suggestive paper "On the Origin of Angiosperms,"* Newell Arber and Parkin remark—"During the course of evolution there would seem to have been considerable 'play upon,' or modification of, every unit of the flower. And this appears to us to be true also of the embryo. Late, or far from primitive adaptations are to be found among embryos, just as among flowers.' *Persoonia* seems to be a case in point, for even in the present incomplete state of our knowledge, it furnishes a very striking series of illustrations of one phase of the "play of variation" upon the embryo—a "play" which seems to be still in progress.

As to whether the well-marked tendency in so many species to produce polycotylous embryos is a primitive or an acquired character, the following considerations seem entitled to carry weight.

(1) There is the possibility, suggested by the discovery of two cotyledons in the embryo of the Mesozoic Cycadophyte, *Bennettites*, "that the dicotylous condition was a primitive feature of the great majority, if not all Spermophyta." The evidence in favour of this view is admirably summarised and discussed by Newell Arber and Parkin in the paper quoted (*op. cit.* pp. 71-73).

*Jour. Linn. Soc. Botany, xxxviii., p. 72, 1907.

(2) The *Proteaceæ* are conceded to be a group of considerable antiquity—a view for which other evidence besides Ettingshausen's reputed discovery of *Persoonia* fruits in the Tertiary strata of Häring is forthcoming. It is, therefore, certainly very remarkable, as well as very suggestive, that, out of an Order comprising about 49 genera and 950 species, only what promises to be the majority of the species of a solitary genus should furnish the sole exception to the statement that dicotylous embryos are characteristic of the Order. I have not been able to find any record of casual deviations from the normal in other Proteads. Among a number of individual seedlings other than those of *Persoonia*—nothing like a representative series, however—I have seen only one abnormal example, a seedling of *Isopogon anemonifolius* with three cotyledons.

(3) When the four species with dicotylous embryos, and the six species of which only a single fruit was examined, in the Baron's list, are left out of consideration, there remain only two species, *P. arborea* from Victoria, and *P. chamæpeuce* which are credited with single numbers (3 and 6). The Baron offers no comment on these cases, nor does he say how many embryos were examined. Further examination is desirable, because at present these species seem to be the only exceptional cases of species which produce polycotylous embryos, in which the number of cotyledons is constant. One would like to have these points settled. Apart from these cases, the experience of later observers has only been confirmatory of Robert Brown's—" I am not even certain that their number is constant in those species in which this anomaly occurs."

(4) There is the evidence afforded by the not rare occurrence of incompletely divided or bipartite cotyledonary members. Examples of these transitional forms have been furnished in every case in which a fair number of seedlings have been examined.

When all these matters are taken into account, the conclusion seems inevitable, that polycotyledony in *Persoonia* represents a departure from the normal—that it is an acquired and not a primitive character; and that it has been derived from a dicotyledonous ancestor by the splitting of the two seed-leaves.

One may perhaps venture to express the hope that Western Australian naturalists will take up the investigation of seedlings of the 24 species restricted to that State, only six of which appear in the Baron's list, and two of these were represented by single fruits. It would also be very interesting if a New Zealand botanist would report the results of the examination of 100 seedlings of *P. Toro*, because this species, according to the Baron, produces both dicotylous and polycotylous embryos, a condition which has not yet been met with in any Australian species.

I avail myself of the opportunity of appending figures of three young seedlings of *Nuytsia floribunda* R.Br. [N.O. *Loranthaceæ*] from life, because I consider that this plant must be relegated to the same category as *Persoonia*; and no illustrations of these interesting young forms have yet appeared, as far as I can ascertain.

The first mention of polycotyledony in this species is to be found in a communication dated June, 1839, from James Drummond to Sir William Hooker, and published in Hooker's Journal of Botany (Vol. ii. p. 346, 1840). Drummond says—"The trunk of the *Nuytsia* is from two to four feet in diameter; its leaves are like those of *Taxus elongata*, and the seeds resemble Rhubarb; they vegetate with several cotyledons like the pine." About two years later, Mr. H. [? J. C.] Bidwill independently discovered the fact, and sent a short communication about it, dated July 5, 1841, to London.* He says—"In the government garden at Sidney is a single plant of *Nuytsia*,† which flowers every year,

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* Ann. Mag. Nat. Hist. viii., p.439, 1842.

† Local traditions relating to the history of this particular plant are at variance. The following quotation from a letter of Allan Cunningham's to his friend, Mr. Heward, seems to leave no room for doubt—"How fine *Grevillea robusta* (forty feet high) is at this time in the Botanic Garden, and at Mr. Macleay's, at Elizabeth Bay ! it is a mass of orange blossom : . . . and that rarest of rarities, *Nuytsia* of R.Br., is on the verge of a splendid flowering. It was brought to us by Baxter from Western Australia, and is the only specimen on our side of the continent." (Hooker's Lond. Journ. Bot. i. p.286, 1842).

but does not ripen many seeds. I this year picked up several and sowed them, but they have not come up. As I was particularly anxious to preserve the plant, I invariably looked around it for seedlings whenever I entered the garden, and a few days since discovered two just breaking the ground. I then found that this curious plant had three (!) cotyledons, which are awl-shaped and perfectly equal in size and appearance. As I never recollect to have heard of a plant with three cotyledons before, I thought it worth mentioning, in order to compare it, if possible, with *Schœpfia*, *Gaiadendron*, *Aucuba*, &c., the other terrestrial genera of (so-called) *Loranthaceæ*."

In the "Flora Australiensis" Mr. Bentham says of *Nuytsia*—"Embryo with 3 or 4 unequal cotyledons" (Vol. iii., p.387, 1866). In Bentham and Hooker's "Genera Plantarum" the embryo is described as . . . "cotyledonibus 2-4 inæqualibus radicula supera longioribus." (Vol. iii. p.206, 1883).

Of 26 young seedlings raised from seed kindly supplied to me by Dr. Cleland, one had 2 unusually broad cotyledons which appeared to have escaped undergoing the prevalent subdivision; fourteen nominally had 3, and the remaining eleven nominally 4. But a considerable majority of the twenty-five specimens presented some phase of a condition like that present in the most extreme cases of the transitional forms of species of *Persoonia* already mentioned. That is to say, instead of the intercotyledonary clefts being all of equal depth, one cotyledonary member may be seen to be separated from its neighbour on one side by a cleft which is not so deep as that which separates it from its neighbour on the other side. Two cotyledonary members may be affected in this way. I consider these to represent cases of incomplete cotyledonary subdivision. Otherwise no cases of bifid or bipartite cotyledons were met with.

Dr. Cleland sent me his list for thirty-two seedlings (natural seedlings, I believe these were) examined by him—twenty-three (nominally) had 3 cotyledons, and nine had 4; minor details being left out of account.

Dr. Cleland also very kindly sent me six young seedlings in spirit. Three of these (nominally) had 3 cotyledons, two had 4, and one had 5. One of the examples with 3 afforded an instance of incomplete separation. Three is evidently the dominant number in *Nuytsia.*

The Order *Loranthaceæ*, according to the "Genera Plantarum," comprises 13 genera and about 500 species. In all the other genera of the Order dicotylous embryos appear to prevail, as a rule, with the exception of *Nuytsia*, and Subsection *a* (*Eupsittacanthus*) of Section 16 (*Psittacanthus*, comprising certain South American species with versatile anthers) of the genus *Loranthus*, as subdivided in the "Genera Plantarum," of which the authors say—"Cotyledones ubi notæ 4 (rarius ex Eichl. 5-6)."

In conjunction with this fact there are to be considered the inconstancy in the number of the cotyledonary members, the wide range of variation (2 5) encountered in less than 100 individuals, and the evidence furnished by incompletely subdivided cotyledonary members. Hence the conclusion seems justifiable that *Nuytsia* is another instance like *Persoonia.*

I have examined the cotyledons of a number of seedlings of *Atkinsonia ligustrina* F.v.M., the Eastern Australian terrestrial member of the Order, without finding any anomalies. But in a very few examples of young seedlings of *Loranthus miraculosus* Miq., I have noted the presence of three cotyledons.

I gladly acknowledge my indebtedness to Mr. C. T. Musson, of the Hawkesbury Agricultural College, for very material assistance in obtaining seedlings of *P. nutans*, and for the negatives from which figs. 3 and 5 of Plate xxxiv. were reproduced; to Dr. Cleland of Perth, for seeds and specimens of, and much information about, *Nuytsia;* and to Dr. R. Greig-Smith for his trouble in providing me with the excellent photos of the seedlings of *Nuytsia* reproduced in Plate xxxv.

EXPLANATION OF PLATES XXXIV.-XXXV.

Plate xxxiv.

Fig.1.—Seedling of *Persoonia ferruginea*, with two cotyledons.

Fig.2.—Seedling of *P. salicina*, with three cotyledons (the middle one appearing foreshortened).

Fig.3.—Seedling of *P. lanceolata,* with four cotyledons.
Fig.5.—Young seedling of *P. mollis,* with five cotyledons.
Fig.6.—Young seedling of *P. nutans,* with six cotyledons.
Fig.7.—Seedling of *P. pinifolia,* with seven cotyledons (the third and fourth, counting from the left, appearing foreshortened; a number of the lowest foliage leaves were removed to expose the cotyledons).

(These seedlings were selected simply to make up a series illustrating the variation in the number of cotyledons, and not primarily to illustrate the cotyledonary arrangements of any particular species).

(The figs. are nat. size, or slightly enlarged.)

Plate xxxv.

Top row, Figs.1-4 (counting from the left).

Four seedlings in which the epicotyls have been cut off close to the cotyledons, and the latter photographed from above.
Fig.1.—*P. linearis* with 4 cotyledons, three of which are bifid or bipartite.
Fig.2.—Another *P. linearis* with 5, one deeply bipartite (one accidentally cut off, indicated by the dotted lines).
Fig.3.—*P. pinifolia* with 6.
Fig.4.—*P. lanceolata* with 3.

Nuytsia floribunda.

Middle row (counting from the left).

Fig.5.—Young seedling, with four cotyledons (the two nearer cotyledons appearing foreshortened). This example shows the inequality of the cotyledons.
Fig.6.—Another young seedling with three cotyledons, showing the remains of the seed carried up and still fixed on the tips of the cotyledons.

Bottom row (counting from the left).

Figs.7-8.—Side and front views of another seedling with three cotyledons. In this case the seed was buried too deeply for the cotyledons to carry it up, when straightening. Two of the cotyledons have withdrawn from the buried seed, the third not yet released.

(About nat. size.)

Note.—The nnmbers on the blocks should be disregarded.

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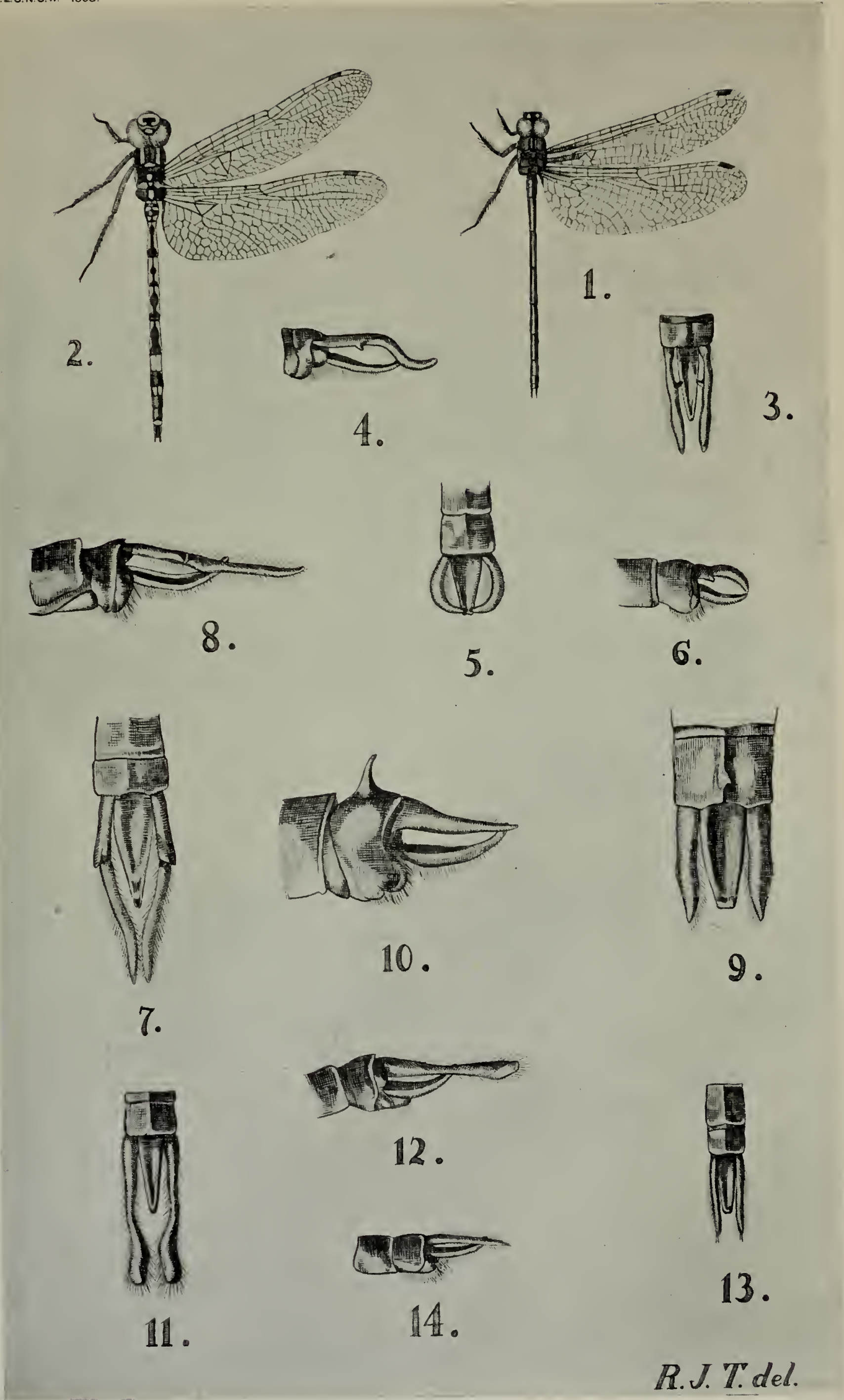


AUSTRALIAN CORDULIINÆ.

AUSTRALIAN CORDULIINÆ.

VIEW OF THE VALLEY OF THE MURRAY, FROM LAKE ALBINA.

FIG 1. MERSEY BLUFF.

FIG. 2. GOAT ISLAND, LOOKING SOUTH.

FIG. 1. BLACKMAN'S POINT BURNIE.

FIG. 2. ROCKY CAPE EAST, LOOKING NORTH-EAST.

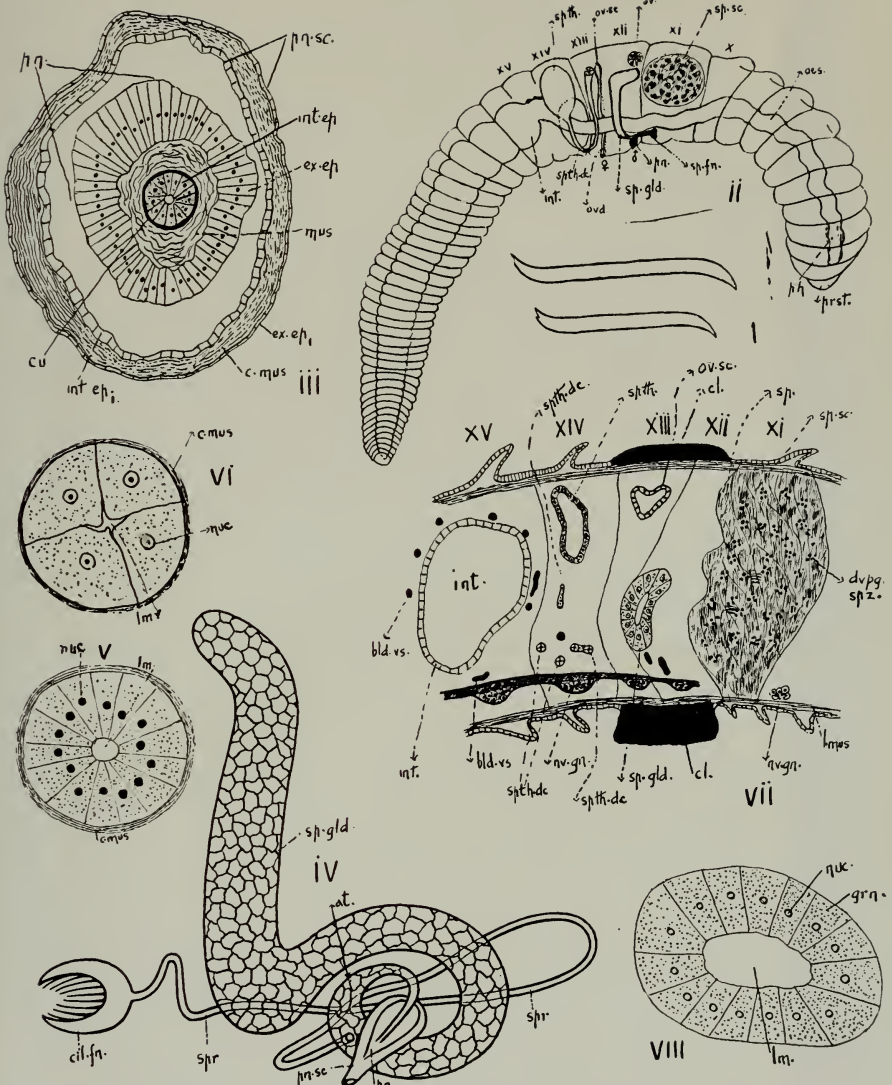
FIG. 1. TABLE CAPE ON THE RIGHT.

FIG. 2. NEAR CRAYFISH CREEK, LOOKING EAST.

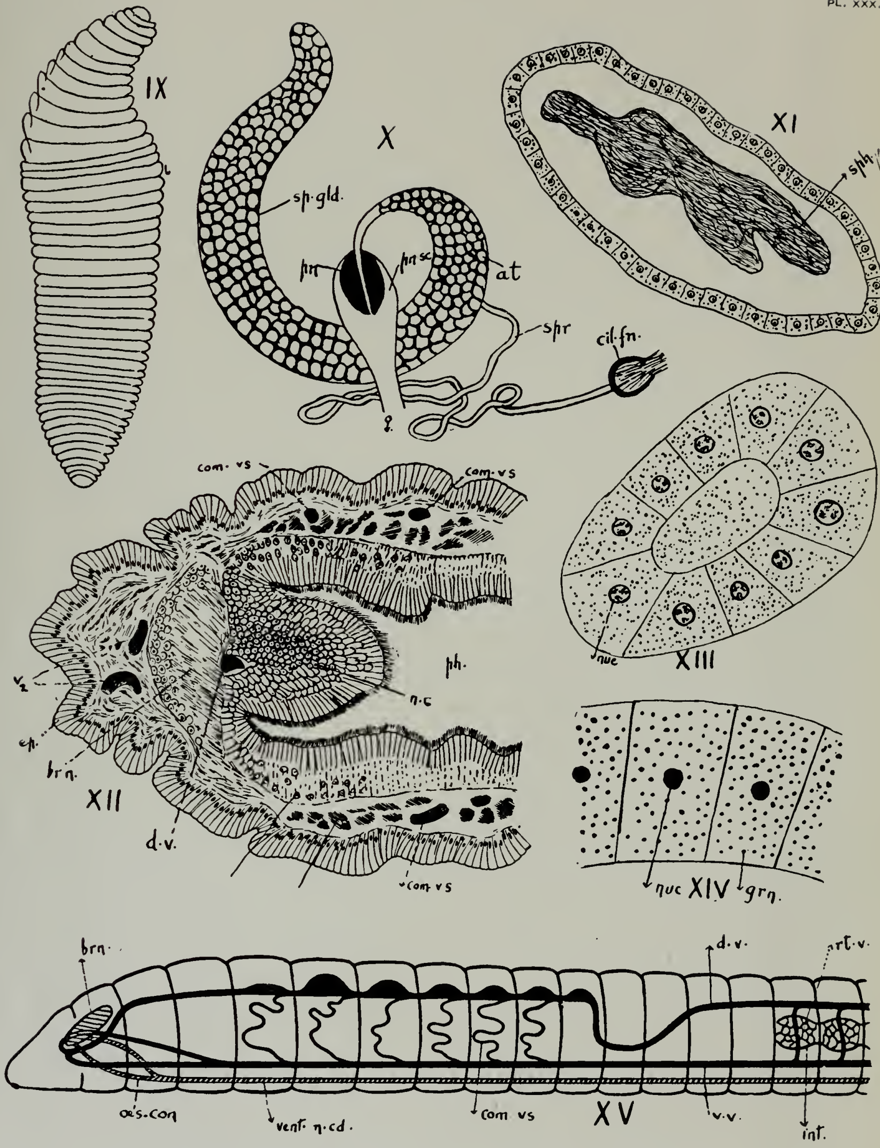
FIG. 1. ROCKY CAPE NORTH, LOOKING EAST-SOUTH-EAST.

FIG. 2. CIRCULAR HEAD, WITH BASALT IN THE FOREGROUND.


GEOLOGICAL SKETCH MAP
OF PART OF THE
NORTH COAST OF TASMANIA
FROM RIVER TAMAR TO CIRCULAR HEAD
AND
LONGITUDINAL SECTION OF SAME ALONG LINE MARKED ON MAP
SCALE OF MILES
Scale of original drawing - 1 mile to an inch
INDEX TO FORMATIONS
SEDIMENTARY ROCKS
ALLUVIUM.
DRIFT. (Including sand dunes and shingle beds).
TERTIARY.
PERMO-CARBONIFEROUS.
ROCKS OF UNDETERMINED AGE. (Probably Cambrian or pre-Cambrian)
LIMESTONE.
CONGLOMERATE
GLACIAL DRIFT
IGNEOUS ROCKS
BASALT.
DIABASE.
TRACHY-DOLERITE.
North Point
HALF MOON BAY
Circular Head
STANLEY
BLACK RIVER
RIVER DETENTION
Rocky Cape
HELLYER
Sisters I.
Table Cape
FREESTONE COVE
RIVER INGLIS
WYNYARD
EMU BAY
Blackman's Pt.
WIVENHOE
HEYBRIDGE
ULVERSTONE
RIVER LEVEN
Goat I.
RIVER FORTH
Don Bluff
RIVER DON
Mersey Bluff
RIVER MERSEY
Port Sorell Point
PORT SORELL
BURGESS
Little Badger Head
Badger Head
West Head
RIVER TAMAR
SEA LEVEL
Circular Head
Green Hills
Black River
Crayfish Creek
River Detention
Rocky Cape Range
Sisters Creek
Sisters Range
Jacobs Boat Harbour
Table Cape
Freestone Bluff
River Inglis
Seabrook Ck.
Woody Hill
River Cam
Cooey Ck.
Stony Ck.
Emu River
Chasm Ck.
River Blythe
Heybridge Rivulet
Sulphur Ck.
Penguin Ck.
River Leven
Buttons Creek
Clayton Rivulet
River Forth
River Don
River Mersey
Port Sorell
Asbestos Range
West Head
River Tamar
Junction of trachy-dolerite of Circular Head and basalt of Green Hills hidden by sand dunes and drift.
Altered slates with quartzite and conglomerates, and strong band of altered limestone.
Hard flaggy sandstones and slates much jointed and sometimes greatly folded, but generally dipping at low angles.
Blue and grey hard flaggy sandstones & sandy schists
Quartzite in massive bands highly inclined and much faulted. Occasional outcrops of slate and schist.
Quartzite massive and tumbled much contorted on line of strike with patches of local conglomerate.
Thick bedded basalt dipping seaward & partly overlying the trachy-dolerite of Table Cape.
Glacial drift with large rounded and sub-angular boulders of granite and silurian rocks and other moraine matter in infinite variety.
Clay slate and foliated schist and flaggy sandstone veined with white quartz in places and much cross-jointed.
Grey and parti-coloured slates with bands of quartzite.
Masses of hard conglomerate and breccia with slates and bands of hard altered sandstone and quartzite highly inclined and often veined with white quartz.
Hard altered sandstones and micaceous schists with bands of conglomerate, quartz schist, and quartzite.
Micaceous and quartz schists, black & grey slates and quartzite.
Basalt.
Basalt.
Diabase partly covered by tertiary drift.
Basalt.
Diabase.
Basalt
Reclaimed marsh land little above sea level.
Diabase partly covered by tertiary drift.
Diabase
Sand dunes and post-tertiary drift.
Sand dunes and post-tertiary drift.
Diabase.



FIGS. 1-5 & 8. ASTACOPSIDRILUS NOTABILIS, g.et sp.n. FIGS. 6, 7, 9. A. FUSIFORMIS, sp.n.



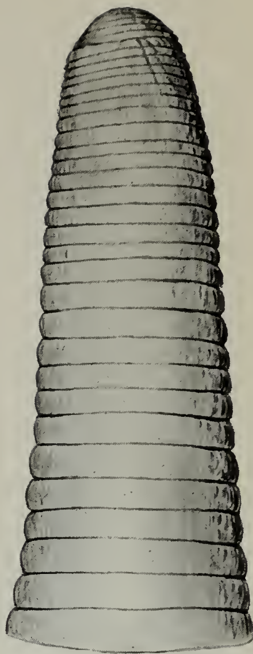
FIGS. 10, 11. ASTACOPSIDRILUS FUSIFORMIS. FIGS. 12-15. A. NOTABILIS.

XVI

XVII

ASTACOPSIDRILUS NOTABILIS, g.et sp.n

2



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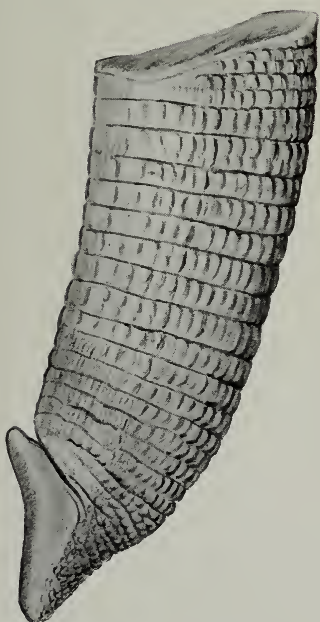
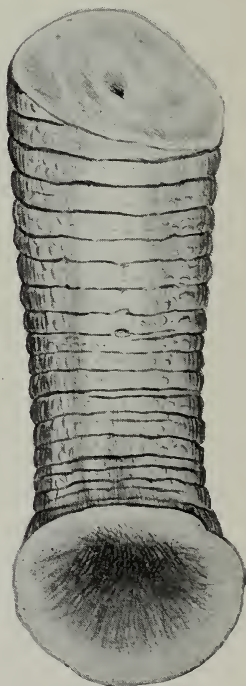
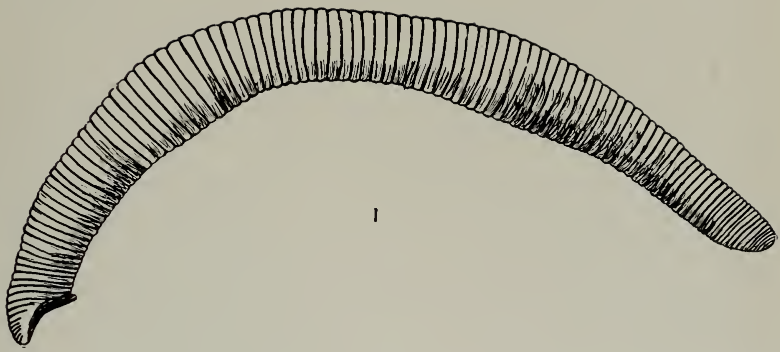


4



5

DINETA CYLINDRICA, g.et sp.n.



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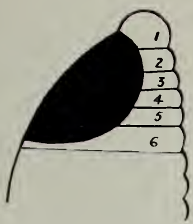

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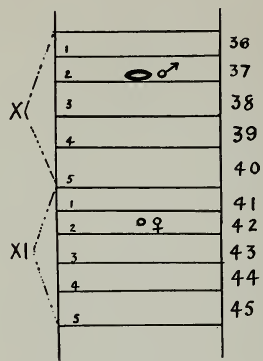

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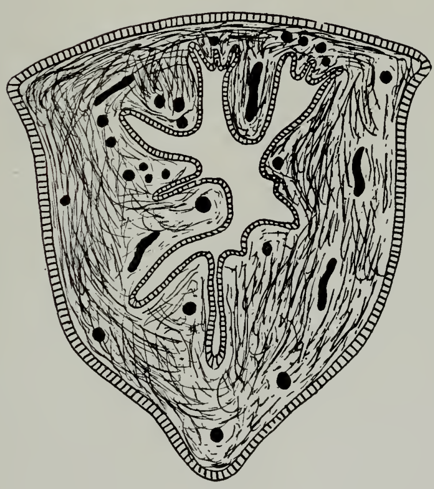
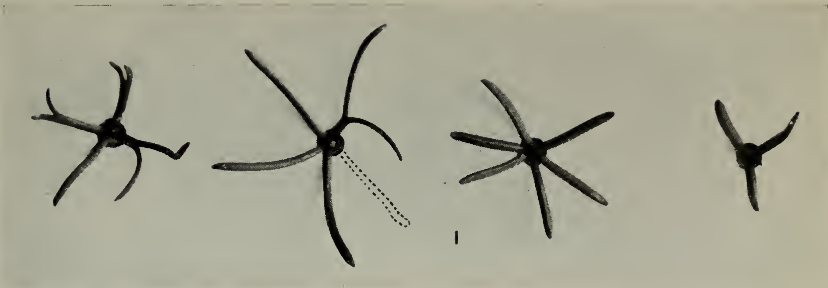


9

DINETA CYLINDRICA, g.et sp.n.

SEEDLINGS OF PERSOONIA spp.



1 2 3 4

5 6

7

8

FIGS. 1 - 4 (Top row) PERSOONIA spp.
FIGS. 5, 6 (Middle row) } NUYTSIA FLORIBUNDA R.Br.
FIGS. 7, 8 (Bottom row) }

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