

THE
PROCEEDINGS
OF THE
LINNEAN SOCIETY
OF
NEW SOUTH WALES

FOR THE YEAR

1930

VOL. LV.

With one Portrait, one coloured Plate, forty Plates
and 268 Text-figures.

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CORRIGENDA.

- Page 131, line 20, for *atripes*, n. sp. read *nigripes*, n. sp.
 Pages 137-139, for *Apistomyia indica* read *Apistomyia trilineata*
 Page 349, line 21, for *Winthemia albicens* read *Winthemia albiceps*
 Page 364, line —, the work on the History of the Botanic Gardens mentioned was read before the Royal Australian Historical Society in October, 1927, by R. H. Cambage, and published in the Proceedings of that Society, Vol. xiv, Part 1.
 Page 499, line 24, for *Atriplex acutivalvum* read *Atriplex acutibractum*
 Page 715, line 34, and Page 716, Text-figure 24, for *Pultenaea ellipticum* read *Pultenaea elliptica*
 Page 724, line 37, for *Angophora lanceolatus* read *Angophora lanceolata*
 Page 727, line 4 from bottom of page, for *Banksia ericifolium* read *Banksia ericifolia*

THE
PROCEEDINGS
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LINNEAN SOCIETY
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ANNUAL GENERAL MEETING.

WEDNESDAY, 26th MARCH, 1930.

The Fifty-fifth Annual General Meeting was held at Macleay House, 16. College Street, Sydney, on Wednesday evening, 26th March, 1930.

Dr. H. S. Halcro Wardlaw, President, in the Chair.

The minutes of the preceding Annual General Meeting (27th March, 1929) were read and confirmed.

PRESIDENTIAL ADDRESS.

The notable feature of the past year has been the successful conclusion of the negotiations for the erection of a Science House, to which reference has been made in the annual addresses of my predecessors. The steps leading to this may be summarized briefly for the information of members. In 1925 there began a series of conferences between representatives of this Society, the Royal Society of New South Wales and the Institution of Engineers, Australia, to consider the possibility of erecting jointly a Science House which might house most, if not all, of the scientific societies and bodies of Sydney.

After some preliminary discussions it was resolved to approach the Government of New South Wales to ask if the Government would be willing to grant a piece of land for the purpose. This was done and the Government immediately expressed its sympathy and instituted inquiries as to the possibility of complying with the request. The result was entirely satisfactory and finally three sites offered were inspected by representatives of the three Societies. Preference was expressed for the site at the corner of Essex and Gloucester Streets. Before this site could be granted to the Societies it was necessary for the Government to pass an enabling Act, and accordingly an "Act to enable the Crown to grant certain land situate in Gloucester and Essex Streets, Sydney, to the Royal Society of New South Wales, the Linnean Society of New South Wales, and the Institution of Engineers, Australia, for the purpose of erecting a Science House; and for purposes connected therewith" was placed before Parliament and passed by both Houses in May and June, 1928. It then became necessary for the three Societies and the Government

to agree on a form in which the Grant would be acceptable to all. Unforeseen difficulties cropped up and caused delay, but agreement was finally arrived at and the deed of grant was drawn up and completed.

Meanwhile the three Societies had promoted an architectural competition for the design of the proposed building, mainly with the object of securing an architect, one of the provisions of the competition being that the successful competitor should be employed to carry out the work unless the adjudicators and promoters were satisfied that there was some valid objection to his employment. The competition attracted considerable notice and of the thirty-three designs submitted, the adjudicators (Messrs. G. J. Oakeshott, Howard Joseland and J. L. Berry) placed as the first three those submitted by the following: i, Messrs. Peddle, Thorp and Walker; ii, Mr. Leith C. McCredie; iii, Mr. John Crust. Subsequent examination of the financial aspect of the scheme resulted in the adoption of some modification of the original plans.

Further difficulties were met when the representatives of the three Societies came to the task of drawing up for submission to the Councils an Agreement embodying the conditions under which Science House was to be built and administered. These difficulties were ultimately overcome and an Agreement was drawn up and accepted by the three bodies concerned.

The negotiations have occupied a long period during which there have been times when it appeared as if it might be impossible for final agreement to be reached by the three Societies. The difficulties that arose from time to time caused your Council much anxious thought and also called for tactful action by your representatives on the Joint Committees, which have conducted much of the negotiation. The final Agreement has only been achieved after exhaustive discussions during the course of which each of the three Councils has from time to time agreed to make concessions for the purpose of attaining the desired objective. The task of drawing up the Agreement between the three Societies made considerable demands upon the time and the tact of your representatives on the Provisional Management Committee which was appointed in December, 1928. In the deliberations of that Committee during the period of many difficulties, much valuable service was rendered this Society by Mr. Cheel and Dr. Walkom. The Agreement having been completed, tenders for the erection of the building were called and of fourteen tenders received the successful one was that of Messrs. John Grant and Sons for the erection of a building of six storeys at a cost of £38,750. The contract has been finalized and it provides for the completion of the building within thirty-nine weeks, so Science House should be ready for occupation about the end of 1930.

On the Joint Management Committee, which will control and administer the building on behalf of the three Societies, your Council has appointed Dr. G. A. Waterhouse and Dr. A. B. Walkom as representatives of the Linnean Society.

It is very gratifying to note the successful work accomplished by the Australian Expedition to the Antarctic under the leadership of Sir Douglas Mawson. In January I joined with the Presidents of the Australian National Research Council, the Australasian Association for the Advancement of Science and the Royal Society of New South Wales in sending the following message by radio to the leader of the Expedition:

"We, Sir Thomas Lyle, President Australian National Research Council, Andrews, President Australasian Association Advancement of Science, Professor

Cotton, President Royal Society New South Wales, Doctor Wardlaw, President Linnean Society of New South Wales congratulate you and Captain Davis and all on *Discovery* on success already achieved. We have high hopes for your future. We admire your splendid efforts for Science and wish you all God speed and safe return."

This was in due course acknowledged in the following radio message from the leader of the Expedition: "Self and staff greatly appreciated your stimulating message which arrived duly. Mawson."

The fact that we receive regular news from the Expedition by wireless makes us inclined to discount the dangers and discomforts to which members of the Expedition are subject, but we should not thus overlook the hardships endured by the Expedition in pursuit of the advancement of Science.

The British Scientific Expedition to the Great Barrier Reef completed its year's work about the end of July last, and the scientific results are expected to be highly satisfactory. The programme of work originally drawn up was practically completed and it was found possible for some of it to be carried out in greater detail than was anticipated. In addition there were some important extensions of the original proposals, chief amongst them being researches on the effect of sediment on corals, and the making of a series of hand bores in various parts of the reef, showing the substratum to be soft mud. The range of work was a very wide one and the published results, when available, will form an important addition to the literature of coral reefs and life in tropical seas. The purely scientific work included observations on plankton; hydrography; ecology of the coral reefs; breeding, development and growth of corals and other reef organisms; and feeding, digestion, respiration, and significance of symbiotic algae in corals and in clams. In addition considerable geographical work was done in the reef area and on adjacent coasts.

Besides the pure scientific work, much attention was given to economic problems associated with the reef—including work on Trochus, Pearl shell, Beche-de-mer, Oysters, Fish, Turtles and Sponges—resulting in the accumulation of a considerable amount of interesting and valuable information as to the possibilities of taking advantage of these assets.

One of the most gratifying results of the success of the Expedition is the determination of the Queensland Government to carry on much of the marine biological work initiated by the Expedition and to maintain the station at Low Island where the Expedition had its headquarters.

When the Council decided to institute an annual lecture as a memorial to the late J. J. Fletcher, it invited Sir Baldwin Spencer, as one of Mr. Fletcher's oldest and closest friends, to deliver the first lecture of the series. Sir Baldwin accepted the invitation, but his death in Patagonia during last year has deprived members of the opportunity of hearing him speak of our late Secretary and President. The Council had, therefore, to select another lecturer. Their choice fell on Mr. A. H. S. Lucas, who has accepted the invitation to deliver the first Fletcher Memorial Lecture during 1930.

The second number of the Memorial Series containing an appreciation of the late J. J. Fletcher, written by the late Sir Baldwin Spencer, has been issued.

With the object of making available to the public accurate representations in colour of species of the native flora, your Council has agreed to a scheme for the publication from time to time of coloured plates depicting selected species of

Australian wild flowers. These plates will appear as supplements to the Proceedings and it is hoped to issue two or more each year. It is the intention to print extra copies, not only of the plates themselves, but also on post cards, both plates and post cards being made available for sale.

The occurrence of vacancies on the National Park Trust during 1929 gave an opportunity for the scientific societies to move for the appointment of representatives on the Trust. A deputation met the Minister for Lands and put the views of the Societies before him and as a result Professor T. G. B. Osborn was appointed a member of the Trust.

It is pleasing to be able to report that in June last the Government again extended for a further period of one year protection to species of native plants which have been threatened with extinction by indiscriminate picking. It is apparent that this wise measure of protection is having a beneficial effect in the preservation of some of the most striking and beautiful of our native flowers.

Dr. Walkom was granted leave of absence to enable him to accept an invitation to attend the meeting of the British Association for the Advancement of Science in South Africa during July and August last. The meetings were held in Cape Town and Johannesburg, and visiting members were given ample opportunity of seeing various parts of the country. On his return Dr. Walkom gave a short account of some of his impressions and particularly of the Kirstenbosch National Botanic Garden at Cape Town. This garden is claimed to be the only one in the world maintained wholly for the cultivation and study of the native flora. Following on this it was resolved by this Society "that the State Government be urged to set apart an area of Crown land for the purpose of cultivating, preserving and exhibiting the native flora". A Committee has been elected by the Council to further the objects of the resolution, and the matter has been placed before the Government. This Committee has drawn up a scheme in connection with this matter, involving for the present the reservation of a single area only, and this will be placed before the authorities at an early date.

The concluding part of Volume liv of the Society's PROCEEDINGS was issued in February. The complete volume (694 plus xcvi pages, thirty plates and 211 text-figures) contains thirty-seven papers from twenty-seven authors. In addition to the usual variety of papers, the volume included the completion of the address prepared by the late J. J. Fletcher on "The Society's Heritage from the Macleays". Mr. Fletcher did not actually complete the preparation of this before his death, but his accumulated notes were handed over to the Society by Mrs. Fletcher and these were prepared for publication by Dr. Walkom.

I take this opportunity of paying the Society's tribute to the late Doctor Henry William Armit who, for some years, has been responsible for the high standard of printing attained in the PROCEEDINGS, and whose sudden death on 12th March last came as a great shock to us.

Exchange relations with scientific societies and institutions continue to be satisfactory. The receipts for the year total 2,084, as compared with 1,777, 2,540 and 1,821 for previous sessions. During the year the following institutions have been added to the exchange list which now numbers 219: Entomological Department of the National Museum, Prague; Faculté des Sciences de l'Université Masaryk, Brno, Czechoslovakia; Laboratorio di Entomologia, R. Istituto Superiore Agrario, Bologna; Nasionale Museum, Bloemfontein; and University of Lund, Lund, Sweden.

The vacancy on the Council caused by the resignation of Dr. I. M. Mackerras on account of his removal to Canberra, was filled by the election of Professor W. J. Dakin, D.Sc. A further vacancy has now resulted from Dr. Nicholson's transfer to Canberra and will be filled by the Council at its next meeting.

Since the last Annual Meeting, thirteen Ordinary Members have been elected, four have resigned and we have lost by death one Ordinary Member and one Corresponding Member. The names of three members have been removed from the list on account of arrears of subscription.

WALTER BALDWIN SPENCER, born at Stretford, Lancashire, in 1860, died at Ushuaia, Patagonia, on July 14, 1929. His death removes one who has taken a leading part in the advance of Biology and Anthropology in Australia during the last forty years. He came to Victoria as Professor of Biology in 1887 and from the time of his arrival he exercised a marked influence on the development of scientific activities in Australia. His own researches covered a wide field, first in biology and later in anthropology, and he was an artist of no mean ability. He accompanied the Horn Expedition to Central Australia in 1894; he acted in 1912 as Special Commissioner and Chief Protector of Aborigines in the Northern Territory, furnishing a valuable report to the Government as a result of his year's observations. He was perhaps most widely known for his works on the Australian aboriginals—*The Native Tribes of Central Australia* (1899), *The Northern Tribes of Central Australia* (1904), *Across Australia* (1912), *The Native Tribes of the Northern Territory*, *The Arunta* (1927) and *Wanderings in Wild Australia* (1928)—most of which were accomplished in collaboration with the late F. J. Gillen.

He was knighted in 1916, and on his retirement from active University work in Melbourne, was appointed Emeritus Professor. He was elected a Corresponding Member of this Society in 1893, having contributed to the Macleay Memorial Volume.

For nearly half a century Sir Baldwin Spencer has been an inspiring figure in the scientific life of Australia. His death, perhaps, is even more inspiring than his life. At an age when he might have been taking his well earned rest, he set out to engage in active anthropological research under conditions which might have given pause to the most vigorous man, and which indeed proved too severe.

ARTHUR ANDREW HAMILTON, born at Liverpool, England, on 9th September, 1855, died at his home at Croydon on 23rd April, 1929, in his seventy-fourth year. Before coming to Australia he was for some years engaged in the emigration traffic from England to Canada, and he travelled extensively in the northern and western parts of Canada, as well as in southern United States and Mexico. He arrived in Melbourne in 1880 and proceeded to New Zealand, where he was employed on a station in the Waikato district. Whilst he was there a rush took place to the Thames goldfields at Te Aroha, in which he joined. Later, in 1887, he came to Sydney and obtained employment during the formation of portion of Centennial Park. On the completion of this he was appointed to a permanent position in the Botanic Gardens, and when the late Mr. Maiden took control, Mr. Hamilton was afforded an opportunity of conducting experimental work in the cultivation of Australian plants, of which between six and seven hundred were grown. In 1911 he was appointed Botanical Assistant in the National Herbarium. After his retirement in 1920 he was for a time Secretary to the

Chamber of Agriculture and Metropolitan Branch of the Agricultural Bureau. He joined this Society in 1899 and had almost completed thirty years' membership at the time of his death. He was also a member of the Royal Society of New South Wales for a number of years, had filled the offices of President and Honorary Secretary of the Naturalists' Society, and was an active member of the Horticultural Association.

From the time of his election to membership till 1923 he was a regular and interested attendant at the meetings of this Society, and he contributed in no small measure to the success of the meetings by his frequent exhibition of interesting botanical specimens during the years 1900-1923. He also contributed seven papers to the PROCEEDINGS, mostly on ecological and taxonomic botany, between 1910 and 1920, the most notable being those on the flora of the Blue Mountains (1915) and the Saltmarsh Vegetation of the Port Jackson District (1919). He also published papers in the *Journal of the Royal Society of New South Wales*, as well as numerous notes in more popular journals and magazines.

The year's work of the Society's research staff may be summarized thus:

Mr. H. L. Jensen, Macleay Bacteriologist to the Society, arrived in Sydney on 19th September, 1929, and was welcomed at the September monthly meeting of the Society.

Before his arrival the Council had approached the Senate of the University with the object of obtaining laboratory accommodation for the Bacteriologist at the University and satisfactory arrangements were made for him to carry on his research work in the Department of Agriculture of the University. Mr. Jensen took up his duties without delay and, as the whole of the Bacteriologist's equipment had been placed in store after the death of Dr. Greig Smith, the first task was to release this and to fit up his laboratory ready for work. This done, he was able to commence his research, and he thought at first to study bacteria which decompose heterocyclic N-compounds, especially purine derivatives, but the difficulty of procuring these chemicals led to the abandonment of this plan for the time. In its place a study of the microbiology of arid and irrigated soils was commenced. Examination of soils from typical "dry-farming" areas confirmed the statement of American soil bacteriologists that the microflora of such soils is characterized by a particular abundance in actinomycetes. About sixty strains of actinomycetes have been isolated and are being kept under observation; the majority apparently represent new and undescribed forms. It is proposed to continue the study of these organisms with the object of discovering whether they are capable of decomposing lignins and humic matter—no single organism in pure culture having yet been shown definitely to be capable of this decomposition. An interesting group of organisms, evidently belonging to the genus *Micromonospora* Oerskov, has been isolated and it is hoped to publish an account of the morphology and physiology of the group in the near future.

Miss H. Claire Weekes, Linnean Macleay Fellow of the Society in Zoology, was awarded a fellowship by the Rockefeller Foundation and asked the Council's permission to resign her Linnean Macleay Fellowship at the end of July. Her request was granted and she left for England during August and is now working under Professor J. P. Hill, an Honorary Member of the Society, at University College, London. She occupied the months during which she held her Fellowship in studying placentation in six species of viviparous lizards which she had collected in Tasmania. This paper was practically complete at the time of her resignation,

but she has taken advantage of the opportunity to submit it to Professor J. P. Hill before handing it in for publication.

Miss Ida A. Brown, Linnean Macleay Fellow of the Society in Geology, spent the first portion of the year in the preparation for publication of two papers which appeared in the PROCEEDINGS for 1929—"Preliminary Note on Monzonitic and Nepheline-bearing Rocks of Mount Dromedary, N.S.W." and "A Garnet-bearing Dyke near Moruya, N.S.W."

She was granted leave by the Council to attend the Fourth Pacific Science Congress in Java in May. Her attendance at the geological and vulcanological meetings and excursions at this Congress and the personal association with geologists from many countries round the Pacific should be of the greatest value in her future geological work. On her return she completed the preparation of a paper on the Devonian and Older Palaeozoic Rocks of the South Coast. Further work has been done on the geology of the Mount Dromedary district, particularly in the examination and chemical analysis of some of the peculiar rock types mentioned in the preliminary note already published. Advantage was taken of an opportunity which offered, to examine in the field the Tertiary Marine sediments in the Gippsland Lake district, and in other areas along the coast of Victoria and South Australia. This should materially aid in her description of the Tertiary sediments near Lake Corunna, N.S.W., the most northerly extensions known of the southern Tertiary beds.

During the coming year Miss Brown proposes to continue investigations on the geology of the South Coast of New South Wales, dealing with problems of the geological age, conditions of sedimentation, mutual relationships and subsequent tectonic history of the sedimentary rocks, and the relationships, petrogenesis and correlation of the associated igneous rocks.

Two applications for Linnean Macleay Fellowships, 1930-31, were received in response to the Council's invitation of 25th September, 1929. I have pleasure in reminding you that the Council reappointed Miss Ida Alison Brown, B.Sc., to a Fellowship in Geology and appointed Mr. Frank Alfred Craft, B.Sc., to a Fellowship in Geography for one year from 1st March, 1930, and in wishing them a successful year's research.

Mr. Frank Alfred Craft, B.Sc., is the first Linnean Macleay Fellow in Geography. He graduated in Science at the University of Sydney with First Class Honours and University Medal in Geography in March, 1927. He was awarded a Government Research Scholarship for 1927. The results of his work during this period are contained in two papers in the PROCEEDINGS for 1928, describing the physiography of the basins of the Cox and Wollondilly Rivers. During 1928 and 1929 Mr. Craft has been teaching geography at the Maitland Boys' High School and has continued reading in connection with his proposed research work. He proposes to devote his year's tenure of a Fellowship to an extension of his previous work to include the valley of the Shoalhaven River, an area including the Gourock, Currockbilly and Sassafra Ranges and the valley of the Shoalhaven from the source of the river through Braidwood and Nerriga to Tallong, where it would link up with his previous work. He hopes to compile form line maps of areas at Tallong and Nerriga in an attempt to decide the question of suggested stream capture between the Wollondilly and Shoalhaven Rivers. Mr. Craft's earlier papers, and the difficult field work which they involved, have provided ample evidence of his enthusiasm and ability to carry out the work

he proposes and we look forward to a series of valuable and interesting results from his work as a Fellow.

SOME ASPECTS OF THE ADAPTATION OF LIVING ORGANISMS TO THEIR ENVIRONMENT.

Our interests as members of this Society lead us to consider the relation of living things to their environment from many points of view. We are on the whole, perhaps, more usually concerned with the morphological aspects of this relation, but in this portion of my address I wish to direct attention to certain chemical relationships which subsist between the living organism and its surroundings. After all, the chemical constitution of bodies may be regarded merely as a more intimate expression of their morphology, as an expression involving smaller units than those which are commonly studied by visual examination. And in considering the material relationships between a living organism and its environment we cannot ignore the relationships involving exchanges of energy. The conditions of the former are to some extent determined by the requirements of the latter. A survey of this kind would involve the discussion of a wide range of questions. I wish to refer only to one or two of these upon which biochemical information appears to have thrown light, and to discuss one or two examples where adaptations have more obviously been brought about by chemical adjustments.

The thesis which I wish to submit to you may be expressed in two statements: that the changes which living organisms have undergone in adapting themselves to their environment have had as their object the maintenance unchanged of certain essential characters, and that the organism which has most successfully adapted itself to its surroundings is that which has acquired, to the greatest extent, the power of adapting its environment to its needs.

The most bewildering diversity of forms is met with among living things. All these variations of structure may, no doubt, be regarded as adaptations of one kind or another to the various environments in which the different organisms are to be found. It will be as well, therefore, to make clear at the outset what I wish to be understood by my use of the phrase "adaptation to environment", and then to go on to see whether any common factor can be found for the superficially diverse means by which the living organism seeks to attain this adaptation, before discussing any particular examples of adaptive mechanisms.

By the term environment I mean that portion of its surroundings with which an organism can enter into exchanges of matter and energy. The limits of the environment may be hard to define, and will depend upon the particular exchanges which are being considered. In the more complex organisms one part may be the environment of the rest.

I shall use the term adaptation as implying broadly any means by which an organism is enabled to survive in its surroundings, not as an individual but as a species. The term so understood means not merely the ability to survive, but the ability to survive without alteration of certain characters. A moment's reflection will show that, by this criterion, we have no convincing evidence that any living organism has yet proved itself to be completely adapted to its environment. On every hand evidence is daily being brought to light of species which have become extinct, and yet the members of every living species must have descended, in unbroken succession, from individuals of one or other of those extinct species. Those transient species were obviously not completely adapted to their surroundings, but there was within the living

matter of the individuals which composed them, some more effective type of adaptation which has enabled it to survive the impermanence of its external form.

The extinction of so many species has been due, not so much, perhaps, to their inability to adapt themselves to their surroundings, as to their inability to make their adaptations quickly enough to keep pace with their changing environment. For, during the ages which have passed since living forms first made their appearance, the nature of their environment has, no doubt, altered as profoundly as have the living organisms themselves.

Even the simplest living organism seems to be much more complex than any inanimate system of which we have detailed knowledge. But there is no valid reason for supposing that processes other than those which are described as physical or chemical play any part in their fundamental reactions. We may, therefore, expect the behaviour of the living organism to show many similarities and analogies to that of inanimate systems in their relation to their environment. On the other hand, there are what at present seem to be rather characteristic differences between the two types of system, although, on close analysis, these distinctions become hard to draw.

A general property of inanimate physical systems is their tendency to reach a state of equilibrium, that is, they tend to reach a state in which exchanges of matter and energy between the various parts of the system, and between the system and its surroundings are no longer apparent. It is true that it may be possible to demonstrate that fluctuations in the state of different parts have not entirely ceased in a system which has reached this condition, but these changes which still continue do not lead to any gross or permanent redistribution of matter or energy.

The same property which makes any physical system tend to reach a state of equilibrium, will also resist any agency which tends to disturb this state. If an attempt is made to change such a system in any way the system will react so that the change produced is not as great as it would have been if such a reaction had not taken place. For example, if a volume of gas be heated at constant pressure it will expand, and in expanding it will cool, so that the total rise of temperature will not be as great as it would have been had the gas not expanded. This system resists the rise of temperature due to heating. Again, many substances, when they are dissolved in water, cause the temperature of the resulting solution to fall. But these substances are less soluble in the colder water, so that less will dissolve than would have if the temperature had not fallen. The system resists the change of concentration caused by the substance going into solution. This behaviour is known as the principle of Le Chatelier.

The reaction of a living organism to changes of its environment is not, however, limited to that which would take place according to the principle of Le Chatelier. In the first place a living organism is continually expending energy, and so prevents itself from ever attaining a state of equilibrium with its surroundings. Further, it is provided with regulatory mechanisms which not merely resist changes due to alterations of environment, but which are able to neutralize, even to reverse, their effects.

Some of these regulating mechanisms are remarkably efficient. Their object is to maintain unchanged any system of which they are a part. But no such mechanism, however perfect it may be, can render an organism completely independent of external changes. Some response to these changes, however

small that response may be, is necessary to set the adjusting mechanism in action, and this mechanism, once set in motion, will not cease to act until the condition aimed at is overshot, no matter how slightly. Such an effect is common to all governing mechanisms. All that they can do is to ensure that the variations imposed upon the organism by a changing environment shall be restricted within certain limits. The more effective the mechanism is, the closer together will these limits be.

Broadly speaking, we may say that the living organism first protects itself against the variations of its surroundings by placing barriers between itself and its environment. The process of encystment and the formation of spores are what appear to be simple examples of this type of reaction which are shown by very simple organisms. Even more highly developed organisms make use of devices of this kind at some stage of their life histories, as in the formation of seeds by plants.

There is no doubt about the effectiveness of such a mechanism for protecting an organism against unfavourable changes of its environment. The extreme difficulty with which the spores of certain microorganisms are destroyed, even by the most drastic treatment, is well known. The tenacity with which the seeds of certain plants retain their viability has been demonstrated by Cambage (1928) who showed that seeds of *Acacia melanoxyton* were capable of germination after ten years' soaking in sea water. In its simplest form, however, a protective mechanism of this kind imposes severe restrictions upon the organism using it. At times such an organism must purchase its survival by an almost complete suspension of its vital activities. The mechanism can do no more than protect the organism from destruction by extremes of variation in its environment, and appears to display the phenomenon of adaptation in its crudest form. It is a regulatory mechanism which permits of wide variation in the rate at which the organism is able to carry on its activities. Except for this power of passive resistance, an organism limited to this kind of adaptive mechanism is still very largely at the mercy of its environment.

Another way in which an organism may place a barrier between itself and certain parts of its surroundings is by removing itself from those parts. It is able to do this when possessed of the property of motility which is shown even by some of the most primitive forms of life. As an adaptive mechanism, motility in many ways is a distinct advance beyond processes similar to encystment. The motile organism is able to make use of one part of its environment to protect itself against another. Instead of erecting about itself, when conditions become unfavourable, barriers composed of its own substance, it is able to place parts of its environment between itself and those conditions.

It is evident that the freedom of an organism possessing motility must be much greater than that of similar organisms without this mechanism. Its effect is to render unnecessary many of the variations of activity to which the non-motile organism must be subject, by avoiding many of the occasions on which those variations would occur. It is an adaptive mechanism which avoids many adaptive modifications on the part of the organism. In addition it is capable of being much more selective in action than a mechanism which withdraws the organism from a condition of interchange with its environment. The working of this mechanism is seen most clearly perhaps in the tropisms which many of the more primitive living forms display. The movements of the more complex organisms

do not always bear such an evident relation to the effects of environment as do those of the simpler. They are complicated as a rule by the simultaneous action of many other adaptive mechanisms. The large scale movements, however, even of the higher animals, such as migrations, are sufficiently analogous to tropisms to suggest that they may be the results of some common underlying mechanism.

An organism possessed of the property of motility is considerably more independent of its surroundings than an organism limited to the type of adaptive mechanism first discussed, but its chances of survival are not necessarily greater. While it does survive, however, its vital activities are likely to be much less subject to variation than those of an organism whose only protection is quiescence.

Although this mechanism shows a great advance over that previously discussed, its effectiveness is still decidedly limited. It is, no doubt, adequate for those simple organisms whose normal environment is not subject to much simultaneous variation in several components. Such a mechanism is likely to break down, if not assisted by other regulatory devices, when the organism is faced with concurrent changes of different factors of its environment. Removal of the organism from a portion of its environment unfavourable in one respect may deprive it of conditions which may be favourable in other respects. An organism restricted to this type of adaptive mechanism, or even possessing it in addition to the power of becoming encysted, would often find itself in a dilemma.

Primitive relations between organism and environment.

The action of all of the mechanisms which regulate the chemical relations of the organism is essentially to control the exchange of material which takes place between the organism and its surroundings. In its crudest form this mechanism acts simply by abolishing interchange between organism and environment when the characters of the latter become unsuitable. As these mechanisms develop in effectiveness, and, incidentally, in complexity, so do they increase in selectivity. They become able to control independently the exchange of a wide variety of substances with the outside world, and so to regulate the concentrations of these substances in contact with the living matter that the organism may carry on its activities with a minimum of adventitious disturbance.

The fact that the living organisms of today have evolved from more primitive forms seems to involve the assumption that the mechanisms which have enabled living matter to survive have done so because of their ability to preserve at least some of its primitive characters. It will be interesting, therefore, to cite evidence which has been adduced in support of the hypothesis that living organisms tend to retain some of the properties which they may have possessed at very early stages of their evolution, no matter how complex they have eventually become.

Conjectures as to the series of reactions which may have led to the appearance of organic matter out of which the first living organisms were formed need not concern us. We are more concerned at the moment with the conditions of environment which may have existed when living forms were in the early stages of their evolution. It may be mentioned, however, that investigations such as those of Moore (1914) and of Baly (1927) and their co-workers have indicated the possibility of the synthesis of naturally occurring organic compounds from water, carbon dioxide and inorganic salts under the influence of radiant energy and in the presence of inorganic catalysts.

No matter what the conditions may have been under which living matter first arose, they were obviously favourable to its appearance. Conversely, since the first living organism may be assumed to have been a direct product of its environment, there can be no doubt but that it was eminently well adapted to its surroundings. In the meantime, the conditions surrounding the living organism have undergone tremendous changes. As far as we know, none of the living organisms of the present day can be regarded as direct products of their environment.

When the composition of one of the higher forms of animal life is compared with that of its surroundings, the differences which are observed are much more obvious than the resemblances. Out of some eighty elements around it, the organism chooses four from which to build up about ninety-five parts out of every hundred of its substance. When, however, certain parts of an organism are compared with certain kinds of environment, a much closer correspondence can sometimes be seen, and there are indications that more intimate relations may once have prevailed between the two than can now be shown.

There must have been something fundamentally essential in the conditions under which life began. The enormous development of complexity which has taken place in some of the living organisms of the present day can be traced largely to the series of modifications which seem to have had for their object, the maintenance, in the immediate vicinity of living matter, of conditions resembling those of its primitive state. From this point of view the whole story of evolution is one of adaptation to environment. It is a history of the mechanisms developed, of the subterfuges resorted to, of the changes undergone by living matter to maintain essential characters unchanged in a changing world.

There seems to be a general agreement among biologists that living forms originated in the sea. The chemical examination of organisms supports this view. All the reactions of living matter take place in aqueous solution. The ultimate units of structure, the cells, even of the most highly developed land forms, still live in a medium which bears certain striking resemblances to sea water.

We have no direct means of knowing what was the composition of the aqueous medium in which living matter first made its appearance. It must, however, have been a dilute salt solution, but of a composition differing materially from the sea water of the present time with respect both to the concentrations of and the proportions between the various ions present. The water which first condensed on the cooling surface of the earth would, in its course downwards to the lower levels, begin to leach out the soluble materials with which it came into contact. The more soluble materials would dissolve more readily than the less soluble. As this leaching action continued, the available supplies of the more soluble materials would diminish more rapidly than the available supplies of the less soluble substances. It may be assumed, then, that the earlier river waters, and the seas which they fed, were relatively richer in these more soluble materials than the waters of later periods.

During the period of their evolution in the waters of the seas, living organisms have thus been exposed to a medium of continuously, if slowly, altering composition. Does the study of the chemical composition of the living organism of the present afford any evidence that it has passed through these conditions? The individuals of the more highly evolved species during their ontogeny pass through a series of modifications of structure which summarize, as it were, the stages through which the present form of the species has been reached during the

course of evolution. Macallum (1926) has shown that there is reason to believe that just as the complex organism acquired certain structures at definite stages of its evolution, so it has perpetuated certain of its chemical properties from remote phases of the history of its forerunners.

Chemical and morphological characters.

At present the ontogeny of the chemical characters of organisms is not known with anything like the detail which is available with regard to their morphological development. A similar state of affairs exists with regard to our knowledge of the chemical phylogeny of living forms. The palaeontologist has access in the sedimentary rocks to records of extinct species from which he can reconstruct at least some of their morphology. But as a rule the chemical characters of extinct organisms do not leave any direct record in the rocks. The information which we have as to the composition of extinct organisms is largely based on analogies drawn from our knowledge of the composition of existing structures homologous with those observed in fossil remains, or from the persistence of structures which were mainly composed of inorganic material.

Fortunately this rule is not entirely without exceptions. In one or two rare instances there is reason to believe that organic compounds present in long extinct organisms have been preserved from the remote past. It is a matter of pride to us to know that the latest of these rare discoveries has been made by a distinguished member of this Society, our esteemed past president, Sir Edgeworth David. In the course of the examinations made in connection with his discovery of structures of living origin in Pre-Cambrian strata, David (1928) observed that some of these structures consist of organic matter which is apparently the original chitin of which the skeletons of these animal (annelids) were largely composed.

Direct glimpses like this into what has been termed the palaeochemistry of living things are of great importance. They give direct support to the otherwise very indirect evidence upon which is based our belief in the stability of some of the chemical characters of living organisms.

The paucity of our knowledge of the detailed composition of living things does not permit us to classify them in such small subdivisions as are made possible by our more detailed knowledge of their morphology. In this connection, however, the pioneering work of Smith and Baker (1920) must receive due mention. These investigators in their now classical researches followed out the relation between certain of the chemical constituents and the structure of a group of Australian plants.

Investigations of this kind, however, relate rather to the association which is to be found between highly specialized structures and compounds in living things. They bring out the changes which have taken place during the evolution of the chemical characters of living things rather than emphasize the relative permanence of some of the more primitive of these characters.

When we wish to consider the more fundamental chemical characters of the living organism, we must examine the less highly specialized tissues, and the wider divisions of morphological differentiation. We must study the distribution of relatively simple inorganic compounds, rather than that of the highly complex organic substances. Only when comparisons are made on the basis of such broad distinctions of form as that between organisms having a closed circulatory system

and those without it, are correspondingly fundamental differences of chemical properties to be discerned.

The proportions of certain constituents of the organism and its environment.

There is no doubt that the unicellular organisms represent an earlier stage in the evolution of living things than do the metazoan or metaphytan forms. They probably flourished in the primordial oceans for long periods before multicellular organisms made their appearance. They must have been much more closely related to the medium from which they had been produced than the later forms. In particular, their inorganic constituents are likely to have corresponded fairly closely with those of the medium which bathed their cells. The differentiation between the medium and its product had not proceeded as far as it has reached in more complex forms of life.

It has been pointed out, however, that the inorganic composition of these primitive oceans must have been changing all the time. The effect of regulatory mechanisms in the cell would be to hinder, if not entirely to prevent, the changes from reaching the interior of the cell itself. By the time that living organisms had reached the state of complexity of the primitive multicellular structure, we may imagine them as groups of cells permeated by a solution which showed distinct differences in inorganic composition from that of the solution which bathed them. At first the surrounding medium would have free access to the cells of such a simple organism. But, as the complexity of the organism developed, access would become restricted to certain channels forming a primitive open circulatory system. The next stage in complexity would be the closure of these channels against the free ingress and egress of the surrounding medium, and the development of a closed circulatory system.

At this stage of evolution, the first barrier controlling the exchanges which take place between the cell and its environment would no longer be situated on the surface of the cell itself. Any changes which reached the liquid actually surrounding the cells would first be subject to the regulatory mechanisms in the outer surface of the organism and in the circulating fluid. The cell would be provided with an immediate environment to some extent under the control of the organism itself.

During all the period necessary for these developments, the change of composition of the surrounding medium would be still in progress. But once the action of a closed circulatory system became effective, the changes in composition of the medium bathing the cells would not proceed so rapidly. Although the composition of the external medium might continue to change, the changes would only reach the circulating fluid, the internal environment of the cells, in a modified form. The organism would tend to preserve the composition of the fluid with which it had been bathed while a closed circulatory system was being evolved.

Such an organism would be capable of very considerable independence of its external medium, an independence which would increase as its external regulatory mechanisms grew in perfection. Not until living organisms had reached this stage of complexity would they become able to emerge from the medium in which they had evolved, and their appearance as land forms of multicellular organisms become possible.

It is well known that the inorganic composition of the cells of various tissues of an organism differs materially from the inorganic composition of the circulatory fluid. According to the hypothesis outlined above, the inorganic constituents of the cells ought to correspond to those of sea water at an early stage in the evolution of living things. The composition of the circulating fluid ought, on the other hand, to correspond, with regard to its inorganic constituents, to the composition of sea water of a much later period.

Macallum (1926) has collected a good deal of evidence in developing this hypothesis. The most striking difference between the inorganic constituents present in the cells and those in the circulating fluids of one of the higher animals is the relative abundance of salts of potassium in the former and of salts of sodium in the latter. There is a remarkably close correspondence between the proportions of these two elements in the circulating fluid of the most highly organized living forms which have so far been developed and in the sea water of the present day. If the comparison could be made with the composition of the sea water during the period in which the vertebrates first appeared, the correspondence would perhaps be still closer, owing to the slightly greater proportion of potassium in the sea water of that period.

The difficulties in the way of forming an accurate estimate of the composition of sea water during the comparatively recent geological epoch in which vertebrates appeared are great enough. Much greater are those difficulties in the way of an attempt to form a similar estimate of the composition of the sea water of the remote age during which unicellular organisms were evolving. Even though no attempt has been made to fix the proportion within narrow limits, it seems likely that the proportion of potassium to sodium must have been many times as great as it is at present. With respect to these elements, the composition of those primaeval seas must have been considerably closer to that of the cell contents of the present day than to that of the circulating fluid.

Even when such diverse cellular tissues as human muscle and herring ova are examined, the difference between the relative proportions of sodium and potassium is not very marked. A general similarity of the proportions of these elements in cellular tissues is apparent. These considerations have been used to support the hypothesis that the living organism has retained with remarkable tenacity certain of the chemical characters imposed upon it at remote periods of its evolution.

The concentration of the environment of cells.

So far only the proportions between certain elements in living tissue have been considered. It may now be asked whether the actual concentrations of chemical substances present also show any relation to those of the medium within which living organisms evolved during a considerable period of their history.

The most convenient single measure of the total concentration of materials dissolved in a liquid is the osmotic pressure. The data which have been collected by Botazzi (1908) show that the osmotic pressures of the body fluids of the most highly developed groups of terrestrial living forms, vary only between remarkably narrow limits. When different forms of sea life are examined, however, a very different state of affairs is found. Even if the examination be restricted to vertebrate forms, wide ranges of osmotic pressure of the body fluids are met with. In the elasmobranchs, for example, the osmotic pressure of the body fluids

is practically that of the sea water in which they live. In the teleosts, on the other hand, the osmotic pressure of the body fluids differs widely from that of the sea water, and approaches the values found for mammalian fluids.

Dakin (1908) has shown that the differences observable among different species of fish are due to the fact that they possess adjusting mechanisms of different degrees of efficiency and not the maintenance of specifically distinct levels of osmotic pressure. Specimens of plaice taken in a brackish portion of the North Sea gave values for the osmotic pressure of their blood 20% lower than that of specimens taken where the osmotic pressure of the sea water was about 74% higher. The osmotic pressure of the blood of cod on the other hand showed a variation of only about 3%, while the variations of osmotic pressure in the localities from which they were taken covered as wide a range as 64%.

The same data which have been used to show that the proportions between some of the elements in the bodies of living organisms are perpetuations of the proportions to which these organisms were exposed at certain stages of their development, have been used to show that the osmotic pressure of the body fluids of the higher animals may also be a perpetuation of the conditions of an early stage of their development. The sea water at the time when these animals were developing closed circulations must have been much more dilute than it is to-day: its osmotic pressure has been assessed at a value only about one-third of what it is at present. Such a value would be very close to the osmotic pressure of the body fluids of the higher animals.

Exchange of material between organism and environment.

The mechanism for the control of the proportions between certain of the constituents of the living organism must be of considerably more ancient origin than the mechanism for the control of the total concentrations of these constituents. Even the simplest unicellular organisms must be possessed to some extent of the former mechanism. The means for controlling the concentration of materials, as expressed by their osmotic pressure, has, on the other hand, only been developed in the most complex metazoa.

It has already been indicated that the action of the former mechanism is a result of the control which the barriers between the cell and its environment are able to exert over the passage of materials into and out of the interior of the cell. It will also be dependent to some extent upon what may for the moment be termed the "affinity" of the cell contents for certain of these materials.

Very little is yet known about the conditions governing the passage of different substances across the cell membrane into the body of the cell. The properties of the surface presented by the cells to their immediate environment must be the most important factors in the process. These properties are determined largely by the degree of dispersion of protein and phospholipide colloids of which the cell membrane largely consists. The proportions of the ions adsorbed to these colloids exercise an important influence on their condition. In particular, they affect the distribution of the dispersant medium (water) between their sol and gel phases, and so can vary the area of the portion of the surface through which water soluble substances would be able to pass.

The importance of maintaining the correct balance between the proportions of the ions in contact with living tissue was fully recognized by Ringer (1884). In his classical series of papers he investigated in some detail the effect of variations of these proportions on the properties of living matter. These

investigations have been the starting point of much of the later work. Hamburger (1921), who made use of a rather highly specialized type of cell for his experiments, was the first to study directly this effect on the permeability of the cell wall. He was able to demonstrate clearly that variations of the proportions of the ions in the fluid to which these cells were exposed were able markedly to alter their permeability towards different materials.

Comparative studies have not so far been made to show how the power of the organism to regulate the relative proportions of the different elements, or more particularly ions, in its substance has developed during the course of evolution. A great deal of attention has been paid within recent years to the study of the proportions between the hydrogen and hydroxyl ions which are derived from the medium in which all the vital reactions take place. It seems, however, that the power of regulating the proportion between these ions must be of later development than the ability to preserve certain ratios between various other ions. Among the lower organisms considerable variation of the concentration of hydrogen ions may be survived by some forms. In the highest forms of life, however, the concentration of those ions is kept extraordinarily constant. It is allowed to vary between narrower limits even than the osmotic pressure. The proportions between certain inorganic substances in solutions, such as those in the neighbourhood of and within living cells, determine what shall be the proportions between the ions of the solvent water. Indeed, even in the higher organisms, the occurrence of rapid variations in the proportions of these ions is prevented by the concentrations of certain other substances which are present. These are known as buffer substances. Among the inorganic salts which exercise this controlling action the more important are the sodium salts of carbonic and phosphoric acids.

The control of the permeability of the living cells must thus largely depend on the composition of the medium with which they are in contact, and on the presence of certain substances in the cells themselves.

The mechanism controlling the total concentration or osmotic pressure of the medium bathing the cells of an organism, on the other hand, must also be actuated by the composition of this medium, but in a manner different from that by which it influences the permeability of the tissues. It is true that the exchange of material between an organism with a closed circulatory system and its environment is limited to certain areas of its surface, for example, to the areas covered by the epithelium of the alimentary and respiratory tracts. By these epithelia some selective action is, no doubt, exercised over the materials entering the organism. Their situation alone is such as to prevent access to them of any but selected parts of the environment. But as a characteristic feature of organisms possessing this mechanism is the freedom rather than the restriction of its exchanges with the outside world, the main regulatory mechanism must be sought elsewhere.

All organisms which have the power of regulating the osmotic pressure of their body fluids are provided with an excretory organ corresponding to a kidney. This mechanism exercises its control over the composition of the circulating fluid by eliminating from the organisms those constituents passing through it which are present in excess. It contributes to the independence of the organism of its environment, or in other words to its adaptation thereto, by placing another means at its disposal for keeping within suitable limits the immediate environment of its cells.



Even in those vertebrates in which the osmotic pressure of the body fluids is close to that of the surrounding medium there is a considerable degree of control exercised over the proportions of the various materials present. While the proportions between the various ions may be close to that of the sea water, their total concentration may be only a fraction of this. The remainder of the osmotic pressure in these cases is contributed by excretory products, principally urea, which are allowed to reach relatively high concentrations. This fact has been taken as evidence that the primary function of the kidney is not to excrete end-products of metabolism, but to adjust the composition of the immediate environment of the cells.

The possession of such a mechanism enables the organism to undertake more active measures to adapt itself to its environment, and in some degree to adapt its environment to its needs. The environment of such an organism has already been modified before it gains access to any but specialized portions of the living substance. While, then, the cells of the organism are enabled to continue their existence under more or less primitive conditions, the organism as a whole is able to carry on its activities but little affected by the vicissitudes of a changing environment.

Control of environment by organism.

(a). Food supply.

In discussing the means taken by certain primitive organisms to adapt themselves to their surroundings, reference was made to the process of encystment and the performance of tropic movements. It was pointed out that in protecting the organism against unfavourable conditions, these two classes of mechanism had at least one feature in common. They owe their effectiveness to the fact that barriers are placed between the organism and unfavourable conditions. In the first instance cited, the barrier is composed of the substance of the organism. The surface of contact between the organism and its environment is rather sharply defined. In the second instance, the barrier is composed of a part of the environment, which the organism places between itself and the unfavourable conditions. The change which takes place is not in the organism, but in the distribution of its environment about it. In neither instance, however, does the environment itself undergo any perceptible modification, nor does the organism itself appear to undergo further change.

As our definition of the term adaptation is the power to remain essentially unchanged in spite of external changes, it might be supposed that, as adaptive mechanisms increased in efficiency, they would bring about an ever sharper differentiation between the organism and its environment. An examination of the relevant data shows that what actually happens is just the reverse of this. Far from tending to isolate themselves more completely from their surroundings, the most perfectly adapted organisms are those in which the freest interchange is allowed with the environment.

Although the effect of each increase in the complexity of the mechanism of adaptation is to place additional barriers between the essential living unit, at the same time it extends further the range over which the organism is able to modify or, as it were, overlap its environment. Each adaptation, by increasing the intimacy of the relations between the organism as a whole and its external surroundings, protects the cell itself still more effectively from variations in the medium in which it lives.

One of the most important factors in the environment of an organism is the supply of available food materials which it contains. The ability favourably to control this supply must therefore be of great assistance to an organism to maintain itself in that uniform state which we have conceived as one of the principal aims of adaptive processes. This ability is possessed by man in an outstanding degree. But many organisms possess this power to a greater or less extent. It is seen more especially in the provision which they make for the nutrition of their young.

In oviparous animals and in many plants the young organism, when it leaves the body of its parent, is enclosed in a more or less impervious membrane which contains a supply of food material. By this means the young organism is able to pass through certain stages of its development in an environment which is entirely independent of outside fluctuations of food supply. In organisms of this kind, direct association between the parent and its offspring ceases at a comparatively early stage of the development of the latter. This does not mean that the parent ceases to have any influence over the environment of its offspring as soon as the direct association between the two ceases. One need only refer to the elaborate precautions taken by birds to preserve a suitable environment about their young after hatching.

The direct association between parent and offspring persists in viviparous animals until a much later stage in the development of the latter. In these organisms, as in the former class, the environment of the young during the period of gestation is furnished by the circulating fluid of the body of its parent. The variations of this fluid are kept within certain limits by the regulatory mechanisms of the parent. The young organism is thus provided with a medium of constant properties while its own regulatory mechanisms are developing. In some viviparous animals the association between parent and offspring ceases almost completely at birth, and the young organism, having been provided with its own adjusting mechanisms, as efficient as those of its parent, is left to adapt itself to its new surroundings.

Like most of their adaptive mechanisms, the devices of mammals for the care of their young are more complex and effective than those of other forms of life. In addition to the protective measures to which allusion has been made, the mammals provide for their offspring a special food, milk, during part of their extra-uterine life. The period for which this provision is made varies widely among different species. In man it extends, under natural conditions, over the greater part of a year, in some races much longer.

This mechanism for the adaptation of one factor of the environment to the needs of the organism, represents one of the last stages in adaptation by modifications of bodily structure and function. It is interesting to observe how closely, in this latest adaptive mechanism, certain properties of the environment are adjusted to the needs of the organism.

It should be remarked at the outset, however, that one of the most striking properties of milk has probably no significance in relation to its use as a food by the young organism. This is the fact that the osmotic pressure of milk has a value very close to that of the body fluids of the animal by which it is consumed. Milk probably owes this property to the manner of its secretion from the body fluids of the maternal organism. Before the milk is absorbed by

the young animal, certain of its constituents must undergo a process of digestion or hydrolysis. The sum of the osmotic pressures of the products of digestion is considerably greater than that of the original milk, so that the osmotic pressure of the solution actually absorbed differs materially from that of the body fluids of the young animal.

When the composition of milk is examined, it is found that although the proportions of the various constituents show considerable variations among different animals, and even among individuals of the same species (Wardlaw, 1915, 1917, 1926), the same constituents are present in each. The concentration of each constituent appears to be adapted to the needs of each species. It will be remembered that in considering the relation of the most primitive living organisms to their environment, some of the evidence was mentioned which seemed to point to a close relation between the proportions of certain elements of inorganic compounds present in the surrounding medium, and the proportions of these elements in the body of the organism itself.

A comparison between the proportions of the various elements in the inorganic, or more strictly speaking, the incombustible portions of milk and the proportions of the same elements in the bodies of the young organisms which consume the milk, also shows a remarkable correspondence. These proportions are not those of the circulating fluids of the animals. An explanation of this correspondence is not to be sought, therefore, like that between the osmotic pressure of milk and body fluids, in an incidental transference of certain properties from the circulating fluid of the maternal organism to its offspring. The correspondence seems to be due to a definite adaptation of this part of the environment to the needs of the young animal.

A similar correspondence between those organic constituents of the milk, which are used as building materials, and the composition of the young organism has not been found. This is partly, no doubt, because it would be a matter of very great difficulty to estimate separately the various units into which the proteins of milk are broken up in the course of digestion. But may it not be due, in part, to that more primitive and intimate relation between the inorganic constituents of a living organism and its nutrient medium to which the evidence discussed earlier seems to point? The most primitive living things must have had practically no relation to organic compounds in their inorganic environment. The organic compounds of their own cells they synthesized themselves. The relation between the organic constituents of the organism and those of its environment can only have become of importance at a much later stage in the development of living things, and is likely to be less intimate than that with the inorganic constituents. If this be so, it gives further support to the supposition that certain of the fundamental properties of living matter of today are perpetuations of conditions which existed when life was at its beginning.

It must not be thought, however, that numerous adaptations of the organic portions of milk to the needs of the young animal cannot be shown. The organic constituents of milk may be divided into those which can only be used as fuel and those which furnish material for the construction of the body of the young animal. If we compare the milks of animals whose young grow at different rates, for example, we find that there is a definite relation between the concentration of the organic building materials and the rate of growth, the concentrations being greater in the milk of the more rapidly growing animals. A similar relation,

incidentally, is to be seen between the rate of growth and the total concentration of the inorganic constituents.

Even the constituents of the milk, which serve only as fuels, although they play no part in the contribution of material for building up the body of the young animal, show adaptations to the various needs, not merely of different species, but even of different individuals.

The young of warm-blooded animals living in cold climates are, for example, exposed to greater losses of heat than those of animals living in warmer regions. We find a correspondingly higher concentration of the fuel, fat, in the milk of the animals indigenous to cold regions. Again, other things being equal, small animals tend to consume relatively greater quantities of energy per day than larger animals. The milk of small animals is, in general, richer in fat than the milk of larger animals. This relation can not only be seen among different species of mammals varying widely in size, but even in individuals of the same species. The small Jersey cow, for example, yields a milk richer in fat than larger breeds.

The range of variation of size among human individuals is much smaller. The correspondences between the composition of the milk and the needs of the human infant are, therefore, much less obvious. They require a closer scrutiny for their discovery. But it may be shown, by suitable methods, that there is a definite correlation between relatively slight variations of the physical characters of healthy infants and the composition of the milk with which they are supplied by their mothers (unpublished observations). This is surely a striking example of the length to which the adaptation of the immediate environment to the needs of the organism is carried by the most highly organized of all animals.

(b). Exchanges of energy.

None of the devices to which the living organism resorts for the control of the composition of its immediate environment can exert its full effectiveness if the temperature of this environment is allowed to vary unrestricted. Still less, under these circumstances, can the organism attain that freedom from external variation of the rate of its activities which seems to be one of the principal objects of adaptive mechanisms. The rates of chemical reactions vary rapidly with the temperature at which they take place. The effect of these variations upon the activities of organisms without a temperature-regulating mechanism is so striking and so familiar as to require no further reference.

The effect of variation of temperature on the composition of living tissues and of their immediate environment is not so obvious, but is none the less important. Variations of temperature alter the equilibrium constants of chemical reactions. In this way they alter the proportions between the reacting materials which will exist under given conditions. For example, the proportions between the ions in the circulating fluids and cells will not be the same at different temperatures. We have seen the permeability of the living cell is largely controlled by the proportions of the ions present in its immediate vicinity. As it is this permeability which determines many of the fundamental properties of living matter, these properties must be modified by changes of temperature, quite apart from any changes in the rate of the vital activities which they may bring about.

The temperature-regulating mechanisms of all the warm-blooded animals are by no means equally effective. In the higher mammals this mechanism continues to function as long as the external conditions of temperature remain within limits compatible with the life of the animal. In other species, however, the mechanism goes out of action if the temperature of the surroundings falls below certain levels which the animal can still survive. At these lower temperatures the animals behave like cold-blooded animals and have body temperatures close to those of their external environment. This is the phenomenon of hibernation. The ease with which this mechanism is thrown out of action by a fall of temperature differs among different species. It is interesting to observe that in *Echidna* which, on morphological grounds, is regarded as the most primitive of mammals, the action of the heat-regulating mechanism is peculiarly susceptible to disturbance. It ceases to function at external temperatures several degrees higher than those at which an effect is to be seen in other hibernating animals (Wardlaw, 1915, 1921).

It is well known also that the effectiveness of the mechanism for the regulation of body temperature of warm-blooded animals is much less efficient in the immature individuals than in the adults. Even in normal infants, for example, the fluctuations of body temperature are much greater than those of adults, while in premature infants this mechanism is so ineffective that survival is often impossible without the aid of artificial means for keeping its body temperature within suitable limits.

The advantage of a mechanism to free the organism from the effects of still another variable of its environment need not be further stressed. In analogy with the possible connection between certain of the chemical characters of the living organism and the composition of the medium in which it lived at different stages of its development, it might be suggested that the constant temperature of warm-blooded animals is also a perpetuation of conditions which prevailed while this mechanism was being developed. But even such scanty data as those on which the previously mentioned suppositions have been based are in this case lacking.

The living organism is constantly liberating energy, part of which appears as heat. To preserve a constant body temperature it must, therefore, maintain a balance between the rates at which heat is lost and produced. This balance can be maintained by the exercise of a control over one or both of these rates. As one of the principal objects of adaptive mechanisms seems to be to protect the organism against adventitious variations of the rate of its activities, it might be expected that the control of temperature would be effected by regulation of the rate of heat loss, rather than by variation of the rate of heat production. This expectation has, to a considerable extent, been realized in the warm-blooded animals which have been studied from this point of view in sufficient detail, the dog, and man.

It has been found that when these animals are examined under comparable states of activity, the rate at which they produce heat is affected only to a minor extent, even by considerable variations of the temperature of their surroundings. Not only is the organism of these animals able to restrict the loss of heat from their bodies when the external temperature falls, but they are also able to continue to lose heat to their surroundings, even when the external temperature is above that of their bodies.

There are, of course, limits beyond which this mechanism becomes ineffective. If the external temperature rises too high, or if the conditions of humidity are such as to restrict unduly the loss of heat by evaporation, then heat production will exceed heat loss, and the body temperature will rise. The organism is incapable of decreasing its production of heat below a certain value even under these circumstances.

If the external temperature falls to a low enough level, the mechanism for regulating body temperature by controlling the heat loss also becomes ineffective. The body under these circumstances, however, does not lose its power of maintaining a constant temperature, because it is able to increase its heat production until its heat loss is again balanced. The object of the constant body temperature, the maintenance of a constant rate of metabolic activity under given conditions, is certainly nullified to some extent by this adjustment. The organism is outside of the range of perfect adaptation to the temperature of its environment. But, on the other hand, such conditions, even when the external temperature is extremely low, can be survived indefinitely without apparent detriment to the organism. On the whole, therefore, the organism can adapt itself to temperatures below that of its body better than it can to higher temperatures.

Rate of adaptive change.

As the range and the scope of the mechanisms by which the organism is able to modify its environment increase, the necessity for adaptive changes on the part of the organism itself must correspondingly decrease. Thus we are led back to our original postulate that the more effective any adaptive mechanism is, the better does it enable the living organism to persist unchanged in a changing environment. We should, therefore, expect evolutionary changes of structure and function to become progressively slower as we pass to more and more complex organisms, and the mechanisms which were at first developed to preserve the primitive characters of the cell itself, eventually to become so effective as to be able to preserve the characters of the whole organism.

The organism which possesses, in an outstanding degree, the ability to modify its environment is, of course, man. He controls his food supply by the hunting and rearing of food animals, by the gathering and planting of edible plants. He modifies certain of his external conditions by the wearing of clothes and the erection and use of houses. He adds to the effectiveness of his hands by the use of tools. He increases the speed and the range of his movements by travelling in vehicles. By means of various instruments he adds to the acuity of his sense organs. All these external aids to his natural powers may be classed as tools. It is his ability to devise tools which has extended his ability to adapt his environment to his needs so immeasurably beyond the similar power of any other animal.

One of the most striking features of this type of adaptive mechanism is the extraordinary rapidity with which it has been developed, as compared with the evolutionary modifications of bodily structure.

The conjectures which have been made as to the period which has elapsed since the appearance of living forms run into hundreds of millions of years. The period for which records can be obtained of the existence of man is measured on the other hand by hundreds of thousands of years. However vague those estimates may be, there seems to be little doubt that the enormous development

of complexity which some living forms have undergone has occurred within a small fraction of the time during which living organisms have been in existence. The development of the power of man to modify his surroundings as a result of the development of his mental faculties is a still more rapid and recent growth, and is to be measured in centuries. Indeed it may be claimed that man has expanded his powers in this direction more during the last century than during the whole of his previous history.

We have in man, then, the most perfect adaptation to environment shown by any form of life. So great is his power of modifying his surroundings, and so rapidly is this power increasing, that it would seem that further adaptation of his physical structures has become unnecessary. It has even been suggested that his increasing use of artificial mechanisms may bring about a degeneration of some of his bodily powers, and that any further evolutionary development in man may be restricted to the growth of his mental faculties. The past history of the evolutionary adaptation of living organisms to their environment would, however, lead us to expect that any changes which may take place in the organism of man will not be such as would adversely affect the conditions of life of the essential units of his structure. In so far as the changes which have taken place in his habits of life are really adaptations to his environment, we may expect that their effect will be to establish more securely the primitive conditions of his cells.

Summary.

A characteristic feature of living organisms is the possession of mechanisms which protect them against the effects of changes of their environment.

These mechanisms in the earlier forms exert their action by restricting the interchange which they allow between the organism and its surroundings. As they develop in efficiency, they become more selective in action, and are able to preserve the essential characters of the organism while allowing a free interchange with its environment. They have preserved, even in the higher organisms, some of the conditions of cell life which probably existed at very early stages of their evolution.

When sufficiently broad distinctions of form are considered they are found to possess equally distinct chemical features, for example in the proportions of some of the elements which they contain.

As the complexity of organisms has increased, they have rendered themselves more independent of their external environment by providing their cells with an immediate environment of their own. By this means external changes are only allowed to reach the cells in a modified form. The possession of this internal environment enables the organism to obtain the advantages of a freer interchange with its surroundings without endangering the stability of its essential living matter.

The evolutionary development of the adaptive mechanisms of the organism has continually extended the range and scope of its control over its environment. Examples of the most highly specialized forms of this control are the maintenance of a constant body temperature by homoiothermal animals, and the provision of a special food supply for their young by mammals.

As the effectiveness of the mechanisms for the adaptation of the environment to its needs has increased, the need for further adaptive modification of the organism itself has correspondingly diminished.

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Mr. E. Cheel, Honorary Treasurer, presented the balance sheets for the year 1929, duly signed by the Auditor, Mr. F. H. Rayment, F.C.P.A., Chartered Accountant (Aust.); and he moved that they be received and adopted, which was carried unanimously.

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

President: E. Cheel.

Members of Council: C. Anderson, M.A., D.Sc., Professor A. N. St. G. H. Burkitt, M.B., B.Sc., H. J. Carter, B.A., F.E.S., Professor W. J. Dakin, D.Sc., G. M. Goldfinch and A. G. Hamilton.

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

A cordial vote of thanks to the retiring President was carried by acclamation.

Linnæan Society of New South Wales

GENERAL ACCOUNT. Balance Sheet at 31st December, 1929.

xxvi.

LIABILITIES.		ASSETS.	
£	s. d.	£	s. d.
Capital: Amount received from Sir William Macleay during his lifetime	14,000 0 0	Society's Freehold	11,000 0 0
Further sum bequeathed by his Will	6,000 0 0	Investments: Commonwealth Loans ..	12,593 11 0
		N.S.W. Debentures	470 0 0
		Loans on Mortgage	6,600 0 0
Contingencies Reserve	20,000 0 0	Cash: Government Savings Bank ..	19,663 11 0
Fletcher Memorial Fund at 31st December, 1929 ..	11,000 0 0	In hand	362 3 5
Income A/c at 31st December, 1929	23 17 0		10 0 0
Commercial Banking Coy. of Sydney, Ltd.	9 5 3		372 3 5
	2 12 2		
	£31,035 14 5		£31,035 14 5

INCOME ACCOUNT. Year Ended 31st December, 1929.

£	s. d.	£	s. d.
To Salaries and Wages	1,149 10 0	By Balance from 1928	184 14 2
" Printing Publications	855 3 10	" Subscriptions: 1929	147 0 0
" Illustrations	124 13 4	Arrears	18 18 0
		In Advance	4 4 0
" Rates and Insurance	52 19 1	" Life Subscriptions	170 2 0
" Postage	26 3 9	" Entrance Fees	15 15 0
" Petty Cash	7 7 0	" Interest	8 8 0
		" Rents	1,165 0 7
" Audit	26 10 9	" Rents (including 100 copies of Proceedings purchased by Government of New South Wales)	815 13 3
" Printing and Stationery	31 12 8	" Sales (including 100 copies of Proceedings purchased by Government of New South Wales)	202 0 10
" Expenses	6 3 9	" Fellowships A/c (surplus income transferred) ..	1,337 17 3
" Attendance	70 0 0		
" Travelling Expenses	1 13 7		
" Bank Expenses	24 9 0		
" Repairs	167 16 9		
Library and Bookbinding	155 7 5		
" Appropriation: Contingencies Reserve	1,100 0 0		
" Balance to 1930	9 5 3		
	£3,899 11 1		£3,899 11 1

Examined and found correct. Securities produced.
 F. H. RAYMENT, Chartered Accountant (Aust.),
 Auditor.

EDWIN CHEEL,
 Hon. Treasurer.

Sydney, 6th February, 1930.

14th January, 1930.

**LINNEAN MACLEAY FELLOWSHIPS ACCOUNT.
BALANCE SHEET at 31st December, 1929.**

	£	s.	d.		£	s.	d.	
LIABILITIES.								
Amount bequeathed by Sir William Macleay	35,000	0	0			9,105	12	0
Surplus Income capitalized	12,351	13	4			530	0	0
	£47,351	13	4			37,700	0	0
						16	1	4
						£47,351	13	4
ASSETS.								
Commonwealth Loans								
N.S.W. Debentures								
Loans on Mortgage								
Commercial Banking Coy. of Sydney, Ltd.								
						£47,351	13	4

INCOME ACCOUNT. Year Ended 31st December, 1929.

To Salaries of Linnean Macleay Fellows	£	633	6	8				
" Fellows' Subsidies	26	5	0			2,964	2	3
" Capital A/c	966	13	4					
" General A/c	1,337	17	3					
	£2,964	2	3			£2,964	2	3
By Interest								

Examined and found correct. Securities produced.

F. H. RAYMENT,
Chartered Accountant (Aust.),
Auditor.

Edwin CHEEL,
Hon. Treasurer.

Sydney, 6th February, 1930.

14th January, 1930.

BACTERIOLOGY ACCOUNT.
BALANCE SHEET at 31st December, 1929.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Amount bequeathed by Sir William Macleay ..	12,000	0	0	Commonwealth Loans	15,800	0	0
Accumulated Income capitalized	3,800	0	0	Cash: Commercial Bankings Company ..	155	19	3
Income A/c at 31st December, 1929	543	1	1	Government Savings Bank	381	1	10
				In hand	6	0	0
					543	1	1
	£16,343	1	1		£16,343	1	1

INCOME ACCOUNT. Year Ended 31st December, 1929.

To Salary	£	s.	d.	By Balance from 1928	£	s.	d.
" Apparatus and Chemicals	168	6	8	" Interest	78	17	3
" Storage and Cartage	13	17	0	" Refund	797	4	6
" Periodicals	75	0	0		1	0	0
" Travelling Expenses	1	17	0				
" Travelling Expenses	75	0	0				
" Balance to 1930	151	17	0				
" Balance to 1930	543	1	1		£877	1	9
	£877	1	9				

Examined and found correct. Securities produced.
F. H. RAYMENT,
Chartered Accountant (Aust.),
Auditor.

EDWIN CHEEL,
Hon. Treasurer.

Sydney, 6th February, 1930. 14th January, 1930.

ABSTRACT OF PROCEEDINGS.

ORDINARY MONTHLY MEETING.

26th MARCH, 1930.

Mr. E. Cheel, President, in the Chair.

A letter was received from Dr. R. Broom, Corresponding Member, returning thanks for congratulations.

The President offered congratulations on behalf of members to Dr. W. L. Waterhouse, on having obtained the degree of Doctor of Science in Agriculture in the University of Sydney.

The Donations and Exchanges received since the previous Monthly Meeting (27th November, 1929) amounting to 45 Volumes, 440 Parts or Numbers, 36 Bulletins, 12 Reports and 8 Pamphlets, received from 169 Societies and Institutions and 4 private donors, were laid upon the table.

PAPERS READ.

1. Revision of Australian Oenochromidae (Lepidoptera). ii. By A. Jefferis Turner, M.D., F.E.S.

2. A Revision of the Australian Teleasinae (Hymenoptera, Proctotrypoidea). By A. P. Dodd.

3. Notes on Australian Diptera. xxiii. By J. R. Malloch. (*Communicated by I. M. Mackerras.*)

ORDINARY MONTHLY MEETING.

30th APRIL, 1930.

Mr. E. Cheel, President, in the Chair.

Mr. William M. P. Cochran, Rabaul, New Guinea; Professor H. W. Davies, The University, Sydney; Miss Kathleen M. I. English, Yass, N.S.W.; and Miss Mary E. Fuller, Canberra, F.C.T., were elected Ordinary Members of the Society.

The President announced that the Council had elected Messrs. A. F. Basset Hull and H. J. Carter and Drs. W. R. Browne and H. S. H. Wardlaw to be Vice-Presidents, and Dr. G. A. Waterhouse to be Honorary Treasurer for the current Session.

The President also announced that the Council had elected Dr. W. L. Waterhouse to fill the vacancy on the Council caused by the resignation of Dr. A. J. Nicholson.

A letter was read from Mrs. and Miss Armit, returning thanks for sympathy in the death of Dr. H. W. Armit.

A letter was read from Dr. W. L. Waterhouse, expressing his thanks for congratulations on his attaining the Doctorate of Science in Agriculture of the University of Sydney.



The President expressed the congratulations of members to Dr. H. Claire Weekes, on attaining the degree of D.Sc., in the University of Sydney; also to Miss Doris Selby, on attaining the degree of M.Sc., in the University of Sydney.

The President called attention to concession fares offered by the Commonwealth Railways to scientific parties wishing to visit areas traversed by the Commonwealth Railways.

The President also called attention to the publication of the "Catalogue of Scientific and Technical Periodicals in the Libraries of Australia", published by the Council for Scientific and Industrial Research, 314 Albert Street, East Melbourne, C.2.

The Donations and Exchanges received since the previous Monthly Meeting (26th March, 1930) amounting to 17 Volumes, 101 Parts or Numbers, 10 Bulletins, 4 Reports and 3 Pamphlets, received from 67 Societies and Institutions and 1 private donor, were laid upon the table.

PAPERS READ.

1. The Geology of the South Coast of New South Wales. Part ii. Devonian and Older Palaeozoic Rocks. By Ida A. Brown, B.Sc., Linnean Macleay Fellow of the Society in Geology.

2. Notes on the Genus *Apistomyia* (Diptera) and Description of a New Species. By A. L. Tonnoir. (*Communicated by Dr. I. M. Mackerras.*)

3. Australian Coleoptera. Notes and New Species. vii. By H. J. Carter, B.A., F.E.S.

4. Australian Rust Studies. ii. Biometrical Studies of the Morphology of Spore Forms. By W. L. Waterhouse, D.Sc.Agr.

NOTES AND EXHIBITS.

Mr. Frank A. Craft exhibited an aboriginal stone axe from Bumballa Estate, Wingello, N.S.W. The specimen measures 8 inches \times 5 inches \times 1½ inches thick, and the cutting edge has been finely ground and polished. The axe is of dense black basalt of a doleritic nature, the sides showing considerable weathering.

Mr. Craft also showed lantern slides illustrating the upland valleys and gorges about the Shoalhaven River near Tallong. The recent migration of the river in an entrenched meander was shown, and the remarkably level skyline of the tableland. The slides illustrated recent erosion and the present land forms in the Tallong area.

ORDINARY MONTHLY MEETING.

21st MAY, 1930.

Mr. E. Cheel, President, in the Chair.

The Donations and Exchanges received since the previous Monthly Meeting (30th April, 1930) amounting to 18 Volumes, 52 Parts or Numbers, 4 Bulletins, 3 Reports and 4 Pamphlets, received from 52 Societies and Institutions and 1 private donor, were laid upon the table.

PAPERS READ.

1. Observations on the Dipterous Family Tanyderidae. By C. P. Alexander. (*Communicated by Dr. I. M. Mackerras.*)

2. The Genus *Micromonospora* Ørskov, a little known Group of Soil Micro-organisms. By H. L. Jensen, Macleay Bacteriologist to the Society.

3. Revision of Australian Oenochromidae (Lepidoptera). Part iii. By A. Jefferis Turner, M.D., F.E.S.

NOTES AND EXHIBITS.

Dr. W. L. Waterhouse exhibited specimens of *Hordeum maritimum* With. which showed genetic variation. Plants had been collected at Cowra, N.S.W., for use in the cereal rust investigations. In the work, bulk sowings of the grass seed revealed a proportion of albino seedlings. Further investigations showed that some single plant progenies produced only normal seedlings, whereas in other pure lines a ratio of 3 normals : 1 albino seedling was found. In Nature, plants heterozygous for albino production occur, genetically different from the normal type. A series of crosses has been planned to give further information on the happening.

The President gave a short account of the progress that had been made in the attempt to have an area set aside in the National Park for the cultivation and exhibition of the native flora of New South Wales.

ORDINARY MONTHLY MEETING.

25th JUNE, 1930.

Mr. E. Cheel, President, in the Chair.

Dr. G. Heydon, School of Public Health and Tropical Medicine, The University, Sydney; Professor J. Macdonald Holmes, The University, Sydney; and Mr. F. H. Taylor, School of Public Health and Tropical Medicine, The University, Sydney, were elected Ordinary Members of the Society.

The President offered the congratulations of members to Professor J. P. Hill on the award to him by the Linnean Society of London of a Linnean Gold Medal for 1930.

The President reported that satisfactory progress had been made with the building of Science House, and that the Foundation Stone had been set on 24th June, 1930, by His Excellency Sir Philip Game, Governor of New South Wales.

The Donations and Exchanges received since the previous Monthly Meeting (21st May, 1930) amounting to 43 Volumes, 180 Parts or Numbers, 18 Bulletins, 5 Reports and 61 Pamphlets, received from 98 Societies and Institutions and 4 private donors, were laid upon the table.

PAPERS READ.

1. Notes on Australian Diptera. xxiv. By J. R. Malloch. (*Communicated by I. M. Mackerras.*)

2. Fifth Contribution towards a new Classification of Australian Asilidae. By G. H. Hardy.

3. The Mosses of Fiji. By H. N. Dixon, M.A., and W. Greenwood, F.L.S.

NOTES AND EXHIBITS.

Mr. David G. Stead exhibited an example of the egg of the Chimaeroid shark, *Callorhynchus tasmanius* Richardson, known as the Elephant Fish. The specimen

had been taken by means of an oyster dredge by himself in Ralph's Bay, near Hobart, Tasmania. This fish is quite abundant in Tasmanian waters and even penetrates the estuaries of the larger rivers, having been taken as high up as Launceston, on the Tamar, and well up the Huon at Hobart. The eggs are deposited in the autumn or late summer apparently, and lie for an undetermined period before hatching, in several fathoms of water. The egg is somewhat boat-shaped, is slightly keeled and is strongly convex underneath. This causes the egg to lie easily on its keel and so that it will swing round with any movements of the tide. Such a construction also ensures the maximum of oxygenation for the developing embryo and prevents the egg from being covered by silt.

Mr. W. W. Froggatt exhibited a piece of red wood from the side of the door of the Government Residence at Rabaul, New Guinea, which had been riddled with holes by leaf cutting bees, *Megachile* sp.; he also exhibited a specimen of the bee.

Mr. L. L. Hall exhibited a mass of rolled Kurrajong leaves from Goulburn. This is caused by the caterpillars of the moth, *Notarcha pycalis* Walker.

Mr. J. R. Kinghorn exhibited a specimen (the holotype) and a skull of his new genus of Elapine snake, *Oxyuranus maclelleni*, described in the Records of the Australian Museum a few years ago. The species is of renewed interest on account of the research on snake venom being carried out by Dr. C. H. Kellaway of the Walter and Eliza Hall Institute of Research, Melbourne. Its affinities and general characteristics were explained. The skull of a Death Adder, *Acanthophis antarcticus*, was exhibited for comparative purposes.

Mr. Gilbert P. Whitley exhibited illustrations of some Queensland Fishes and made remarks upon them.

Dr. W. L. Waterhouse exhibited seedlings of rye showing marked albinism. As a result of selfing, races are showing great variation in the amount of chlorophyll produced. The extreme types show entire lack of this pigment and die as soon as the reserve food in the grain is exhausted. Another exhibit illustrated the occurrence in the seedling stage of cross-bred wheats of the dwarfing character often termed "grass-tuft". These arose in F1 plants derived as a result of crossing two normal varieties. In no case has it been possible to bring such F1 grass-tuft plants to maturity. Several instances of the occurrence of double embryos in cereals were illustrated. These included wheat, barley, rye and maize.

Mr. A. S. Le Souef exhibited a specimen of a mouse from East Sisters Island, Bass Straits. This mouse, in a very isolated locality, is apparently the common house mouse, *Mus musculus*, but it has a white-tipped tail. One would not expect to find a variant established on an isolated island. He also exhibited a specimen of a tree Kangaroo from New Guinea. This species has a beautiful fur which may prove of commercial value to the country.

Mr. E. G. Jacobs exhibited twenty-two plants of various species from Middlesex, British Honduras, Central America. Most of the plants are from the forest regions of the lower highlands and are characteristic rain forest types.

Miss I. Brown exhibited specimens of well preserved leaves from rocks of Tertiary age between Bundanoon and Penrose.

Dr. A. B. Walkom exhibited specimens of a fossil fern, apparently new, from the roof of the Bulli Coal Seam in the Excelsior Colliery, Illawarra District.

ORDINARY MONTHLY MEETING.

30th JULY, 1930.

Mr. E. Cheel, President, in the Chair.

Sir George Julius, Sydney; Miss Gladys Carey, Epping; Miss Lilian R. Fraser, Pennant Hills; Miss Joyce W. Vickery, Homebush; and Miss Jessie A. Webster, Stanmore, were elected Ordinary Members of the Society.

The President offered the congratulations of members to Dr. G. A. Waterhouse on his election as President of the Board of Trustees of the Australian Museum.

A letter was read from Miss Doris Selby, thanking the President and members for congratulations on attaining her M.Sc. degree.

The President referred with pleasure to the proclamation issued by the Government extending the existing protection to certain species of wild flowers for a further period of twelve months.

The President and members offered a very hearty welcome to Professor J. T. Wilson, who expressed his pleasure at being present and also conveyed a message of greeting to members from Professor J. P. Hill.

The Donations and Exchanges received since the previous Monthly Meeting (25th June, 1930) amounting to 18 Volumes, 168 Parts or Numbers, 2 Bulletins, 9 Reports and 39 Pamphlets, received from 84 Societies and Institutions and 2 private donors, were laid upon the table.

PAPERS READ.

1. Notes on Australian Diptera. xxv. By J. R. Malloch. (*Communicated by Dr. G. A. Waterhouse.*)

2. Notes on the Autumn Orchids of the South Maitland Coalfields. By Rev. H. M. R. Rupp, B.A.

3. The Origin of Endemism in the Angiosperm Flora of Australia. By the late Professor A. A. Lawson, D.Sc., F.R.S.E.

NOTES AND EXHIBITS.

Mr. David G. Stead exhibited a drawing (made by Mr. M. Lynch of the Lands Department, Fiji) of a "sea monster" cast up on a mud bank, two miles inside the mouth of the Dreketi River, Labasa, Vanua Levu, Fiji, and seen by Mr. Lynch on 17th November, 1928. The animal was fourteen feet in total length (tail appears to have been mutilated), four feet across at the shoulders and eighteen inches across the narrowest part of the tail. Head and neck together measured three feet in length, the neck being two and a half feet thick. Distance from end of snout to widest part of shoulders was four feet. Though a number of the characters mentioned were difficult to reconcile with each other, Mr. Stead stated that there appeared to be no doubt that the animal was a Dugong (*Halicore*). Further enquiries were being made.

Mr. W. W. Froggatt exhibited some "Blood Wood Apples". These are the large galls of *Cystococcus pomiformis* Froggatt, one of the most remarkable galls in the world. They are found in North Queensland, Central and North-western Australia, growing upon the branchlets of *Eucalyptus terminalis*. The gall starts as a small round marble on the branchlet and becomes as large as a small apple. The blacks eat the coccids in the galls. The gall has thin walls with a large gall chamber; at the base in the centre is a circular depression; at the summit a rounded funnel just beneath the apical opening. The female coccid stands on

her head which forms a circular plate, fitting into the circular depression, with the tip of the abdomen, which is smooth and rounded, fitting into the funnel on the roof of the chamber. She has no mouth, antennae or legs, but four spiracles. The male coccids hatch out inside the gall-chamber, and go through the whole of their development into two-winged slender-bodied coccids within the gall, emerging when adult through the apical orifice. Mr. Froggatt also exhibited two Hymenopterous galls: (1) leaf of tropical jungle plant from Cairns, N. Queensland, covered with minute Chalcid galls, (2) Eucalypt branchlet with mass of long spindle-shaped galls of *Tepperella eucalypti*, from the South Coast of New South Wales.

The President exhibited a flowering plant of "soft-leaved Wattle" (*Acacia pubescens*) taken from a sucker growth near Bankstown two years ago, and cultivated as a pot-plant. This species has a limited distribution and may become extinct, as it rarely matures its pods and seeds. It is noteworthy on account of the leaflets not folding in sleep at night as is the case with most species of the Mimosae. He also exhibited live plants of "Australian Lime" (*Microcitrus australis*) and "Finger Lime" (*Microcitrus australasica*) together with a series of fruits showing considerable variation in shape, size and colour. Three hybrids ("Faustrimon," "Faustrimedon," and "Faustrime") were also exhibited produced as the result of crossing the "finger lime" (*M. australasica*) with three cultivated citrus varieties. Seedling plants of "Bangalow Palm" (*Archontophoenix Cunninghamii*) and the "Curly Palm" or "Belmore Palm" (*Howea belmoreana*) were shown and attention drawn to the suitability of the "Bangalow Palm" for certain decorative effects which it was contended were superior to that of the "Curly Palm".

Seedling plants of several species of *Eucalyptus* were also exhibited to show the distinctive characteristics of the juvenile stage of development in comparison with the adult stage and to demonstrate the easy method of propagating them from seeds and transferring the seedlings from the seed beds to thumb pots for transport purposes.

Mr. H. J. Carter called attention to the very early flowering of *Pittosporum undulatum* following the mild winter experienced this year.

ORDINARY MONTHLY MEETING.

27th AUGUST, 1930.

Mr. E. Cheel, President, in the Chair.

The President announced that the first Fletcher Memorial Lecture would be delivered in the Lecture Theatre of the Australian Museum, College Street, Sydney, on Monday, 15th September, 1930, at 8 p.m., by Mr. A. H. S. Lucas, M.A., B.Sc., the subject being—"Joseph James Fletcher, an Idealist Secretary." A cordial invitation to be present was extended to all.

The President announced that applications for grants to scientific research workers should be made to the Council for Scientific and Industrial Research, 314 Albert Street, East Melbourne, C.2, not later than 1st November, 1930.

The Donations and Exchanges received since the previous Monthly Meeting (30th July, 1930) amounting to 16 Volumes, 116 Parts or Numbers, 6 Bulletins, 2 Reports and 5 Pamphlets, received from 79 Societies and Institutions, were laid upon the table.

PAPERS READ.

1. On *Grevillea Gaudichaudii*, a supposed natural Hybrid between *Grevillea laurifolia* and *G. acanthifolia*. By J. McLuckie, M.A., D.Sc.
2. The Topography and Water Supply of Cox's River, N.S.W. By Frank A. Craft, B.Sc., Linnean Macleay Fellow of the Society in Geography.
3. Goulburn—a vital Point on the New South Wales Highlands. By Frank A. Craft, B.Sc., Linnean Macleay Fellow of the Society in Geography.

NOTES AND EXHIBITS.

Mr. David G. Stead reported that a large Humpback Whale, *Megaptera nodosa*, had found its way into Port Jackson on August 12 and had penetrated so far up the harbour as to pass under the newly joined arch of the Sydney Harbour Bridge. It moved about the harbour all that day and the next morning returned to the ocean. It remained in Watson's Bay for an hour and a half after daylight before going to sea. From close personal observations Mr. Stead estimated this whale to be about 45 feet in length.

It is of interest to note that only two days before, a whale estimated to be about the same size, was observed swimming backwards and forwards all day long off Tuggerah Lakes entrance in a kind of small bay formed by a slightly submerged bank, covered by light surf. Although apparently able to escape, the whale would move a few lengths in one direction and then back again, as though in hiding from its foes, keeping to its small basin. This observation was made by Miss Rachel Davis, of The Entrance.

Miss Lilian Fraser exhibited root-nodules of *Casuarina glauca* which resemble those of *C. Cunninghamiana*, but are on the average rather larger, being up to two inches in diameter, and the individual roots are rather more swollen. The nodule arises as a lateral root which becomes modified by bacterial infection and branches profusely, forming a coralloid structure. It becomes covered with cork except at the growing tips and is a perennial structure. The nodules exhibited were found at Church Point, Pittwater, August, 1930. Root-nodules of *Casuarina Cunninghamiana* have been described (Proc. Linn. Soc. N.S.W., 1923) by Dr. J. McLuckie and, so far as the exhibitor knows, have not been reported for any other species.

The President (Mr. E. Cheel) exhibited a series of specimens of the following species of *Eucalyptus*: *E. capitellata*, *E. eugenioides*, *E. agglomerata*, *E. laevopinea*, *E. Muelleriana*, *E. macrorrhyncha*, and *E. macrorrhyncha* var. *brachycorys*. Baron von Mueller suggested many years ago that the var. *brachycorys* was worthy of specific rank, a statement with which the exhibitor was entirely in accord. Attention was drawn to the extremely variable character of the leaves of seedlings, as well as those of the reversionary shoots or so-called sucker or coppice growths, together with the shape and size of the fruits taken from sapling trees and compared with those of older trees. It was suggested that the whole group of Stringybark forms of Eucalypts should be carefully examined in the field and an exhaustive study made in connection with the literature dealing with these before proposing any more new species.

Specimens of *Callistemon lanceolatus* and *C. pachyphyllus* were also exhibited for comparison with the *Eucalyptus* spp., to show the relative size of the fruits of last season's flowers to those of three-year old capsules on the same branch, the valves of which had not yet opened to shed their seeds.

ORDINARY MONTHLY MEETING.

24th SEPTEMBER, 1930.

Mr. E. Cheel, President, in the Chair.

The President announced that the Council is prepared to receive applications for four Linnean Macleay Fellowships tenable for one year from 1st March, 1931, from qualified candidates. Applications should be lodged with the Secretary, who will afford all necessary information to intending candidates, not later than Wednesday, 5th November, 1930.

The President announced that a large majority of the members who had replied to the *questionnaire* regarding the hour of meeting, which had been circulated to members in the metropolitan district, had expressed a preference for the hour at which meetings are now held; it was therefore proposed to take no further action regarding the suggestion that some hour other than 7.30 p.m. might be more convenient for members.

The President, on behalf of members, expressed appreciation of the Fletcher Memorial Lecture delivered by Mr. A. H. S. Lucas on Monday, 15th inst.

The Donations and Exchanges received since the previous Monthly Meeting (27th August, 1930) amounting to 7 Volumes, 71 Parts or Numbers, 4 Bulletins, 1 Report and 3 Pamphlets, received from 51 Societies and Institutions and 1 private donor, were laid upon the table.

PAPERS READ.

1. Notes on Australian Diptera. xxvi. By J. R. Malloch. (*Communicated by Dr. G. A. Waterhouse.*)
2. Descriptions of New Species of Australian Coleoptera. xxi. By A. M. Lea, F.E.S.
3. An Abnormal *Xanthium* Burr. By J. Calvert, M.Sc., F.L.S. (*Communicated by Dr. B. T. Dickson.*)
4. Notes on Gall-making Coccids, with Descriptions of New Species. ii. By W. W. Froggatt, F.L.S.
5. Trichopterygidae of Australia and Tasmania. Descriptions of New Genera and Species. By C. Deane.

NOTES AND EXHIBITS.

Dr. W. L. Waterhouse exhibited specimens showing variegation of the leaves of wheat and rye plants. The former arose from grain of a normal green plant of "Alberta Red", and the latter as a result of two generations of selfing a normal plant of "March" rye. This rye family already appears to be homozygous for the variegated character.

The President (Mr. E. Cheel) exhibited live plants of *Darwinia taxifolia* var. *intermedia* Cheel (*D. intermedia* A. Cunn.) which is comparatively rare in the Botany Swamps, and *Dendrobium Beckleri* F.v.M., from the Williams River near the foot of the Barrington Tops Range. He also exhibited (i) for comparison with *D. intermedia*, plants of *Darwinia fascicularis* which had been grown in pots for the purpose of forming plantations to exploit the species for its valuable essential oil, and (ii) fresh flowering plants of *Dendrobium graciticaule* which were noted as being fairly plentiful on various trees along the Williams River where they were collected recently.

ORDINARY MONTHLY MEETING.

29th OCTOBER, 1930.

Mr. E. Cheel, President, in the Chair.

Miss Muriel G. Holdsworth, B.Sc., Stanmore, and Miss Germaine A. Joplin, B.Sc., Eastwood, were elected Ordinary Members of the Society.

Candidates for Linnean Macleay Fellowships, 1931-32, were reminded that Wednesday next, 5th November, is the last day for receiving applications.

A letter was read from Dr. H. Claire Weekes, returning thanks for congratulations.

The President expressed the sympathy of members with Professor L. A. Cotton on the death of his wife.

The President called the attention of members to the fact that there will be professional offices available for letting in Science House.

The Donations and Exchanges received since the previous Monthly Meeting (24th September, 1930) amounting to 7 Volumes, 101 Parts or Numbers, 4 Bulletins, 3 Reports and 3 Pamphlets, received from 64 Societies and Institutions and 1 private donor, were laid upon the table.

PAPERS READ.

1. Notes on the Australian Species of the Genus *Atriplex*. By R. H. Anderson, B.Sc.Agr.

2. On Placentation in Reptiles. ii. By H. Claire Weekes, D.Sc.

3. The Uterine Cycle of Pregnancy and Pseudo-Pregnancy as it is in the Diprotodont Marsupial *Bettongia cuniculus*. By Professor T. Thomson Flynn, D.Sc.

4. Additions to the Flora of New England. By W. F. Blakely and Rev. E. N. McKie, B.A.

5. A New Species of *Eucalyptus* from New England. By W. F. Blakely.

NOTES AND EXHIBITS.

The President (Mr. E. Cheel) exhibited fresh flowering specimens of *Callistemon linearifolia*, *C. lilacina*, *C. lilacina* var. *carmina* and a hybrid, *C. acuminatus* × *C. lanceolatus*; and specimens of *Leptospermum emarginata* Wendl., which is united with *L. flavescens* by Bentham and other workers. Specimens of *L. flavescens* var. *leptophylla* were exhibited for comparison. Foliage of a stringybark *Eucalyptus*, raised from seed obtained from Wyndham and which has an aromatic oil identical with the original parent, was also exhibited.

Mr. W. F. Blakely gave an interesting chat, illustrated with lantern slides, on Stringybarks. In it he dealt with the early use of some of the vernacular names of the Eucalypts, which could be traced to some of the first explorers and surveyors, and pointed out that the name "Stringybark" was in common use in 1798, ten years after the colony was founded. He also gave an outline of the classification of the Eucalypts by their barks, and a detailed description of the morphological characters of the Stringybark Series, together with an explanation of their range, size, habit and economic uses, and their utility to the aborigines and also to the early settlers. He also explained that the first Eucalypt known to science was a Stringybark, *E. obliqua*, and that it held the unique position of being the type of the genus *Eucalyptus*. Another distinction claimed for the

Stringybarks was that one of its members, *E. regnans*, is the largest tree in Australia and the second largest tree in the world.

Mr. Blakely concluded by stating that he did not know of a more useful tree in the Commonwealth or one that has played a more important part in the development of this country than the Stringybark.

ORDINARY MONTHLY MEETING.

26th NOVEMBER, 1930.

Mr. E. Cheel, President, in the Chair.

Mr. Allen N. Colefax, B.Sc., Kogarah, Miss Enid M. Edmonds, B.Sc., Rose Bay, and Mr. Erik Munch-Petersen, Ph.B., M.Sc., M.I.F., North Sydney, were elected Ordinary Members of the Society.

The President announced that the Council had re-appointed Miss Ida A. Brown, B.Sc., and Mr. Frank A. Craft, B.Sc., to Linnean Macleay Fellowships in Geology and Geography respectively for a period of one year from 1st March, 1931.

The President announced that Science House is expected to be completed by the end of January, 1931, and that, therefore, this meeting would be the last monthly meeting of the Society to be held at Macleay House.

Detailed drawings made by the Architects (Messrs. Peddle, Thorp and Walker) in connection with the building of Science House were exhibited.

The Donations and Exchanges received since the previous Monthly Meeting (29th October, 1930) amounting to 34 Volumes, 128 Parts or Numbers, 9 Bulletins, 1 Report and 53 Pamphlets, received from 70 Societies and Institutions, were laid upon the table.

PAPERS READ.

1. Xerophytes and Xerophily, with Special Reference to Protead Distribution. By O. H. Sargent. (*Communicated by A. G. Hamilton.*)
2. Australian Rust Studies. iii. Initial Results of Breeding for Rust Resistance. By W. L. Waterhouse, D.Sc.Agr.
3. New Guinea and Australian Coleoptera. Notes and Descriptions of New Species. By H. J. Carter, B.A., F.E.S.
4. The Geology of the South Coast of New South Wales. iii. The Monzonitic Complex of the Mount Dromedary District. By Ida A. Brown, B.Sc., Linnean Macleay Fellow of the Society in Geology.
5. The Leaf-Buds of some Woody Perennials in the New South Wales Flora. By Gladys Carey, B.Sc.
6. Notes on a Cellulose-decomposing Soil-fungus of an unusual Character. By H. L. Jensen, Macleay Bacteriologist to the Society.

NOTES AND EXHIBITS.

Mr. W. W. Froggatt exhibited two specimens of the larva of the Geebung Hawk Moth (*Coequosia triangularis*) from Gosford, showing the two varieties of coloration, green and yellow.

The President (Mr. E. Cheel) exhibited specimens of *Helichrysum leucopsidum* DC., and *Boronia oppositifolia* (Pers.) Cheel (see *Journ. and Proc. Roy. Soc. N.S.W.*, 1927, 408) from Hill Top, between Picton and Mittagong, thus establishing a definite locality near Sydney for these two species which are quite common in Victoria and Tasmania. He also exhibited a specimen of a stemless thistle,

Onopordon acaulum Linn., from Balranald, collected by Stock Inspector Chanter, who reports that it is spreading rapidly in that district. It is recorded for South Australia but has not previously been recorded for this State.

Dr. G. A. Waterhouse exhibited both sexes of *Ogyris zosine araxes*, including an interesting aberration of the male, all reared from pupae found near Penrith, N.S.W. He gave a short account of the habits of the larvae and their attendant ants. He also exhibited a pair of *Ogyris olane* from the same locality; this is a new record for this species of butterfly from the County of Cumberland.

Note on Sterility in the Proteaceae.

Mr. A. G. Hamilton contributed the following note:

In a valuable posthumous paper on The Origin of Endemism in the Angiosperm Flora of Australia (These PROCEEDINGS, IV, 1930, 371), the late Professor A. A. Lawson gives certain criteria from which hybridism may be deduced. With one exception they all appear to be cogent. The exception is sterility. He instances the infertility of the Proteaceae. From my observations of the plants, I am inclined to think that the sterility is accidental and not constitutional, i.e., that it arises from the failure of the pollinating agent to visit the flowers. In most of the Proteaceae, the official pollinators are birds—the honey-eaters mainly.

My experience of the failure of Proteads to produce seeds was even more striking than Professor Lawson's. I observed one small tree of *Banksia serrata* in Centennial Park. There were on it 53 heads of flowers, all dead. Forty-five had no follicles at all. The remainder had between them 30 follicles.

The average number of flowers in each head was 460, giving a total of 24,380. There was therefore 0.12% which developed fruits. On the other hand, I have seen trees, every head of which bore a few, and some 20 or 30 follicles, and now and then one finds a head completely covered with fruits, so closely packed that there is no room for another follicle. Doubtless, in such cases, many pollinated flowers are crushed so that no fruit can form.

Again, I once saw a New Holland honey-eater visit a flower head of *Banksia ericifolia*. It worked on it for a considerable time, so I marked the head, and returning some months afterward found a large number of follicles. It is worthy of note that the bird did not visit any of the neighbouring heads, but flew off to another tree. The conclusion I came to was that it is only at a certain stage that the flowers produce nectar in large quantities, and if that stage is neglected by the birds, no fruits are produced. The aborigines knew of the nectar-producing powers of this plant, and collected the sweet fluid by placing a number of heads on a sheet of bark, and it is recorded that they suffered from severe headaches after a feed.

On a visit to Albany, W.A., in 1904, I found *Banksia occidentalis* trees had every head with a large number of fruits, some so crowded that there was not room for one more. I was told that the little marsupial, *Tarsipes*, was very plentiful all through the bush. As it feeds on the honey of the *Banksia* flowers (and, incidentally, on the insects frequenting them), there can be no doubt but that it is an efficient pollinator, and that it was responsible for the plentiful fruiting of the *Banksias*.

Some years ago I was walking through a glade behind Mt. Kembla where there were very many Waratahs in blossom, and saw a spinebill (a very efficient

pollinator) alight on a Waratah stem just below the flower head. The jar shook the plant, and a shower of drops of nectar flew in all directions. The bird worked at the head for over ten minutes. I marked the head, and coming back after a couple of months, I found 23 fruits developed.

This instance again suggests that it is only at a certain stage of flowering that nectar is produced in sufficient quantities to attract the pollinators.

Two species of *Isopogon* mentioned by Professor Lawson in his tables have 50 and 85% of sterile pollen, yet my experience is that in both, every head produces quantities of fruits. *Lomatia silaifolia* has 70% of sterile pollen and yet it is quite common to see 20 to 30 fruits on a stalk.

I think, therefore, that a good case has been made for the theory that the sterility of the Proteaceae is caused, to a great extent, by the failure of the pollinators to visit the flowers, and that it is not due to any inherent infertility.

DONATIONS AND EXCHANGES.

Received during the period 28th November, 1929, to 26th November, 1930.

(From the respective Societies, etc., unless otherwise mentioned.)

ABERYSTWYTH.

Welsh Plant Breeding Station, University College of Wales.—Bulletin, Series H, Nos. 10-11 (1930); "The Welsh Journal of Agriculture", vi (1930).

ACCRA.

Geological Survey of the Gold Coast.—Bulletin, No. 2 (1928); Memoir No. 1 (1929); Report of the Director for the Financial Year 1928-1929 (1929); "The Utility of Geological Surveys to Colonies and Protectorates of the British Empire", by A. E. Kitson (*Brit. Assn. Adv. Sci. South Africa*, 1929, Section C—Geology) (1929).

ADELAIDE.

Department of Mines: Geological Survey of South Australia.—Bulletin No. 14 (1930); Mining Review for the Half-Year ended December 31st, 1929 (No. 51) (1930).

Field Naturalists' Section of the Royal Society of South Australia and South Australian Aquarium Society.—"The South Australian Naturalist", xi, 1-4 (1929-1930).

Public Library, Museum and Art Gallery of South Australia.—Forty-sixth Annual Report of the Board of Governors, 1929-30 (1930); Records of the South Australian Museum, iv, 2 (1930).

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- Carnegie Corporation Visitors' Grants Committee, Pretoria, South Africa (donor).—
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LIST OF MEMBERS, 1930.

ORDINARY MEMBERS.

- 1927 *Albert, Michel François, "Boomerang", Elizabeth Bay, Sydney.
1929 Allan, Miss Catherine Mabel Joyce, Australian Museum, College Street, Sydney.
1905 Allen, Edmund, c/o Chief Engineer for Railways, Brisbane, Q.
1906 Anderson, Charles, M.A., D.Sc., Australian Museum, College Street, Sydney.
1922 Anderson, Robert Henry, B.Sc.Agr., Botanic Gardens, Sydney.
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REVISION OF AUSTRALIAN OENOCHROMIDAE (LEPIDOPTERA). II.*

By A. JEFFERIS TURNER, M.D., F.E.S.

[Read 26th March, 1930.]

Genus 11. BRADYCTENA, n. gen.

βραδυκτενος, with heavy comb.

Face smooth. Tongue present. Palpi moderate, porrect. Antennae in ♂ unipectinate, the pectinations short (1), and almost as broad as long, extreme apex simple. Thorax and abdomen slender; thorax not hairy beneath. Femora smooth. Tarsi not spinulose. Forewings with tufts of raised scales; 9, 10 arising from end of cell, connate or even short-stalked with 7 and 8, anastomosing with 8 to form the areole from which 8, 9, 10 arise by a common stalk, 11 free. Hindwings with 3 nearer 4 than 2 at origin, 6 and 7 connate, 12 approximated to cell to about two-thirds, thence diverging.

A curious modification of the *Dichromodes* group. It does not seem specially allied to *Phrixocomes*. There is only one species and of that only the type is at present known.

65. BRADYCTENA TRYCHNOPTILA.

Dichromodes trychnoptila Turn., *Trans. Roy. Soc. S. Aust.*, 1906, 131. Tasmania: Zeehan.

Genus 12. PHRIXOCOMES, n. gen.

φριξοκομης, with bristling hair.

Face smooth. Tongue well-developed. Palpi long or very long, porrect, thickened, with loosely appressed hairs. Antennae in ♂ unipectinate, extreme apex simple. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Tarsi not spinulose. Forewings with tufts of raised scales, areole present, 8, 9, 10 arising from areole by a common stalk, 11 free. Hindwings with 3 arising midway between 2 and 4, 6 and 7 closely approximated at origin or connate, 12 closely approximated to cell to about four-fifths, thence diverging.

Type, *P. ptilomacra* Low.

A small genus near *Dichromodes*, distinguished by the tufts on forewings, wide separation of 3 and 4 of hindwings, and long palpi, though the last character is shared by some species of the former genus.

Key to Species.

- 1. Forewings with longitudinal sinuate line *nevistriga*. 66
- Forewings without longitudinal line 2
- 2. Palpi 4 to 6; antennal pectinations 4 *steropias*. 67
- Palpi 7 to 8; antennal pectinations 10 *ptilomacra*. 68

* Continued from these PROCEEDINGS, liv, 1929, 504.

66. PHRIXOCOMES NEXISTRIGA.

Dichromodes steropias ab. *nexistriga* Warr., *Novit. Zool.*, 1900, 101.—
Dichromodes nexistriga Prout, *Gen. Insect.*, Oenochrom., p. 26.

Not having seen this I can add nothing to Warren's brief description. According to Prout it is certainly a distinct species.

North-west Australia: Roeburne.

67. PHRIXOCOMES STEROPIAS.

Dichromodes steropias Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1182. This also I have not seen.

Western Australia: Perth, Geraldton.

68. PHRIXOCOMES PTILOMACRA.

Dichromodes ptilomacra Low., *Trans. Roy. Soc. S. Aust.*, 1892, 8.

♂. 28-30 mm. Head and thorax fuscous irrorated with whitish. Palpi 7 to 8; whitish-grey irrorated with dark fuscous. Antennae fuscous; pectinations in ♂ 10. Abdomen grey. Legs fuscous; posterior pair ochreous-whitish. Forewings triangular, rather narrow, costa strongly arched, apex round-pointed, termen rounded, slightly oblique; pale fuscous sparsely irrorated with dark fuscous; tufts of raised scales beneath costa at one-fourth, and two-fifths, in middle of disc, and on cubital vein at one-third; antemedian line from one-fourth costa to one-fourth dorsum, slender, dark fuscous, edged anteriorly with white, dentate, very acutely angled outwards in middle, its apex reaching fourth tuft; discal dot formed by third tuft, dark fuscous edged with white posteriorly; postmedian line from four-fifths costa to two-thirds dorsum, slender, dark fuscous, edged posteriorly with white, straight, acutely dentate; a finely dentate white subterminal line preceded by a dark shade; an interrupted dark fuscous terminal line; cilia fuscous, bases barred with white. Hindwings rather elongate, termen rounded; grey; cilia grey, apices paler.

South Australia: Mt. Lofty, Port Victor.

Genus 13. DICHROMODES.

Gn., *Lep.*, ix, 320; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1167; Prout, *Gen. Insect.*, Oenochrom., p. 23.

Type, *D. ainaria* Gn.

Face with short projecting tuft of scales. Tongue present. Palpi moderate or long, porrect, thickened above and beneath with loosely appressed hairs; terminal joint concealed. Antennae of ♂ unipectinate, near apex simple. Thorax and abdomen slender; the former not or only slightly hairy beneath. Femora smooth. Tarsi not spinulose. Forewings with 11 free but closely approximated to areole, 9, 10 anastomosing with 8 to form the single areole, from which 8, 9, 10 arise by a common stalk. Hindwings with 6 and 7 separate but approximated at origin, 12 closely approximated to cell to three-fourths or more, thence diverging.

A large genus, some of the species of which are not easy to distinguish. Structural points such as the length of the palpi, and of the antennal pectinations in the ♂, must be carefully observed. The genus is distinctively Australian but has reached New Zealand, where it is represented by five indigenous species.

Key to Species.

1. Palpi whitish-grey or whitish-brown; hind tibiae of ♂ much swollen 2
Palpi not so; hind tibiae of ♂ not or only slightly dilated 4
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69. DICHROMODES ISCHNOTA.

Meyr., PROC. LINN. SOC. N.S.W., 1889, 1189; Prout, *Gen. Insect.*, Oenochrom., Pl. 1, f. 10.

♂. 18-20 mm. ♀. 21 mm. Head grey densely irrorated with whitish. Palpi 2½; brownish-fuscous, upper surface and apex white, base sharply white. Antennae ochreous-grey-whitish; pectinations in ♂ 7. Thorax grey, densely irrorated with whitish. Abdomen ochreous-grey-whitish. Legs pale fuscous irrorated, except anterior pair, with whitish; posterior tibiae in ♂ strongly dilated. Forewings triangular, costa gently arched, apex pointed, termen slightly rounded, slightly oblique; grey densely irrorated with whitish and sometimes with a few fuscous scales; first line from two-fifths costa to two-fifths dorsum, very obscurely whitish, posteriorly edged with some fuscous dots, often obsolete; an obscure, fuscous, subcostal, discal dot beyond middle; postmedian line from four-fifths costa to two-thirds dorsum, whitish edged anteriorly with fuscous, nearly straight or slightly incurved above and below middle with a slight median angle; a very obscure, wavy, whitish, subterminal line, sometimes edged anteriorly with fuscous; a fine, dark fuscous, interrupted terminal line; cilia whitish mixed with fuscous. Hindwings with termen rounded; grey; sometimes a slender, darker, median line; cilia grey.

A very obscure little species easily overlooked, but widely distributed. I have seen no Western Australian example. This and the two following species are characterized by pale brownish or pale grey palpi and dilated male posterior tibiae.

Queensland: Duaringa, Warra near Dalby. Western Australia: Carnarvon.

70. DICHROMODES MOLYBDARIA.

Panagra molybdaria Gn., *Lep.*, x, 131.—*Panagra carbonata* Wlk., *Cat. Brit. Mus.*, xxiii, 1004.—*Dichromodes molybdaria* Meyr., PROC. LINN. SOC. N.S.W., 1889, 1187.

♂, ♀. 26-29 mm. Head whitish-grey. Palpi in ♂ 3, in ♀ 3½; greyish-ochreous, upper surface and apex white. Antennae ochreous-grey-whitish; pectinations in ♂ 8. Thorax pale grey. Abdomen whitish-grey. Legs grey; posterior pair whitish; posterior tibiae in ♂ strongly dilated. Forewings triangular, rather narrow, costa nearly straight, apex pointed, termen nearly straight, moderately oblique; whitish-grey often ochreous-tinged, with a few darker scales, costal edge ochreous; a faint, median, subcostal, discal dot; a moderate, grey, transverse, median band; its anterior edge slightly irregular, from two-fifths costa to two-fifths dorsum; posterior edge from three-fourths costa to two-thirds dorsum, finely dentate, bent inwards beneath middle, obtusely angled and sometimes with a ferruginous spot in middle; sometimes an obscure series of fuscous subterminal dots, that on costa

larger; a dark fuscous interrupted terminal line; cilia whitish-grey. Hindwings with termen rounded; grey; some darker irroration on dorsum; cilia grey.

Queensland: Stanthorpe. New South Wales: Sydney, Jervis Bay.

71. DICHROMODES ESTIGMARIA.

Panagra estigmara Wlk., *Cat. Brit. Mus.*, xxiii, 1001.—*Panagra costinotata* Wlk., *ibid.*, p. 1001.—*Acidalia schistacearia* Wlk., *ibid.*, xxvi, 1609.—*Dichromodes estigmara* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1188.

North Queensland: Kuranda near Cairns, Stannary Hills near Herberton. Queensland: Nambour, Brisbane, Stradbroke Is., Southport, Coolangatta, Toowoomba, Stanthorpe. New South Wales: Sydney, Katoomba, Menangle. Victoria: Melbourne.

72: DICHROMODES GALACTICA, n. sp.

γαλακτικός, milk-white.

♂. 26 mm. Head whitish. Palpi 3; whitish. Antennae whitish with fine fuscous annulations; pectinations in ♂ 6. Thorax and abdomen whitish. Legs whitish; anterior pair irrorated with fuscous. Forewings triangular, costa straight except near base and apex, apex rounded, termen slightly rounded, slightly oblique; whitish; slight fuscous irroration on costa; markings faint, formed by slight fuscous irroration in dots; a dot just beneath midcosta, a second on median vein, and a third above dorsum, represent first line; a minute discal dot at three-fifths; postmedian represented by a series of indistinct dots from three-fourths costa to three-fifths dorsum, sinuate; cilia whitish. Hindwings with termen rounded; whitish; cilia whitish. Underside whitish with postmedian discal dots on both wings.

The uniform whitish coloration makes this a very distinct species.

Western Australia: Busselton in October; two specimens received from Mr. G. M. Goldfinch, who has the type.

73. DICHROMODES PERINIPHA.

Dichromodes perinipha Low., *Proc. Linn. Soc. N.S.W.*, 1915, 475.

♂. 28 mm. Head whitish. (Palpi broken off.) Antennae grey; pectinations in ♂ 6. Thorax grey-whitish mixed with dark fuscous and ochreous scales. Abdomen ochreous-whitish. Forewings triangular, costa straight except near base and apex, apex pointed, termen nearly straight, slightly oblique; whitish with dark fuscous irroration and markings, costal edge and all veins slenderly outlined with ochreous; a subdorsal spot near base; first line at one-fourth, transverse, coarsely dentate, not reaching margins; a large, quadrate, median, subcostal, discal spot; postmedian line from five-sixths costa to three-fourths dorsum, doubly sinuate and finely dentate, edged posteriorly with whitish; both transverse lines interrupt the ochreous neural streaks; a suffused subterminal line; a blackish crenulate terminal line; cilia grey-whitish with some darker points. Hindwings with termen nearly straight, crenulate; grey-whitish; cilia whitish.

Described from a specimen which had been compared with the type by Mr. N. B. Tindale. Very distinct by the form of the hindwings, position of postmedian line, and completely developed ochreous neural streaks on forewings. According to Lower's description the palpi are whitish like the head and thorax.

New South Wales: Broken Hill. South Australia: Pimaroo.

74. DICHROMODES AINARIA.

Dichromodes ainaria Gn., *Lep.*, ix, p. 321, Pl. 3, f. 5; Meyr., *PROC. LINN. SOC. N.S.W.*, 1889, 1170.—*Dichromodes divergentaria* Gn., *Lep.*, ix, 321.—*Dichromodes diasemaria* Gn., *ibid.*, p. 321.—*Cidaria metaxanthata* Wlk., *Cat. Brit. Mus.*, xxvi, 1734.—*Dichromodes subflava* Bastelberger, *Berl. Ent. Zeit.*, 1907, 60.

This species is variable, but may be recognized by the dark central band of the forewings in conjunction with the more or less orange hindwings. Certainly *diasemaria*, as Guenée himself suspected, is merely a local varietal form; in many Tasmanian examples the clear orange of the hindwings is replaced by a very dusky tawny-fuscous. The median band of forewings varies much in form; usually its posterior margin presents a prominent acute tooth in middle, especially well-marked in ♀, sometimes it is bifid; in the ♂ this tooth is more rounded, sometimes dentate, sometimes so reduced as to be scarcely perceptible. The underside of the forewings is dusky in the ♂, in the ♀ mostly orange.

New South Wales: Sydney, Katoomba, Bathurst. Victoria: Melbourne, Beaconsfield, Moe, Gisborne, Dunkeld. Tasmania: Hobart, St. Helen's, Zeehan, Strahan. South Australia: Mt. Lofty.

75. DICHROMODES SCOTHIMA.

Prout, *Gen. Insect.*, *Oenochrom.*, p. 24.

♂. 26-28 mm. Head blackish. Palpi $2\frac{1}{2}$; blackish, base sharply white. Antennae dark fuscous; pectinations in ♂ 3. Thorax blackish. Abdomen fuscous. Legs fuscous irrorated, and tarsi annulated, with white. Forewings triangular, costa straight except near base and apex, apex pointed, termen slightly rounded, slightly oblique; basal area and median band blackish, the former sometimes very slightly paler, in which case slightly outwardly curved blackish transverse lines at one-fourth and one-third may be perceptible, the latter indicating anterior margin of median band; posterior margin of band from three-fifths costa to three-fourths dorsum, with a slight rounded projection in middle; terminal area very pale fuscous with two, equidistant, wavy, whitish, transverse lines; a fine blackish terminal line thickened into small spots between veins; cilia pale fuscous, apices, and at tornus bases, whitish. Hindwings with termen rounded; orange; a moderate fuscous terminal band; a suffused blackish dorsal streak interrupted three times by whitish near tornus; terminal line as forewings; cilia fuscous. Underside tawny suffused with fuscous especially towards margins; a fuscous discal dot on both wings.

Described from two examples taken by Mr. W. B. Barnard. It is allied to *D. ainaria* but quite distinct. The sharply defined white bases of palpi and blackish basal three-fifths of forewings separate it at once.

Western Australia: Albany, Denmark, in March.

76. DICHROMODES LAETABILIS, n. sp.

laetabilis, cheerful.

♂, ♀. 30-32 mm. Head dark fuscous. Palpi in ♂ 3, in ♀ $3\frac{1}{2}$; dark fuscous, base sharply white. Antennae fuscous; pectinations in ♂ $2\frac{1}{2}$. Thorax dark fuscous. Abdomen fuscous. Legs dark fuscous. Forewings triangular, costa straight except near base and apex, apex pointed, termen slightly rounded, slightly oblique; rather dark fuscous with darker markings; a line from one-fifth costa to one-third dorsum; sometimes a less distinct parallel line from one-third costa; a median subcostal

discal dot, elongate transversely; a very slender, finely dentate line from two-thirds costa to two-thirds dorsum, nearly straight; usually a similar parallel posterior line; sometimes a fine wavy whitish subterminal line; a fine terminal line dotted between veins; cilia fuscous. Hindwings with termen rounded; orange, brighter in ♀, more tawny in ♂; a moderate fuscous terminal band, narrowly produced along dorsum, in ♂ sometimes suffused; cilia fuscous. Underside of ♂ fuscous with darker discal dots in both wings; in ♀ hindwings similar, but forewings orange except on costal and terminal areas, and without discal dot.

Easily distinguished from *D. ainaria* by the white bases of the palpi and the absence of a median band on forewings.

Type in Coll. Goldfinch.

New South Wales: Katoomba, in October and November. Victoria: Mt. St. Bernard, in January. Five specimens.

77. DICHROMODES HAEMATOPA.

Turn., *Trans. Roy. Soc. S. Aust.*, 1906, 131.

Characterized by the general reddish colouring, white transverse lines and dark fuscous markings of forewings.

Victoria: Sea Lake.

78. DICHROMODES RUFULA.

Prout, *Gen. Insect.*, *Oenochrom.*, p. 26.

♂. 30 mm. Head pale ochreous. Palpi 3; fuscous, upper edge whitish, base sharply white. Antennae fuscous; pectinations 7. Thorax reddish-ochreous. Abdomen whitish-grey. Legs grey irrorated, and tarsi annulated, with whitish; posterior pair almost wholly whitish. Forewings triangular, rather narrow, costa gently arched, apex round-pointed, termen slightly rounded, slightly oblique; whitish suffused with pale reddish-ochreous; a streak of fuscous irroration along costa; transverse lines reddish-ochreous, containing some dark fuscous scales, not reaching costa; three wavy transverse lines are contained in basal area; first line from beneath one-third costa to one-third dorsum, slightly dentate; median band slightly darker, containing a median, subcostal, fuscous, discal dot; postmedian from two-thirds costa to two-thirds dorsum, bent inwards below middle, finely dentate; a slender line runs parallel to this; a broader subterminal line; a wavy fuscous terminal line; cilia whitish with a faint grey median line. Hindwings with termen rounded; pale grey; a faintly darker discal dot; traces of whitish bars on dorsum towards tornus; cilia whitish.

♀. 28 mm. Forewings with basal area uniformly reddish-ochreous; median band more constricted on costa, anterior edge very strongly dentate, purple-reddish, edged posteriorly with whitish; subterminal line purple-reddish, broad, interrupted.

My two examples are very different, but probably the differences are more varietal than sexual.

Western Australia: Cunderdin, in October and November, two specimens taken by Mr. R. Illidge, Geraldton (British Museum type).

79. DICHROMODES AESIA, n. sp.

Δεισιος, happy, fortunate.

♂. 30 mm. Head pale ochreous, partly reddish-tinged; face fuscous. Palpi 2½; fuscous, base white, sharply defined. Antennae fuscous; pectinations in ♂ 2½. Thorax fuscous; tegulae and a posterior spot reddish-ochreous. Abdomen grey;

tuft grey-whitish. Legs grey. Forewings triangular, costa nearly straight, apex pointed, termen gently rounded, slightly oblique; pale ochreous, reddish-tinged; a broad fuscous-grey costal and a narrower dorsal streak; a small grey basal area containing a reddish-ochreous spot; a narrow median band grey, traversed by longitudinal, suffused, reddish-ochreous streaks, subcostal, median, and subdorsal, towards edges partly fuscous, broadest beneath costa, constricted above middle, still more constricted above dorsum; its anterior edge very slenderly whitish, slightly toothed beneath costa, thence concave; its posterior edge very slenderly whitish, strongly bisinuate, incurved above and beneath middle; a subterminal fuscous-grey fascia, with subcostal median, and subdorsal reddish-ochreous suffusion, its anterior edge suffused, posterior edge sharply defined, with two small teeth beneath costa, a strong rectangular median projection, thence strongly concave to tornus; a terminal series of confluent triangular fuscous spots; cilia grey irrorated with whitish. Hindwings with termen rounded, grey; cilia grey, apices paler. Underside grey, postmedian area paler; hindwings with a fuscous discal dot before middle.

Nearest *D. ioneura*, but the median band is very differently formed. In that species it has a straight posterior edge.

Western Australia: Tammin, in August (A. J. Nicholson); one specimen in Coll. Goldfinch.

80. DICHROMODES IONEURA.

Meyr., PROC. LINN. SOC. N.S.W., 1889, 1182.

This varies much in the extent of the coloured markings, which may be crimson or brownish-ochreous.

South Australia: Pimaroo. Western Australia: Perth, Waroona, Cunderdin.

81. DICHROMODES POECILOTTIS.

Meyr., PROC. LINN. SOC. N.S.W., 1889, 1181.—*Dasyuris tridentata* Swin., *Trans. Ent. Soc. Lond.*, 1902, 649.

Victoria: Dimboola, Daytrap near Sea Lake. Western Australia: Perth, Waroona, Kelmscott, Geraldton, Carnarvon.

82. DICHROMODES EUPREPES.

Prout, *Gen. Insect.*, Oenochrom., 1910, p. 26.—*Dichromodes fulvida* Low., PROC. LINN. SOC. N.S.W., 1915, 475.—*Dichromodes cirrhoplaca* Low., *ibid.*, p. 476.

♀. 25-28 mm. Head grey-whitish with a few fuscous scales. Palpi $3\frac{1}{2}$; fuscous, upper surface mixed with grey-whitish, base sharply white. Antennae fuscous. Thorax whitish-ochreous mixed with fuscous. Abdomen whitish mixed with fuscous or grey. Legs fuscous irrorated, and tarsi annulated, with whitish. Forewings triangular, costa straight to near apex, apex obtusely pointed, termen slightly rounded, slightly oblique; grey-whitish or whitish-ochreous; broadly suffused with grey along costa; a subdorsal, fuscous, basal spot; first line dark fuscous, narrow, straight, from one-fourth dorsum, obliquely outwards to beneath one-third costa, sometimes ill-defined or interrupted, edged broadly with brownish-ochreous anteriorly and with whitish posteriorly; a transversely-oval, dark fuscous, pale-centred, median, subcostal, discal spot; sometimes a median and a dorsal fuscous bar across median band; postmedian line dark fuscous, slender, from two-thirds dorsum obliquely outwards to beneath three-fourths costa, sometimes ill-defined, anteriorly narrowly edged with whitish, posteriorly broadly edged with

brownish-ochreous; a subterminal fuscous line immediately follows, thickened quadrangulately beneath costa, in middle, and on dorsum; a crenulate fuscous terminal line, sometimes reduced to dots; cilia grey-whitish sometimes mixed with fuscous. Hindwings with termen rounded, grey; cilia grey.

Allied to *D. poecilotis*, *ioneura*, and *orthozona*. Distinguished by the outwardly oblique lines of forewing not reaching costa.

Victoria: Dimboola. South Australia: Pimaroo. Western Australia: Waroona, Cunderdin, Coolgardie.

83. DICHROMODES COMPSOTIS.

Meyr., PROC. LINN. SOC. N.S.W., 1889, 1174.

I do not know this species, which appears to belong to the *ioneura* group, and to be different from any I have seen. Mr. L. B. Prout kindly examined Meyrick's type for me.

Western Australia: Perth.

84. DICHROMODES ORTHOTIS.

Meyr., PROC. LINN. SOC. N.S.W., 1889, 1180.

Western Australia: Perth, Waroona, Collie, Albany, Denmark.

85. DICHROMODES ORTHOZONA.

Low., *Trans. Roy. Soc. S. Aust.*, 1903, 189.

♂, ♀. 25-30 mm. Head grey-whitish with some fuscous scales. Palpi 3; dark-fuscous, upper surface partly grey-whitish, base sharply white. Antennae fuscous; pectinations in ♂ 5. Thorax and abdomen grey-whitish mixed with dark fuscous. Legs dark fuscous irrorated, and tarsi annulated, with whitish. Forewings triangular, costa straight except near base and apex, apex obtusely pointed, termen slightly bowed, slightly oblique; dark fuscous mixed with grey-whitish; a short dark fuscous or ferruginous bar from costa near base, not reaching dorsum; first line nearly straight, ochreous-whitish, from one-fourth costa to one-third dorsum, edged anteriorly with dark ferruginous-fuscous, posteriorly by a narrow blackish line with small dentations beneath costa, in middle, and above dorsum; a transversely oval, dark fuscous, more or less pale-centred, median, subcostal, discal spot; median area crossed by fine blackish streaks; postmedian line from three-fourths costa to two-thirds dorsum, very slightly curved outwards, ochreous-whitish, anteriorly narrowly edged with blackish, posteriorly with dark ferruginous-fuscous; a fine, whitish, irregular, subterminal line with quadrangular projections above and below middle; a terminal series of blackish dots; veins in costal and terminal areas more or less outlined by fine brownish-ochreous streaks; cilia whitish barred with fuscous. Hindwings with termen rounded; grey; a darker discal dot; terminal dots and cilia as forewings.

Readily distinguished from *D. euprepes* by the lines of forewings converging towards dorsum, whereas in that species they are parallel and strongly outwardly oblique from dorsum.

Western Australia: Perth. North-west Australia: Roeburne.

86. DICHROMODES PARTITARIA.

Eubolia partitaria Wlk., *Cat. Brit. Mus.*, xxxv, 1699.—*Dichromodes partitaria* Meyr., PROC. LINN. SOC. N.S.W., 1889, 1175.

Mr. Prout suggests that Walker's type may be the same as *D. sigmata* Wlk. The species described by Meyrick, of which I have seen a small series, is very distinct from that species.

Victoria: Dimboola. Western Australia: Perth, Albany, Northampton.

87. *DICHROMODES ANGASI*.

Liodes? angasi Feld., *Reise Novara*, Pl. 131, f. 13.

♂. 25 mm. Head fuscous irrorated with whitish; face dark fuscous. Palpi 2; dark fuscous, base sharply white. Antennae fuscous; pectinations in ♂ 3. Thorax fuscous irrorated with whitish. Abdomen whitish irrorated with fuscous. Legs fuscous; tarsi annulated with whitish; posterior tibiae whitish with some fuscous irroration. Forewings triangular, costa very slightly arched, apex round-pointed, termen slightly bowed, slightly oblique; fuscous with some whitish irroration; a slender, curved, transverse, fuscous line at one-fifth faintly indicated; first line obsolete; discal dot scarcely indicated; postmedian line fuscous, sinuate, very indistinct; a conspicuous grey-whitish terminal band, its anterior edge sharply defined, very irregular, from costa near apex, at first dentate, deeply excavated above and below middle, median projection irregularly quadrangular, ending at tornus; a fine, interrupted, dark fuscous, terminal line; cilia pale grey, on costa darker. Hindwings with termen rounded; grey; a darker terminal line; cilia pale grey.

Allied to *D. partitaria* but considerably larger, the forewings without white lines, the antennal pectinations considerably longer (barely 2 in *partitaria*). My example closely resembles Felder's figure.

Victoria: Sea Lake in March; one specimen received from Mr. D. Goudie.

88. *DICHROMODES PHAEOSTROPHA*.

Dichromodes obtusata var. *longidens* Prout, *Gen. Insect.*, *Oenochrom.*, p. 24.—*Dichromodes phaeostropha* Turn., *Proc. Roy. Soc. Tas.*, 1925, 108.

A good and distinct species, not very closely related to *D. obtusata*. Varietal names have, I believe, no priority. I might have adopted Prout's name had I known of it when publishing my description.

Victoria: Frankston near Melbourne, Beaconsfield. Tasmania: Launceston, Zeehan, Strahan. South Australia: Mt. Lofty.

89. *DICHROMODES ANELICTIS*.

Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1172.

♂. 24-30 mm. ♀. 22-29 mm. Excessively variable; not only may the median band be interrupted above dorsum, but the whole of it between dorsum and angle may be obliterated by whitish or fuscous suffusion; part of it may be blackish between angle and costa; but the very acute posterior angle makes the species always easy to recognize. Rarely there is some ferruginous suffusion in terminal area. The palpi also, in addition to the white area at base and the upper margin, may be mixed throughout with white scales. All these varieties may occur in the same locality.

Victoria: Dimboola, Walpeup, Sea Lake. South Australia: Adelaide, Mt. Lofty. Western Australia: Perth, Waroona, Kelmscott, Albany, Geraldton.

90. *DICHROMODES ORIPHOETES*, n. sp.

ὄρειφουίτης, mountain-ranging.

♂, ♀. 30-34 mm. Head and thorax dark fuscous irrorated with whitish. Palpi in ♂ $2\frac{1}{2}$, in ♀ 3; dark fuscous, a few whitish scales on upper surface, base sharply white. Antennae fuscous; pectinations in ♂ 5. Abdomen ochreous-whitish partly suffused with grey. Legs fuscous irrorated with whitish. Forewings triangular, costa gently arched, apex round-pointed, termen slightly rounded, scarcely oblique; fuscous irrorated with white; a suffused fuscous spot on base of costa and another on dorsum near base; a suffused and interrupted fuscous transverse line slightly beyond; first line from one-third costa to one-third dorsum, white, edged with blackish posteriorly, slightly dentate, slightly outwardly curved; a transverse, median, subcostal, blackish, discal mark; postmedian line from two-thirds costa to two-thirds dorsum, white, edged anteriorly with blackish, indented above and below middle, with a rather obtuse median angle; an irregular white subterminal line, dentate, somewhat projecting in middle; an interrupted blackish terminal line preceded by a grey-whitish line; cilia fuscous, apices barred with white. Hindwings with termen rounded; pale grey suffused with yellowish towards base in ♂, in ♀ almost wholly and more distinctly yellowish; in ♂ two indistinct pale subterminal lines, and a faintly darker discal dot; terminal line and cilia as forewings.

New South Wales: Mt. Kosciusko (5,000 feet) in December; eight specimens received from Mr. G. M. Goldfinch, who has the type.

91. *DICHROMODES DENTICULATA*, n. sp.

denticulatus, finely toothed.

♂. 22 mm. Head and thorax dark fuscous mixed with grey. Palpi 2; dark fuscous, base sharply white. Antennae fuscous; pectinations in ♂ 2. Abdomen fuscous. Legs: anterior pair dark fuscous, tibiae and tarsi annulated with whitish (others missing). Forewings triangular, costa slightly arched, apex round-pointed, termen slightly rounded, slightly oblique; grey irrorated with fuscous; lines dark fuscous; a transverse sub-basal line succeeded by two fine dentate lines; ante-median from a spot on two-fifths costa to two-fifths dorsum, slightly outwardly-curved, dentate; postmedian from a spot on three-fifths costa to three-fifths dorsum, sharply dentate, bent inwards below middle; median band narrow, especially in dorsal half, darker than disc, containing a median, subcostal, dark-fuscous transverse, discal mark; a fine, strongly waved, slightly dentate line from a spot on four-fifths costa to four-fifths dorsum; a very slender, wavy, whitish, subterminal line; a terminal series of triangular blackish dots; cilia grey-whitish mixed with fuscous. Hindwings with termen rounded; grey; cilia grey.

Allied to *D. disputata*, but the shorter palpi and antennal pectinations are sufficient to prove it distinct.

Western Australia: Perth; one specimen received from Mr. L. J. Newman.

92. *DICHROMODES DISPUTATA*.

Panagra disputata Wlk., *Cat. Brit. Mus.*, xxiii, 1009.—*Panagra dentigeraria* Wlk., *ibid.*, xxvi, 1665.—*Dichromodes odontias* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1173.—*Dichromodes disputata* Meyr., *ibid.*, 1173.—*Dichromodes mesozona* Prout, *Gen. Insect.*, *Oenochrom.*, p. 27.

Palpi 2½. Antennal pectinations 4. Very variable; in some examples the whole of the forewings is suffused with reddish scales, in others these are reduced to a few scattered scales in disc and cilia, in others they are completely absent. The head may be dark fuscous or reddish. There is an example from the Grampians in the National Museum, Melbourne, closely agreeing with the description of *odontias*. *D. mesozona* is probably to be referred here.

Queensland: Maryborough, Caloundra, Stradbroke Is., Stanthorpe. New South Wales: Glen Innes, Sydney, Katoomba, Orange. Victoria: Beechworth, Grampians, Dimboola.

93. DICHROMODES PARATACTA.

Meyr., PROC. LINN. SOC. N.S.W., 1889, 1176.

Palpi 2; fuscous more or less mixed with pale ochreous, towards base whitish, but without sharply defined white area. Abdomen fuscous more or less mixed with whitish.

Queensland: Caloundra, Brisbane, Stradbroke Is., Coolangatta. New South Wales: Sydney.

94. DICHROMODES ARISTADELPHA.

Low., *Trans. Roy. Soc. S. Aust.*, 1903, 190.

♂. 24-28 mm. ♀. 24-25 mm. Head pale grey with a few fuscous scales. Palpi 2½; fuscous, upper surface irrorated with whitish, base sharply white. Antennae fuscous; pectinations in ♂ 2½. Thorax pale grey mixed with blackish. Abdomen fuscous, some irroration, apices of segments, and tuft ochreous-whitish. Legs fuscous irrorated, and tarsi annulated, with whitish. Forewings triangular, costa straight, except near base and apex, apex obtusely pointed, termen slightly rounded, slightly oblique; pale brownish-ochreous more or less suffused with fuscous; a transverse dark fuscous mark on costa near base; sometimes a roundish dark fuscous suffusion on dorsum near base; first line from one-third costa to beyond one-third dorsum, slender, ochreous-whitish, outwardly-curved but indented above dorsum, edged anteriorly by a fuscous line; postmedian line from two-thirds costa to three-fourths dorsum, slender, ochreous-whitish, outwardly-curved but more or less indented beneath costa and above dorsum; between these lines is a dark fuscous, partly blackish, median band, containing a narrow, blackish, median, subcostal, discal mark; beyond postmedian line is a brownish-ochreous suffused band; subterminal line whitish, slender, strongly indented above and below middle, edged anteriorly by a dark fuscous or blackish suffusion, posteriorly by a fine fuscous line; terminal area grey-whitish; a fine, blackish, crenulate, terminal line; cilia whitish obscurely barred with fuscous. Hindwings with termen rounded; pale fuscous; a darker discal dot; a finely dentate, darker, postmedian line edged obscurely with whitish posteriorly; sometimes a similar but not dentate subterminal line; cilia fuscous, apices paler.

South Australia: Adelaide in September (Lower's type). Western Australia: Busselton in February, three specimens (W. B. Barnard).

95. DICHROMODES DIFFUSARIA.

Panagra diffusaria Gn., *Lep.*, x, 132.—*Dichromodes strophiodes* Low., *Trans. Roy. Soc. S. Aust.*, 1893, 155.

♂, ♀. 25-28 mm. Head and thorax fuscous with more or less whitish irroration. Palpi in ♂ $2\frac{1}{2}$, in ♀ $3\frac{1}{2}$; dark fuscous, upper surface irrorated with grey-whitish, base sharply white. Antennae fuscous; pectinations in ♂ 4. Abdomen fuscous with some whitish irroration; apices of segments whitish. Legs fuscous irrorated, and tarsi annulated, with whitish. Forewings triangular, costa gently arched, apex obtusely pointed, termen slightly rounded, slightly oblique; fuscous with some whitish irroration; an erect transverse bar from dorsum near base, ending in an acute point beneath costa, dark fuscous; a narrow fuscous transverse line, sometimes reduced to dots, follows this; first line whitish, suffused, nearly straight, from one-fourth costa to one-third dorsum; median band darker, containing a median, subcostal, dark fuscous, discal dot; postmedian line whitish, suffused, sinuate beneath costa, with an acute, projecting, median angle, thence strongly inwardly-curved, from three-fourths costa to three-fourths dorsum; a fine fuscous line follows this; a wavy, whitish, subterminal line, more or less marked, edged anteriorly and sometimes interrupted by dark fuscous; a wavy, blackish terminal line; in some examples there are additional brownish-ochreous markings, most commonly a suffused median spot posterior to postmedian line, sometimes also a longitudinal streak posterior to that line midway between costa and middle, sometimes some suffusion near base and on first line; cilia fuscous barred with whitish. Hindwings with termen rounded; grey; two or three whitish bars on dorsum above tornus, sometimes prolonged into disc; a darker terminal line; cilia grey, bases and apices partly whitish.

The coloured markings are inconstant and often wholly absent, in which case the species has a general resemblance to *D. triparata*, but may be at once distinguished by the white bases of the palpi.

Queensland: Coolangatta. New South Wales: National Park, Katoomba. Victoria: Melbourne, Sale, Grampians. South Australia: Adelaide, Mt. Lofty. Western Australia: Perth, Waroona.

96. DICHROMODES MESOGONIA.

Prout, *Gen. Insect.*, *Oenochrom.*, p. 27.

♂. 24 mm. Head and thorax fuscous with slight whitish irroration. Palpi $2\frac{1}{4}$; fuscous, upper surface irrorated with whitish, base sharply white. Antennae grey; pectinations in ♂ 3. (Abdomen broken off.) Legs fuscous irrorated, and tarsi annulated, with whitish. Forewings triangular, costa gently arched, apex round-pointed, termen slightly rounded, moderately oblique; fuscous irrorated with whitish, median band darker; antemedian line obscure, whitish, nearly straight, edged anteriorly and posteriorly with fuscous, from one-third costa to two-fifths dorsum; an obscure, fuscous, median, subcostal, discal dot; postmedian line slender, whitish, edged anteriorly with fuscous, from two-thirds costa to three-fifths dorsum, slightly angled outwards beneath costa, and again more distinctly in middle; an obscure ferruginous spot on angle of this line; an obscure, whitish, wavy, subterminal line; a fine, interrupted, dark fuscous, terminal line; cilia fuscous with obscure, whitish, basal bars, apices grey mixed with whitish. Hindwings with termen rounded; grey; cilia grey, apices paler.

Redescribed from the type in the National Museum, Melbourne. Probably nearest *D. diffusaria*, but more closely resembling some forms of *D. triparata*, from which it may be distinguished by the palpi being white at base.

Victoria: Sea Lake.

97. *DICHROMODES EMPLECTA*, n. sp.

ἐμπλεκτός, interwoven.

♂, ♀. 25-30 mm. Head dark-fuscous. Palpi 2½; dark-fuscous, some whitish irroration on upper surface; base sharply white. Antennae fuscous; pectinations in ♂ 3. Thorax fuscous with a few whitish scales. Abdomen fuscous irrorated with whitish; tuft greyish-ochreous. Legs fuscous irrorated, and tarsi annulated, with whitish. Forewings triangular, costa straight except near base and apex, apex obtusely pointed, termen slightly rounded, slightly oblique; brownish-fuscous suffused and irrorated with whitish and blackish; a narrow basal dark fuscous fascia; a brown-whitish sub-basal fascia containing some fuscous irroration especially on costa; a brownish-fuscous transverse line, becoming blackish on costa and dorsum, succeeds this; first line from one-third costa to two-fifths dorsum, slender, blackish, strongly but irregularly dentate; a median, subcostal, blackish, sometimes pale-centred, transverse, discal mark; second line from three-fourths costa to two-thirds dorsum, slender, blackish, finely dentate, not angled, its costal half, where it traverses a white suffusion, more or less obsolete; median band more or less filled in with blackish; a wavy brownish-fuscous line from four-fifths costa to four-fifths dorsum; an irregular whitish subterminal line edged anteriorly with blackish, more thickly beneath costa, in middle, and above dorsum; a fine, crenulate, blackish, terminal line; cilia fuscous mixed, and apices barred, with whitish. Hindwings with termen rounded; fuscous; some whitish irroration and two or three blackish bars on dorsum; a darker terminal line; cilia fuscous, apices whitish.

Western Australia: Albany and Denmark in February and March; twelve specimens received from Mr. W. B. Barnard, who has the type.

98. *DICHROMODES CONFLUARIA*.

Panagra confluaria Gn., *Lep.*, x, p. 131, Pl. 7, f. 8.—*Dichromodes confluaria* Meyr., *PROC. LINN. SOC. N.S.W.*, 1889, 1193.

New South Wales: Jervis Bay, Katoomba. Victoria: Melbourne, Beaconsfield, Moe, Gisborne, Dunkeld. Tasmania: Hobart, St. Helen's, Launceston, Deloraine, Zeehan. Western Australia: Perth, Waroona, Albany.

99. *DICHROMODES ROSTRATA*, n. sp.

rostratus, having a beak.

♀. 35 mm. Head and thorax whitish mixed with fuscous. Palpi extremely long (8); fuscous, upper surface irrorated with whitish, base sharply white. Antennae grey. Abdomen whitish mixed with fuscous and ferruginous. Legs whitish irrorated with fuscous. Forewings triangular, costa nearly straight, slightly sinuate, apex pointed, termen nearly straight, oblique; grey-whitish irrorated and partly suffused with dark-fuscous; a broad grey-whitish streak along costa from base to apex, giving off from near base a finger-shaped process with rounded extremity reaching to two-fifths of disc midway between costa and dorsum; a similar streak on dorsum from base to tornus becoming narrower posteriorly; a white straight line from beneath five-sixths costa to above three-fifths dorsum, preceded by a dark fuscous mark beneath costa, and a large dark fuscous suffusion which extends basally on both sides of the finger-shaped process; a blackish, subcostal, discal dot beyond middle; a fine, whitish, subterminal line commencing near apex, outwardly toothed in middle, and forming a second tooth.

on apex, anterior margin shaded, and teeth filled in with dark fuscous; a dark fuscous, terminal line edged anteriorly by a white line; cilia fuscous, bases and apices whitish. Hindwings with termen only slightly rounded; grey; a darker discal dot and terminal line; cilia grey, apices whitish.

This very distinct species, remarkable for its long palpi, is nearest *D. confluaria*.

Western Australia: Merredin, one specimen received from Mr. L. J. Newman.

100. DICHROMODES EXPLANATA.

Panagra explanata Wlk., *Cat. Brit. Mus.*, xxiii, 1009.—*Dichromodes explanata* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1179.

New South Wales: Sydney, Bathurst. Victoria: Melbourne, Sale, Bendigo, Grampians. South Australia: Mt. Lofty. Western Australia: Albany.

101. DICHROMODES OBTUSATA.

Panagra obtusata Wlk., *Cat. Brit. Mus.*, xxiii, 1008.—*Panagra devitata* Wlk., *ibid.*, 1010.—*Dichromodes obtusata* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1177.

Palpi in ♂ 2½, in ♀ 3. Two males from Western Australia have palpi 2, and sub-basal line of forewings more fuscous than ferruginous, but they are not separable specifically.

Queensland: Stradbroke Is., Coolangatta. New South Wales: Sydney, Jervis Bay, Katoomba, Bathurst, Mittagong. Victoria: Melbourne, Beaconsfield, Sale, Gisborne. South Australia: Adelaide, Mt. Lofty. Western Australia: Bridgetown, Cunderdin.

102. DICHROMODES LISSOPHRICA, n. sp.

λίσσοφρικος, smoothly rippled.

♂. 28 mm. Head grey. Palpi 2; fuscous, base sharply white. Thorax and abdomen grey. Legs fuscous (posterior pair missing). Forewings triangular, costa slightly arched, apex obtusely pointed, termen slightly rounded, slightly oblique; pale grey, markings fuscous; costal edge fuscous to two-thirds; a fuscous bar from base of costa half-way across disc; antemedian from one-third costa to two-fifths dorsum, sharply angled in disc first outwards, then inwards, then again outwards, closely preceded by a similar parallel line; a subcostal, fuscous, discal dot well beyond middle; postmedian from two-thirds costa to three-fourths dorsum, slightly sinuate, sharply dentate, with two larger posterior teeth below middle; two faint indistinct dentate lines beyond this; cilia grey. Hindwings with termen only slightly rounded; whitish-grey; cilia whitish-grey.

Western Australia: Perth in October; one specimen received from Mr. J. Clark.

103. DICHROMODES EXSIGNATA.

Panagra exsignata Wlk., *Cat. Brit. Mus.*, xxiii, 1010 (*nec* Meyr.).—*Dichromodes diasemaria* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1171; *Turn.*, *Proc. Roy. Soc. Tas.*, 1925, 107 (*nec* Gn.).—*Dichromodes uniformis* Bastelberger, *Berl. Ent. Zeit.*, 1907, 60.—*Dichromodes exocha* Prout, *Novit. Zool.*, 1916, 1.

Meyrick and myself have wrongly attributed the name *diasemaria* to this species. Meyrick's description applied to the ♀ only; I have myself described both sexes from Tasmanian examples. A ♂ from Sydney has the markings better

defined than in Tasmanian specimens of this sex, and the median band is distinctly darker. A ♂ from Katoomba resembles the ♀ in having the first and postmedian line followed by a pale shade. In both the hindwings are dark grey without any brownish tinge. In some aberrant examples the median band is darker than basal and terminal areas; this should be noted as an exception in my key.

New South Wales: Sydney, Katoomba. Tasmania: St. Helen's, Beaconsfield, Cradle Mt. (3,000 feet), Zeehan, Strahan.

Prout's type (A. Simmons) is from Kelso near Beaconsfield, Tasmania, not from New South Wales.

104. DICHROMODES ORECTIS.

Meyr., PROC. LINN. SOC. N.S.W., 1889, 1183.

♂, ♀. 20-22 mm. Head whitish-grey. Palpi 2½; fuscous, upper surface whitish-grey, base sharply white. Antennae grey; pectinations in ♂ 3½. Thorax whitish-grey. Abdomen whitish-grey, with a few fuscous scales. Legs fuscous; in posterior pair mixed with whitish. Forewings triangular, costa straight except near base and apex, apex round-pointed, termen slightly bowed, slightly oblique; whitish-grey, markings and some irroration dark fuscous; a short transverse mark from base of costa; first line from one-third costa to one-third dorsum, slightly wavy, sometimes preceded by a parallel line, sometimes thickened and blackish except towards costa; a median, subcostal, round, pale-centred, discal spot; postmedian line from two-thirds costa or slightly beyond to two-thirds dorsum, sinuate to middle, where it forms an acute angle and is bent and curved inwards, sometimes thickened and blackish except towards costa, sometimes interrupted into a series of dots, sometimes a ferruginous-ochreous spot at angle; sometimes a fuscous parallel line follows this; subterminal very obscure, whitish, anteriorly more or less suffused with fuscous; a terminal series of blackish dots; cilia grey, apices paler. Hindwings with termen rounded; grey; cilia as forewings.

At first sight the different forms of this species may be puzzling, but the variation is analogous to that in *atrosignata*.

Western Australia: Albany and Busselton in February; four specimens received from Mr. W. B. Barnard; Geraldton in November and December.

105. DICHROMODES SEMICANESCENS.

Prout, *Novit. Zool.*, 1913, 388.

♀. 18 mm. Head fuscous irrorated with grey. Palpi fuscous, base whitish. Thorax and abdomen grey. Forewings rather broadly triangular, apex round-pointed, termen rounded, slightly oblique; grey; dorsal area, except base, irrorated with dark fuscous; costal area suffused with pale ferruginous-ochreous; several areas of longitudinal ferruginous-ochreous suffusion in terminal area; a dark fuscous terminal band narrowing to a point at tornus; antemedian line slender, indistinct, dark fuscous, arising from a blackish spot on costa at one-fourth; similar costal spots shortly before and after middle; discal spot blackish, followed by some fuscous suffusion; postmedian line scarcely traceable. Hindwings fuscous; dorsal margin slightly paler with indications of commencing fuscous transverse line.

I do not know this species, and have abstracted these details from Prout's description.

Western Australia: Geraldton.

106. *DICHROMODES SIGMATA*.

Panagra sigmata Wlk., *Cat. Brit. Mus.*, xxiii, 1005.—*Dichromodes sigmata* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1179.

♂. 24 mm. Head and thorax fuscous irrorated with whitish. Palpi $3\frac{1}{2}$; dark fuscous, upper surface irrorated with grey-whitish, base sharply white. Antennae grey; pectinations in ♂ 3. Legs fuscous irrorated, and tarsi annulated, with whitish. Forewings triangular, costa gently arched, apex obtusely pointed, termen slightly rounded, moderately oblique; fuscous, rather densely irrorated with whitish; first line from one-fourth costa to one-third dorsum, at first outwardly oblique, bent beneath costa, thence straight, white edged posteriorly with blackish, which is thickened in middle and above dorsum; a median, subcostal, dark fuscous, discal dot; postmedian line from two-thirds costa to two-thirds dorsum, unevenly edged anteriorly with blackish, which is thickened beneath costa, in middle, and above dorsum, at first sinuate and transverse, slightly angled outwards in middle, thence incurved; angle of postmedian line edged posteriorly with brownish-ochreous; a short longitudinal streak of the same colour posterior to this line midway between costa and middle; a suffused whitish terminal band; a wavy blackish terminal line; grey obscurely barred with whitish. Hindwings with termen rounded; grey; cilia grey.

Queensland: Stanthorpe; one example in February. New South Wales: Sydney (British Museum type).

107. *DICHROMODES LYGRODES*, n. sp.

λυγρωδης, gloomy.

♀. 28 mm. Head and thorax dark fuscous with some whitish irroration. Palpi 3; dark fuscous, upper edge irrorated with grey-whitish, lower edge slenderly grey-whitish towards base. Antennae grey-whitish annulated with blackish. Abdomen grey irrorated with fuscous. Legs dark fuscous irrorated, and tarsi annulated, with whitish; posterior pair mostly whitish. Forewings triangular, costa slightly arched, apex round-pointed, termen slightly rounded, slightly oblique; dark fuscous irrorated with ochreous-whitish; antemedian line represented by two or three ochreous-whitish dots; a median, subcostal, transverse, blackish, discal mark; postmedian line formed by a very distinct series of ochreous-whitish dots, from two-thirds costa to two-thirds dorsum, with a slight posterior prominence below costa and a distinct posterior angle below middle, concave above and below angle; an ochreous-whitish wavy subterminal line partially developed; a fine, blackish, crenulate, terminal line; cilia fuscous, apices mostly ochreous-whitish. Hindwings with termen slightly rounded; pale grey; indistinct whitish anteriorly, fuscous-edged postmedian and subterminal lines; cilia grey, apices grey-whitish.

South Australia: Pimaroo; one specimen in Coll. Lower, now in South Australian Museum.

108. *DICHROMODES LIOSPODA*.

Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1178. I have not seen this species. New South Wales: Sydney.

109. *DICHROMODES LEPTOGRAMMA*, n. sp.

λεπτογραμμος, faintly marked.

♀. 22 mm. Head and thorax grey-whitish irrorated with fuscous. Palpi $2\frac{1}{4}$;

fuscous, upper surface irrorated with whitish, base sharply white. Antennae grey-whitish, towards apex dark grey, towards base annulated with dark fuscous. Abdomen grey. Legs fuscous; posterior pair grey-whitish irrorated with fuscous. Forewings triangular, costa nearly straight, arched towards apex, apex round-pointed, termen slightly rounded, slightly oblique; grey-whitish irrorated with dark fuscous; lines slender, grey-whitish, indistinct; antemedian from one-third costa to two-fifths dorsum, nearly straight; postmedian from two-thirds costa to four-fifths dorsum, slightly wavy; discal dot obsolete; cilia grey-whitish with a fuscous median line. Hindwings with termen rounded; grey; cilia grey.

Very obscure, the markings being scarcely perceptible. It is probable that they are more distinct in some examples.

Western Australia: Perth in October; one specimen received from Mr. J. Clark.

110. *DICHROMODES LIMOSA*, n. sp.

limosus, muddy.

♂, ♀. 23-26 mm. Head and thorax whitish-grey. Palpi 3; pale fuscous, upper edge whitish, base narrowly white. Antennae grey-whitish; pectinations in ♂ 7. Abdomen and legs ochreous-grey-whitish. Forewings triangular, costa gently arched, apex acute, termen slightly rounded, slightly oblique; ochreous-grey-whitish with some fine fuscous irroration; costal edge more or less ochreous-tinged; first line very slender, pale, sometimes indistinct, from two-fifths costa to two-fifths dorsum, usually edged posteriorly by minute subcostal, median, and subdorsal fuscous dots; a median, subcostal, fuscous, discal dot; postmedian line very slender, pale, sometimes indistinct, from four-fifths costa to three-fifths dorsum, slightly outwardly-curved beneath costa, thence nearly straight or slightly wavy, usually edged anteriorly by a series of fuscous dots; sometimes whole of median band, except towards costa, is suffused with fuscous; a fine, pale, dentate or wavy, subterminal line; an interrupted blackish terminal line; cilia grey, apices more or less ochreous-whitish. Hindwings with termen rounded; pale grey; sometimes indications of a fine, pale, transverse, median line; cilia as forewings.

Variable in the presence or absence of a dark median band. The more obscure examples might be confused with *D. ornata*, but the white base of palpi, slight ochreous tinge, and dorsal termination of first line much nearer to postmedian line than to base, are sufficient distinctions.

North Queensland: Cape York. Queensland: Yeppoon in October; Rockhampton in July; Emerald in September; Bundaberg in June; Brisbane in September and March; Warra near Dalby. New South Wales: Lismore in October. Ten specimens.

111. *DICHROMODES LEPTOZONA*, n. sp.

λεπτοξωνος, with slender girdle.

♂, ♀. 20-23 mm. Head and thorax grey irrorated with whitish. Palpi 2½; grey, upper surface whitish, base white. Antennae pale grey; pectinations in ♂ 5. Abdomen ochreous-grey-whitish. Legs grey; posterior pair whitish; posterior tibiae of ♂ strongly dilated and grooved in distal three-fourths. Forewings triangular, costa straight to near apex, apex pointed, termen slightly rounded, slightly oblique; grey with dense whitish irroration; a slender grey median band,

sometimes blackish towards dorsum, containing a minute blackish discal dot, strongly expanded on costa, less so on dorsum, constricted in middle, anterior edge from two-fifths costa to two-fifths dorsum, outwardly curved, posterior edge from four-fifths costa to three-fifths dorsum, nearly straight or slightly waved; terminal area grey traversed by a slender whitish subterminal line; an interrupted blackish terminal line; cilia grey with whitish points, apices grey. Hindwings with termen rounded; grey; sometimes a faintly darker transverse line from dorsum succeeded by a paler tornal area; a darker terminal line; cilia grey. Underside of hindwings whitish irrorated with grey, with grey discal dot and postmedian line.

Western Australia: Kalamunda near Perth in December, ♂ type in Coll. Barnard; in September, ♀ in Coll. Goldfinch.

112. DICHROMODES PERSONALIS.

Colobochila? personalis Feld., *Reise Novara*, Pl. 120, f. 20.—*Dichromodes personalis* Meyr., PROC. LINN. SOC. N.S.W., 1889, 1194—*Epidemia ophiosema* Low., *Trans. Roy. Soc. S. Aust.*, 1901, 64.

I have seen Lower's type and can confirm Prout's identification. The species is very distinct and cannot be mistaken. Although the internal groove and tuft of the posterior ♂ tibiae are well marked, the tibiae are only slightly dilated.

Western Australia: Perth, Waroona, Merredin, Mt. Barker, Albany.

113. DICHROMODES OPHIUCHA.

Meyr., PROC. LINN. SOC. N.S.W., 1889, 1186.

The absence of both transverse lines makes this species easily recognizable.

Queensland: Toowoomba (W. B. Barnard). New South Wales: Sydney, National Park.

114. DICHROMODES EUSCIA.

Meyr., PROC. LINN. SOC. N.S.W., 1889, 1185.

Distinguished by the absence of the antemedian line.

New South Wales: Katoomba. Tasmania: Zeehan, Strahan.

115. DICHROMODES INDICATARIA.

Eubolia indicataria Wlk., *Cat. Brit. Mus.*, xxxv, 1698.—*Dichromodes indicataria* Meyr., PROC. LINN. SOC. N.S.W., 1889, 1186.

Variable, but distinguished by the wholly fuscous palpi (except upper edge), combined with the finely dentate postmedian line.

Queensland: Caloundra, Stradbroke Is., Southport, Coolangatta. New South Wales: Sydney, Jervis Bay. Victoria: Melbourne, Beaconsfield, Grampians. Western Australia: Perth, Kelmscott, Waroona, Bunbury, Geraldton.

116. DICHROMODES ICELODES, n. sp.

είκελωδης, similar.

♂. 22 mm. Head grey with whitish points. Palpi 4; fuscous; upper surface grey with whitish points. Antennae fuscous; pectinations in ♂ 3. Thorax grey. Abdomen pale grey. Legs fuscous; posterior pair grey. Forewings triangular, costa straight except near base and apex, apex pointed, termen slightly bowed, scarcely oblique; grey with fine whitish irroration; markings fuscous; ante-medial line from one-third costa to two-fifths dorsum, slender, slightly dentate;

discal spot annular, rather large, in centre grey; postmedian from before two-thirds costa to mid-dorsum, finely dentate, slender; subterminal line well marked, slightly wavy; a fine interrupted terminal line; cilia grey with whitish points on basal half. Hindwings with termen gently rounded; grey; a darker discal dot before middle; slight indications towards dorsum of a paler subterminal line; cilia grey.

♀. 20 mm. Palpi 5. Forewings with markings broader, blackish, very distinct; discal spot fused with postmedian line; cilia with indistinct fuscous bars.

Very near *D. indicataria*, but may be distinguished by the longer palpi.

New South Wales: Mt. Kosciusko (5,000 feet) in November, two specimens in Coll. Goldfinch.

117. DICHROMODES RAYNORI.

Prout, in Seitz, *Indo-Aust. Geometridae*, p. 9.

♂, ♀. 20-24 mm. Head grey. Palpi in ♂ 4, in ♀ 5 to 6; fuscous, some whitish irroration on upper surface. Antennae grey; pectinations in ♂ 8. Thorax grey. Abdomen grey irrorated with ochreous-whitish. Legs fuscous; posterior pair whitish with a few fuscous scales. Forewings triangular, costa slightly arched, apex obtusely pointed, termen nearly straight, slightly oblique; pale grey; first line from one-third costa to one-third dorsum, broad, straight, blackish, partly or wholly obsolete towards costa; a median, subcostal, faintly marked, pale-centred, discal spot; postmedian line from two-thirds costa to two-thirds dorsum, broad, blackish, angled in middle, curved inwards beneath angle, partly or wholly obsolete above angle, posteriorly edged by a whitish line; a very faint, crenulate, pale, subterminal line, with dark anterior edge; a terminal series of blackish dots; cilia grey, apices paler. Hindwings with termen only slightly rounded; grey; traces of darker postmedian and terminal lines; cilia as forewings.

The sexes are nearly similar. Very like the ♀ of *D. atosignata*, but the palpi are much longer. In the latter species the discal dot of forewing is smaller, darker, and very rarely pale-centred.

Queensland: Stradbroke Island in August, September, and January; seven specimens. New South Wales: Sydney.

118. DICHROMODES ATROSIGNATA.

Panagra atosignata Wlk., *Cat. Brit. Mus.*, xxiii, 1006.—*Eubolia lina* Butl., *Ann. Mag. Nat. Hist.* (5), ix, 1882, 96.—*Dichromodes atosignata* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1184.

♂. 26-34 mm. ♀. 25-29 mm. Palpi in ♂ $2\frac{1}{2}$ to 3, in ♀ 3 to $3\frac{1}{2}$. Antennal pectinations in ♂ 4. The ♂ is variable in colour and in the degree of angulation of postmedian line of forewings. The ♀ is more constant, but strikingly different in the broad blackish suffusions edging the antemedian and postmedian lines towards dorsum, and in it the angle of the latter is always acute.

Queensland: Caloundra, Coolangatta, Toowoomba. New South Wales: Sydney, Jervis Bay. Victoria: Melbourne, Beaconsfield, Sale, Dimboola. South Australia: Mt. Lofty.

119. DICHROMODES TRIPARATA.

Panagra molybdaria Wlk., *Cat. Brit. Mus.*, xxiii, 995 (*nec* Gn.).—*Panagra triparata* Wlk., *ibid.*, 1005.—*Dichromodes triparata* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1190.

Queensland: Stradbroke Is., Coolangatta. New South Wales: Lismore, Sydney, Katoomba. Victoria: Melbourne, Grampians. Western Australia: Albany.

120. *DICHROMODES MESODONTA*, n. sp.

μεσοδοντος, toothed in the middle.

♂. 23 mm. Head dark fuscous irrorated with whitish; face wholly dark fuscous. Palpi $2\frac{1}{2}$; dark fuscous, upper surface irrorated with whitish. Antennae grey annulated with dark fuscous, towards apex wholly dark fuscous; pectinations $3\frac{1}{2}$. Thorax dark fuscous irrorated with whitish. Abdomen fuscous. Legs fuscous; posterior pair grey-whitish. Forewings triangular, costa gently arched, apex round-pointed, termen slightly bowed, slightly oblique; grey-whitish densely irrorated with blackish and fuscous; antemedian line slender, whitish, edged posteriorly with blackish, straight, from one-third costa to one-third dorsum; an indistinct, median, subcostal, transverse, blackish, discal mark; postmedian line slender, whitish, edged anteriorly with blackish, from two-thirds costa to two-thirds dorsum, with a slight median angle, incurved above and beneath angle; a faint, whitish subterminal line; cilia grey with a few dark fuscous scales, apices partly whitish. Hindwings with termen rounded; grey; cilia grey.

♀. 22-24 mm. Head, thorax, and antennae wholly dark fuscous. Forewings darker; median band much darker, often blackish towards dorsum; discal dot more distinct, blackish; lines much better marked; postmedian with angle more pronounced and acute; cilia sometimes partly barred with dark fuscous.

There is considerable sexual dissimilarity.

Western Australia: Perth in October; four specimens, including one ♂, received from Mr. J. Clark; Collie in November (one ♀ in Coll. Lyell from J. K. Ewers).

121. *DICHROMODES STILBIATA*.

Liodes stilbiata Gn., *Lep.*, x, 120.—*Panagra plusiata* Wlk., *Cat. Brit. Mus.*, xxiii, 1007.—*Dichromodes stilbiata* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1192.

The ♂ posterior tibiae are similar to those of *D. personalis*. The conspicuous white postmedian line, nearly straight, but strongly curved outwards on dorsum, is a good distinguishing character.

Queensland: Brisbane, Stradbroke Is. New South Wales: Glen Innes, Sydney, Jervis Bay, Katoomba, Mt. Kosciusko. Victoria: Melbourne, Moe, Gisborne. Tasmania: Hobart, Lake Fenton (3,500 feet), Deloraine, Cradle Mt. (3,000 feet), Zeehan, Strahan. South Australia: Mt. Lofty, Adelaide.

122. *DICHROMODES CONSIGNATA*.

Panagra consignata Wlk., *Cat. Brit. Mus.*, xxiii, 1006.—*Panagra petrilineata* Wlk., *ibid.*, 1008.—*Dichromodes consignata* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1191.

New South Wales: Bathurst. Victoria: Sale, Gisborne, Castlemaine, Dunkeld, Grampians. South Australia: Adelaide, Mt. Lofty. Western Australia: Perth.

123. *DICHROMODES RIMOSA*.

Prout, *Gen. Insect.*, *Oenochrom.*, p. 27.—*Dichromodes albitacta* Prout, *ibid.*, 27.

♂. 31-32 mm. Head grey-whitish irrorated with fuscous. Palpi $2\frac{1}{2}$; fuscous, upper surface irrorated with grey-whitish. Antennae fuscous; pectinations in ♂ 6. Thorax fuscous. Abdomen ochreous-whitish irrorated with fuscous. Legs fuscous

irrorated, and tarsi annulated, with white. Forewings triangular, costa gently arched, apex round-pointed, termen slightly rounded, slightly oblique; grey-whitish more or less irrorated or suffused with fuscous; sometimes median band except towards costa is almost wholly fuscous; first line from one-fourth costa to one-third dorsum, fuscous, edged anteriorly with whitish, strongly dentate; a median, subcostal, dark fuscous, transverse, discal mark, sometimes containing a few grey-whitish scales; postmedian line from two-thirds costa to two-thirds dorsum, sinuate, fuscous, interrupted on veins by a series of whitish dots, sometimes edged posteriorly with fuscous; a fine, indistinct, whitish, dentate, subterminal line, anteriorly edged with fuscous suffusion; an interrupted blackish terminal line; grey-whitish irrorated with fuscous or grey. Hindwings with termen rounded; grey, slight whitish irroration near tornus; terminal line and cilia as forewings. Underside of forewings grey, of hindwings whitish irrorated with grey; a fuscous discal dot and wavy postmedian line on both wings.

Described from Prout's types (kindly loaned by the National Museum and Mr. Lyell), which are, I consider, certainly conspecific. It resembles some varieties of *D. usurpatrix*, but the longer antennal pectinations show it to be certainly distinct. Minor points are the grey-whitish head and strongly dentate first line of forewings.

Victoria: Nhill near Dimboola in September, Sea Lake in October.

124. DICHROMODES USURPATRIX.

Dichromodes exsignata Meyr., PROC. LINN. SOC. N.S.W., 1889, 1178 (*nec* Wlk.).—*Dichromodes usurpatrix* Prout, *Gen. Insect.*, Oenochrom., p. 24.

Some examples of the male of *D. atrosignata* are very similar, but this species may be distinguished by the pale grey colour and inconspicuous lines of the forewings, which are quite free from any brownish tinge or suffusion, and from blackish lines. The palpi are also somewhat longer (3 to 3½). The sexes are quite similar.

New South Wales: Sydney. Victoria: Melbourne, Beaconsfield, Gisborne. South Australia: Mt. Lofty.

125. DICHROMODES BERTHOUDI.

Prout, *Gen. Insect.*, Oenochrom., p. 27.

Extremely similar to *D. usurpatrix*, but the palpi are distinctly shorter (♂ 2¼), the antemedian line of the forewings is more distinctly dentate, the discal dot is not pale-centred, and the white spot on costa posterior to the postmedian line is more conspicuous.

Western Australia: Waroona, Collie.

126. DICHROMODES ORNATA.

Panagra ornata Wlk., *Cat. Brit. Mus.*, xxiii, 1004.—*Dichromodes ornata* Meyr., PROC. LINN. SOC. N.S.W., 1889, 1189.—*Dichromodes orthogramma* Low., *Trans. Roy. Soc. S. Aust.*, 1894, 81.

Probably, I think, Walker intended to name this species *inornata*, but by some accident the first syllable was omitted. It is an obscure species, and some of its variations are puzzling, and not to be understood without the aid of a good series. The palpi vary from rather pale fuscous to grey. The antemedian and postmedian pale lines are very faint, and the former may be obsolete. The

latter may be rather broadly edged with dark fuscous, or by a very thin line, or by minute dots, and may be nearly straight, wavy, or with a distinct median angle. The antemedian line has rarely a linear fuscous edge, more often this is replaced by dots, and even these may be obsolete.

North Australia: Darwin. North Queensland: Cairns. Queensland: Duaringa, Caloundra, Brisbane, Stradbroke Is., Southport, Coolangatta, Toowoomba. New South Wales: Sydney, Katoomba.

Genus 14. ADEIXIS.

Warr., *Novit. Zool.*, 1897, 27.

Face with anterior projecting cone of scales. Palpi moderate, porrect; second joint thickened with appressed hairs; terminal joint concealed. Antennae of ♂ bipectinate, inner row of pectinations much shorter than outer towards base, but becoming equal towards middle, extreme apex simple. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Posterior tibiae of ♂ slightly dilated with internal groove and tuft. Tarsi not spinulose. Forewings with areole present, 8, 9, 10 stalked from areole, 11 free. Hindwings with 6 and 7 closely approximated at origin, 7 from near before angle, 12 approximated to cell to about three-fourths.

Type, *A. inostentata* Wlk.

There are only two species, the second being *A. griseata* Huds. from New Zealand. The genus is closely allied to *Dichromodes*, differing only in the bipectinate ♂ antennae.

127. ADEIXIS INOSTENTATA.

Panagra inostentata Wlk., *Cat. Brit. Mus.*, xxiii, p. 1012.—*Adeixis insignata* Warr., *Novit. Zool.*, 1897, 27.—*Paragyrtis inostentata* Meyr., *Trans. Ent. Soc. Lond.*, 1905, 222.

♂. 20-26 mm. ♀. 18-24 mm. Head and thorax whitish-grey. Palpi in ♂ $2\frac{1}{4}$ to $2\frac{1}{2}$, in ♀ $2\frac{1}{2}$ to 3; ferruginous-brown. Antennae ochreous-grey-whitish; pectinations in ♂, outer row $3\frac{1}{2}$, inner row $1\frac{1}{2}$. Abdomen grey-whitish. Legs grey; posterior pair whitish. Forewings triangular, costa slightly arched, apex pointed, termen slightly rounded, oblique; grey densely irrorated with whitish; costal edge dark grey; a minute, fuscous, median, subcostal, discal dot; a grey line or shade from mid-dorsum to costa near apex, sometimes thickened towards dorsum, often very slender or obsolete, occasionally slightly dentate; a slender fuscous terminal line; cilia grey, apices white on costal half. Hindwings with termen rounded; whitish or whitish-grey; cilia whitish-grey.

Northern Territory: Melville Is. North Queensland: Herberton. Queensland: Yeppoon, Nambour, Caloundra, Brisbane, Stradbroke Is. New South Wales: Lismore, Sydney, Katoomba, Jervis Bay. Victoria: Beaconsfield, Gisborne. Tasmania: Hobart, Strahan. South Australia: Mt. Lofty. Western Australia: Waroona, Bridgetown.

Genus 15. XENOGENES.

Meyrick, in Prout, *Gen. Insect.*, Oenochrom., p. 12.

Face smooth, slightly rounded or flat. Tongue present. Palpi short or moderate, porrect or subascending, thickened with appressed scales; terminal joint minute. Antennae in ♂ sometimes dentate, moderately or shortly ciliated.

Thorax and abdomen slender; the latter not hairy beneath. Femora smooth. Posterior tibiae with two pairs of spurs; in ♂ somewhat dilated. Tarsi not spinulose. Forewings with 2 from three-fourths, 6 from beneath upper angle, a rather large and broad areole, from which 7 and 10 arise separately, 11 free, not closely approximated to areole. Hindwings with 3 and 4 approximated at base, 5 from middle of cell, 6 and 7 stalked, 12 approximated to cell from base, separating before middle or shortly before end of cell.

Type, *X. chrysoplaca* Meyr.

I have not seen this species, and have been able to examine only *X. eustrotiodes*. There are structural differences between them, but it is doubtful whether they are of generic value.

128. XENOGENES CHRYSOPLACA.

Meyr., in Prout, *Gen. Insect.*, Oenochrom., p. 13.

Queensland: Duaringa.

129. XENOGENES EUSTROTIODES.

Xenogenes? eustrotiodes, Prout, *Gen. Insect.*, Oenochrom., p. 13.

♂. 18-21 mm. Head and thorax fuscous mixed with white and ochreous. Palpi 1; fuscous, apex ochreous. Antennae fuscous; in ♂ slightly serrate, minutely ciliated. Abdomen ochreous. Legs fuscous; posterior tibiae ochreous-whitish. Forewings triangular, costa nearly straight, apex rounded, termen slightly rounded, slightly oblique; white with fuscous and grey markings; a short fuscous bar on costa from base; a moderately broad fuscous transverse fascia, its anterior margin from one-fifth costa to one-third dorsum, outwardly curved and indented in middle, posterior from two-fifths costa to mid-dorsum; a fuscous dot on three-fifths costa giving rise to an outwardly curved line to half-way across disc, in its concavity a large grey spot, midway between this and fascia a short transverse grey line; a fuscous fascia from costa before apex, broadest on costa where it is divided by a white dot, narrowing to a point in mid-disc, thence connected by an interrupted grey line with a small grey tornal blotch; fine white subterminal and submarginal lines, the former dentate, separated by a broad grey line; an interrupted fuscous terminal line; cilia white, faintly barred with grey. Hindwings with termen rounded; whitish-ochreous; a fuscous median discal mark; a fuscous mark on two-thirds dorsum; a fuscous terminal band, sometimes incomplete towards tornus; cilia as forewings.

Western Australia: Perth, Waroona.

Genus 16. SYMPHYLISTIS, n. gen.

συμφυλιστίς, of the same race.

Face smooth, not projecting. Palpi moderate, porrect; second joint thickened, with appressed scales; terminal joint minute. Antennae of ♂ bipectinate, extreme apex simple, pectinations moderately long. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Tarsi not spinulose. Forewings with 11 free, 10 and 9 long-stalked from cell, 9 anastomosing immediately after separation at a point with 8 to form a long narrow areole, 7 from shortly before end of areole, 5 from middle of cell. Hindwings with 3 and 4 separate, 5 from above middle of cell (three-fifths), 6 and 7 approximated at origin, 12 closely approximated to cell as far as two-thirds, thence diverging.

Unfortunately in the single known example both hindlegs are missing, but probably the posterior tibiae have two pairs of spurs. The genus appears to be a primitive one, very low on the stem from which arises the *Dichromodes* group, and intermediate between this group and *Circopetes*. The only known species is Western Australian.

130. SYMPHYLISTIS LEPTOCYMA, n. sp.

λεπτοκυμος, slenderly waved.

♂. 32 mm. Head and thorax grey with fine whitish irroration; face fuscous-brown. Palpi $1\frac{3}{4}$; fuscous-brown. Antennae grey; pectinations in ♂ 6. Abdomen grey; apices of segments narrowly whitish. Legs fuscous; tarsi with fine whitish annulations. Forewings triangular, costa straight, apex acute, termen bowed on vein 4, crenulate, oblique; grey, with very slender fuscous lines; a fuscous dot on one-fourth costa, giving rise to a slender line sharply long-toothed beneath costa, shortly toothed in middle, thence oblique to one-sixth dorsum; a median, subcostal, blackish, discal dot; a fuscous mark on three-fourths costa, giving rise to a fine line sharply dentate beneath costa, thence oblique and nearly straight to one-third dorsum; this is succeeded by three, parallel, slightly waved lines, posteriorly edged with whitish from dorsum to termen; a terminal line; cilia brownish-grey. Hindwings with termen dentate on veins 4 and 7, wavy elsewhere; as forewings but without first line, and second line not dentate. Underside similar but more obscure.

Type in Coll. Lyell.

Western Australia: Waroona in July; one specimen (G. F. Berthoud).

Genus 17. DINOPHALUS.

Prout, *Gen. Insect.*, Oenochrom., p. 46.

Face with strong conical corneous projection, sometimes terminating in one or two sharp corneous processes. Palpi moderately long, porrect or obliquely ascending; second joint roughly hairy; terminal joint moderate or short. Tongue strongly developed. Antennae in ♂ unipectinate, towards apex simple, pectinations long (rarely with a shorter inner row). Thorax and abdomen stout; the former densely hairy beneath. Femora hairy. Posterior tibiae without middle spurs. Tarsi spinulose. Forewings with 11 anastomosing with or running into 12, 10 and 9 long-stalked, 9 anastomosing with 8 immediately after origin (sometimes arising at point of anastomosis), forming a long narrow areole, 7 from end or near end of areole. Hindwings with 5 from middle or above middle of cell, 6 and 7 separate, connate or stalked, 12 anastomosing with cell for a considerable distance.

Type, *D. cyanorrhaea* Low.

I include here *Ophiographa* Prout and *Lissocraspeda* Prout. The frontal armature, which is an adaptation to facilitate the emergence of the imago from the pupal shell, is here, I consider, only a specific character. The neurational variations occur in nearly related species, and probably further material will show that they occur in the same species. In one example I found that 12 of forewing separates just before costa. The genus is a natural whole, closely allied to *Lissomma*, but easily separated by the absence of middle spurs. It also has a much stronger frontal process, even when this is not terminated by a sharp hook or points.

Key to Species.

1. Frontal prominence terminating in two sharp points 2
- Frontal prominence terminating in a single point 5
2. Frontal prominence with terminal spikes porrect 3
- Frontal prominence with terminal spikes hook-like and directed downwards .. 4
3. Forewings with a sinuous fuscous line from one-third dorsum towards apex
..... *cyanorrhæa*. 131
- Forewings with oblique, dentate, antemedian line *idiocrana*. 132
4. Forewings with transverse, dentate, antemedian line *eremæa*. 133
- Forewings without such line *pygmaea*. 134
5. Frontal prominence terminating in a sharp hook directed downwards 6
- Frontal prominence with obtuse apex *drakei*. 140
6. Forewings with five blackish transverse lines *serpentaria*. 135
- Forewings with two blackish transverse lines 7
7. Forewings with a subterminal series of fuscous blotches edged posteriorly with
 whitish *macrophyes*. 136
- Forewings without subterminal series of blotches 8
8. Forewings with postmedian line from near base of dorsum *lechriomita*. 137
- Forewings with postmedian line from dorsum well beyond middle 9
9. Hindwings grey towards base *postmarginata*. 138
- Hindwings white towards base *dilutaria*. 139

131. *DINOPHALUS CYANORRHÆA*.

Hypographa cyanorrhæa Low., *Trans. Roy. Soc. S. Aust.*, 1903, 191.

♂. 24 mm. Head whitish with a few fuscous scales; fillet fuscous; face with a strong, porrect, flattened, corneous projection, its anterolateral angles prolonged into a pair of sharp spikes. Palpi rather long and slender, closely applied to frontal projection; whitish mixed with fuscous; second joint long; terminal joint very short. Antennae grey; pectinations in ♂ 5. Thorax fuscous mixed with whitish. (Abdomen and hindlegs missing.) Legs grey; anterior pair mostly fuscous. Forewings elongate, narrow, costa straight almost to apex, apex pointed, termen strongly oblique, irregularly dentate, being toothed on veins 3, 4 and 6; grey; a suffused fuscous line from one-third dorsum, very oblique towards, but not reaching, costa before apex, slightly bisinuate, followed by a broad whitish suffusion, bisected by a fine fuscous line from dorsum to costa near before apex; a faint parallel line follows this; cilia dark-grey with some whitish scales between dentations. Hindwings rather broad, apex obtusely rounded, angled and toothed on vein 3; 6 and 7 short-stalked; grey; a suffused, whitish, transverse, median band, containing a fine transverse grey line; cilia as forewings.

Described from Lower's type, which appears to be unique.

Central Australia: Alice Springs.

132. *DINOPHALUS IDIOCRANA*, n. sp.

ἰδιοκρανος, with peculiar head.

♂. 26-28 mm. ♀. 30 mm. Head fuscous irrorated with whitish; face with a strong, porrect, flattened, corneous projection, its anterolateral angles prolonged into a pair of sharp spikes; when the palpi are depressed a short, corneous shelf is seen projecting from lower margin of face, and the superior projection is seen to be hollowed on each side, with a median ridge. Palpi moderate, porrect; fuscous irrorated with whitish. Antennae fuscous irrorated with whitish; pectinations in ♂ 8, in ♀ 3½, lessening towards base and apex, apical third simple. Thorax and abdomen fuscous with whitish irroration. Legs dark-fuscous irrorated with whitish; first joint of posterior tarsi in ♂ dilated and deeply excavated on ventral surface. Forewings narrow, elongate, triangular, costa nearly straight but slightly

sinuate, apex pointed, termen very irregular with rounded projections on veins 3 and 7; fuscous mixed with whitish, appearing grey; a dark fuscous line from midcosta to one-fourth dorsum, strongly dentate, with a posterior tooth above and another beneath middle; an irregularly waved dark-fuscous line from costa just before apex to three-fourths dorsum, sometimes preceded by a more suffused line; a very indistinct whitish subterminal line; cilia dark-fuscous with some whitish bars between projections. Hindwings with termen irregularly waved; pale-grey; a wavy fuscous postmedian line; cilia as forewings.

North Queensland: Townsville in January (F. P. Dodd). N.W. Australia: Sherlock River (Coll. Lyell). Three specimens.

133. DINOPHALUS EREMAEA.

Hypographa eremaea (misprinted *oea*) Low., *Trans. Roy. Soc. S. Aust.*, 1907, 171.

♂. 24-30 mm. ♀. 30-32 mm. Head and thorax grey; face with a long, truncated, cone-shaped projection ending in two short chitinous hooks directed downwards. Palpi 2; grey. Antennae grey; pectinations in ♂ 10, in ♀ 3. Abdomen whitish-grey; apices of segments fuscous. Legs fuscous; posterior pair paler. Forewings elongate-triangular, costa straight, apex subrectangular, termen rounded, oblique; grey; a suffused, whitish, subcostal, median, discal spot; a blackish line from one-third costa to one-third dorsum, with two acute posterior teeth, one above and one beneath middle; a similar line from five-sixths costa to two-thirds dorsum, irregularly bisinuate; a suffused, dentate, whitish, subterminal line; cilia whitish, apices and bars opposite veins fuscous. Hindwings with termen rounded, sinuate towards tornus; white; two slender, more or less obsolete, transverse, postmedian, fuscous lines, sometimes indicated on dorsum only; a terminal fuscous suffusion more pronounced towards tornus; cilia white, on tornus fuscous.

In some examples the two lines are connected by a crossline above dorsum.

North Australia: Darwin. North Queensland: Cape York, Claudie River, Cairns, Townsville.

134. DINOPHALUS PYGMAEA.

Lissocraspeda pygmaea Prout, *Novit. Zool.*, 1913, p. 390.

♂. 19 mm. Head fuscous; frons strongly produced in a long truncate scale-covered process. Palpi 2; fuscous. Antennae grey; pectinations in ♂ 8. Thorax fuscous. Abdomen whitish with grey irroration, apices of segments grey. Legs fuscous irrorated, and tarsi annulated, with whitish. Forewings triangular, costa straight, apex round-pointed, termen long, bowed, oblique; fuscous without defined markings; a dark-fuscous mark on one-third costa; a fine irregular dark-fuscous line at three-fourths; cilia fuscous. Hindwings with termen rounded, tornus slightly produced; white; a fuscous submarginal dot opposite three-fifths dorsum, a second linear posterior to this, and a short parallel line before tornus; some fuscous suffusion near termen; cilia whitish, on tornus dark-fuscous. Under side of forewings grey; of hindwings white with a dark-fuscous terminal line, a few dark-fuscous scales towards costa, but no tornal markings except in cilia.

N.W. Australia: Sherlock River. Described from the British Museum type.

135. DINOPHALUS SERPENTARIA.

Hypographa serpentaria Gn., *Ann. Soc. Ent. Fr.*, (4) iv, 1864, 16; *Eutetia undulifera* Wlk., *Cat. Brit. Mus.*, xxxiii, 1865, 824.

♂, ♀. 34-36 mm. Head and thorax fuscous mixed with whitish; face with strong corneous projection ending in a sharp hook directed downwards. Palpi $1\frac{1}{2}$; fuscous mixed with whitish. Antennae fuscous; in ♀ simple; pectinations in ♂ 6. Abdomen fuscous mixed with whitish. Legs dark-fuscous; tibiae and tarsi with whitish annulations. Forewings elongate-triangular, costa nearly straight but slightly sinuate, apex rounded, termen rounded, oblique, deeply dentate; grey; markings blackish partly edged with whitish; a short line from costa near base; wavy transverse lines at about one-eighth, one-fourth and three-eighths; a transverse, subcostal, median, discal lunule; a line from five-eighths costa strongly bent inwards beneath discal mark, crossing third line, ending on dorsum between second and third lines; a very sharply dentate, posteriorly white-edged line from three-fourths costa to two-thirds dorsum; an irregularly waved, posteriorly white-edged, subterminal line; a blackish terminal line; cilia fuscous, apices whitish between dentations. Hindwings with termen rounded, dentate; grey; basal third white with a grey discal mark near posterior edge; the grey area is edged with a fuscous line, and contains two transverse fuscous lines partly edged posteriorly with whitish; terminal line and cilia as forewings.

Victoria: Melbourne, Beaconsfield.

136. DINOPHALUS MACROPHYES.

Ophiographa macrophyes Prout, *Gen. Insect.*, Oenochrom., p. 48.

♂. 30 mm. Head fuscous; face with a rather slender, down-curved, acute, apical hook. Palpi 2; dark-fuscous. Antennae fuscous; pectinations in ♂ 4. Thorax fuscous with some whitish hairs. Abdomen dark-grey; a brown transverse bar beyond middle, thence paler; under side whitish-grey with some ochreous-tinge towards base. Legs densely hairy, whitish mixed with pale-grey; anterior pair dark-grey. Forewings elongate-triangular, costa nearly straight, apex obtusely pointed, termen rounded, crenulate, oblique; grey, blotched with fuscous; a subbasal transverse series of fuscous blotches; a blackish line from one-fifth costa to one-third dorsum, rather irregular, with an acute posterior median projection, edged anteriorly, except median tooth, with white; a transverse, blackish, antemedian, discal mark; a blackish line, edged posteriorly with white, from three-fourths costa to two-thirds dorsum, bent inwardly beneath costa, thence outwardly-curved, bent inwardly again above dorsum; this is preceded and followed by transverse series of fuscous blotches, of which the second is edged posteriorly with whitish; an interrupted blackish terminal line; cilia fuscous, in crenulations white. Hindwings with termen slightly rounded, crenulate; grey; a suffused, wavy, fuscous, transverse line before middle; a fine, fuscous, posteriorly white-edged, transverse line after middle; terminal line and cilia as forewings. Under side of forewings grey, with fuscous, white-edged, postmedian line; of hindwings grey-whitish, with broad, dark-fuscous, postmedian band.

Western Australia: Albany, Kojareena (Waterhouse).

137. DINOPHALUS LECHRIOMITA, n. sp.

λεχριομιτος, with oblique threads.

♂. 34 mm. Head and thorax grey with whitish irroration; face with strong corneous prominence ending in a sharp median hook directed downwards. Palpi 2; grey with whitish irroration. Antennae grey with whitish irroration; in ♂ bipectinate to apex, outer pectinations long (8), inner much shorter ($2\frac{1}{2}$).

Abdomen grey with whitish irroration. Legs fuscous, irrorated, and tarsi annulated, with whitish. Forewings elongate, suboval, costa straight, apex rounded, termen long, rounded, strongly oblique; wavy; grey densely irrorated with whitish; two very oblique, fine, wavy, blackish lines; first from base, at first longitudinal then curved towards, but not reaching, costa near apex; second from dorsum near base to apex, curved; indications of a fuscous line intermediate between these; a fine blackish terminal line; cilia grey, apices and bases whitish. Hindwings with termen rounded, wavy; whitish; towards termen broadly suffused with grey; an interrupted blackish terminal line; cilia whitish.

Peculiar in antennal structure, but as it agrees with this genus in all other respects, separation appears undesirable. Even the specialized structure of the face is exactly as in other species of the *serpentaria* group. The only difference is the presence of a short inner row of antennal pectinations.

Central Australia Museum Expedition, 1916. One specimen in the South Australian Museum.

138. DINOPHALUS POSTMARGINATA.

Ophiographa postmarginata Prout, *Novit. Zool.*, 1913, 390.

♂, ♀. 23-24 mm. Head brownish-fuscous; frons strongly projecting, obliquely conical, ending in a hook-like, corneous process, which projects downwards between palpi. Palpi $1\frac{1}{2}$; brownish-fuscous. Antennae pale brownish-fuscous; pectinations in ♂ 8. Thorax brownish-fuscous. Abdomen whitish-brown, extreme base in ♂ narrowly white. Legs fuscous; posterior pair partly whitish; all tarsi annulated with whitish; posterior pair with terminal spurs only in both sexes. Forewings triangular, costa straight; apex round-pointed, termen long, bowed, oblique, wavy; brownish-fuscous; markings dark-fuscous; a sharply dentate line from one-third costa to mid-dorsum; a discal dot beneath midcosta; an irregularly dentate, slightly sinuate line from three-fourths costa to three-fourths dorsum, edged posteriorly by a pale line, or sometimes obscured by a postmedian fuscous suffusion; an interrupted terminal line; cilia whitish; at apex and tornus fuscous. Hindwings with termen rounded and slightly sinuate beneath apex and before tornus; white; a minute median fuscous discal dot; a terminal fuscous band, broader in ♀; traces of a darker dentate postmedian line; cilia whitish, towards tornus fuscous. Under side of forewings grey; of hindwings whitish, with fuscous discal dot, but without terminal band.

N.W. Australia: Sherlock River; two specimens, including the type, in the British Museum.

139. DINOPHALUS DILUTARIA.

Hypographa dilutaria Warr., *Novit. Zool.*, 1903, 260.

♀. 27 mm. Head and thorax fuscous; face with a strong anterior projection ending in an acute hook directed downwards. Abdomen whitish. Forewings grey; basal and postmedian areas fuscous, but the latter grey towards termen; a blackish, curved, slender, transverse line at one-third with five strong posterior teeth; a thicker and more suffused line from three-fourths costa to two-thirds dorsum, crenulate, edged anteriorly with brownish; an indistinct discal dot; an interrupted terminal line; cilia grey with fuscous bars opposite veins. Hindwings grey with fuscous terminal band.

I have not seen this species. The description is translated from that of Warren; the structure of the frontal process is given by Prout.

N.W. Australia: Roeburne.

140. DINOPHALUS DRAKEL.

Ophiographa drakei Prout, *Gen. Insect.*, Oenochrom., p. 48.

♂, ♀. 34-36 mm. Head fuscous finely irrorated with whitish; face with a strong corneous projection ending in an obtuse apex somewhat bent downwards. Palpi 1 $\frac{3}{4}$; fuscous mixed with whitish. Antennae fuscous; in ♀ simple; pectinations in ♂, 4. Thorax with rounded anterior and slight posterior crest; fuscous finely irrorated with whitish. Abdomen fuscous-grey. Legs fuscous; some irroration, and obscure tarsal annulations, whitish. Forewings elongate-triangular, costa straight, sometimes sinuate before apex, apex acute, termen rounded, slightly oblique, sinuate; grey, sometimes with darker antemedian and postmedian bands; a blackish line from one-third costa to two-fifths dorsum; outwardly curved, indented above middle, and more deeply above dorsum; an irregularly sinuate and dentate blackish line from four-fifths costa to two-thirds dorsum; an obscure, dentate, whitish, subterminal line, not always developed; an interrupted blackish terminal line; cilia fuscous, bases whitish between dentations. Hindwings with termen rounded, dentate; grey, becoming paler towards base; a median discal dot and a fine, fuscous, postmedian, transverse line, both faintly marked; an interrupted blackish terminal line; cilia whitish with a median fuscous line. Under side of hindwings with a large blackish terminal blotch.

New South Wales: Sydney, Jervis Bay, Katoomba. Victoria: Beaconsfield. South Australia: Mt. Lofty.

Genus 18. LISSOMMA.

Warr., *Novit. Zool.*, 1905, 418; Prout, *Gen. Insect.*, Oenochrom., p. 49.

Face densely hairy, sometimes with rounded prominence. Palpi moderately long, porrect; second joint densely hairy beneath; terminal joint smooth, cylindrical, obtuse. Antennae of ♂ unipectinate, towards apex simple, pectinations long; in ♀ shortly unipectinate or simple. Thorax stout, more or less crested posteriorly; under side densely hairy. Femora hairy. Posterior tibiae of ♂ with two pairs of spurs. Tarsi spinulose. Forewings with 11 anastomosing with or running into 12, 10 and 9 long-stalked, 9 anastomosing with 8 to form a long narrow areole, 7 from end or near end of areole. Hindwings with 5 from above middle of cell, 6 and 7 separate, connate, or stalked, 12 anastomosing with cell to three-fourths.

Type, *L. himerata* Warr.

Differs from *Hypographa* in the strong anastomosis of 12 of hindwings with cell.

Key to Species.

- | | |
|---|------------------------|
| 1. Forewings whitish or pink | 2 |
| Forewings dark-fuscous or grey | 3 |
| 2. Forewings wholly pink | <i>himerata</i> . 141 |
| Forewings whitish, towards costa pinkish tinged | <i>minuta</i> . 142 |
| 3. Forewings wholly or partly dark-fuscous, hindwings with defined white basal area | 4 |
| Forewings and hindwings grey, the latter without defined white basal area .. | 6 |
| 4. Hindwings with dark-fuscous terminal blotch leaving apex white .. | <i>incongrua</i> . 143 |
| Hindwings with grey terminal band including apex | 5 |

5. Forewings grey with dark-fuscous fasciae *ampycteria*. 144
 Forewings dark-fuscous *hiracopis*. 145
 6. Forewings with dark-fuscous postmedian fascia, its anterior edge straight and sharply defined *atmoscia*. 146
 Forewings posteriorly suffusedly darker with acutely dentate postmedian line *macrodonata*. 147

141. LISSOMMA HIMERATA.

Warr., *Novit. Zool.*, 1905, 418.

♀. 35 mm. Head, thorax, and abdomen pink. Forewings deep pink; a slightly darker, anteriorly pale-edged, slender, straight line from three-fifths costa to mid-dorsum; a similar line, posteriorly pale-edged, slightly curved, from costa shortly before apex to three-fourths dorsum; cilia pink. Hindwings as forewings but without median line, and with costal half of wing whitish. Under side pink; the dorsum of forewings narrowly, of hindwings broadly, whitish.

I have not seen this species. The description is adapted from Warren.

North Australia: Eureka (Tunney, Feb., 1903).

142. LISSOMMA MINUTA.

Monoctenia minuta Swin., *Ann. Mag. Nat. Hist.*, (7) ix, 1902, 167.—*Hypographa pallida* Warr., *Novit. Zool.*, 1902, 347.—*Lissomma minuta* Warr., *Novit. Zool.*, 1905, 418.

♀. 27-32 mm. Head and thorax ochreous-whitish; face rounded, prominent. Palpi 2; ochreous-whitish, pinkish-tinged. Antennae ochreous-whitish; pectinations in ♀ 3. Abdomen ochreous-whitish tinged with pinkish towards base of dorsum. Legs ochreous-whitish; anterior pair pinkish. Forewings triangular, costa straight, apex pointed, termen rounded, slightly oblique; ochreous-whitish, towards costa pinkish-tinged; markings very pale grey; a slender line from one-third costa to two-fifths dorsum, outwardly-curved; a transverse discal mark beneath midcosta; a slender oblique line, sometimes wavy, from three-fourths costa to three-fourths dorsum; cilia concolorous. Hindwings with termen gently rounded; whitish, towards termen grey-whitish; a very pale grey transverse line at three-fourths; cilia grey-whitish. Under side similar but more obscure.

Described from a series of six specimens in the British Museum.

N.W. Australia: Sherlock River.

143. LISSOMMA INCONGRUA.

Agrotis incongrua Wlk., *Cat. Brit. Mus.*, x, 353.

♂, ♀. 36-40 mm. Head and thorax dark-fuscous; face with moderate rounded prominence. Palpi 1½; dark-fuscous. Antennae dark-fuscous, in ♀ simple; pectinations in ♂ 6. Abdomen grey; under side whitish; apical segment and tuft fuscous. Legs fuscous; tarsi annulated with whitish. Forewings elongate-triangular, costa straight, apex pointed, termen rounded, oblique, crenulate; dark-fuscous; a little whitish irroration on base of dorsum; a blackish line from one-third costa to one-third dorsum with a few whitish marginal points, a slight posterior tooth above middle and another, more prominent, above dorsum; a similar, finely dentate, sinuate line from two-thirds costa to two-thirds dorsum; a suffused, blackish, sinuate, median line between these; a very fine, doubly sinuate, white sub-terminal line, preceded by short blackish streaks on veins; an interrupted blackish terminal line; cilia dark-fuscous. Hindwings with termen slightly rounded,

crenulate; white; a large dark-fuscous terminal blotch extending nearly to costa, but leaving apex white; cilia dark-fuscous, towards apex white. Under side of forewings grey almost without markings; of hindwings like upper side, but with some dark-fuscous irroration, and with two dark-fuscous transverse lines immediately preceding blotch.

New South Wales: Jervis Bay (Moss-Robinson). South Australia: Adelaide (in South Australian Museum).

144. LISSOMMA AMPYCTERIA, n. sp.

ἀμπυκκτηριος, banded.

♂. 24 mm. Head with loose hairs projecting forwards between antennae, face rounded, prominent, hairy; fuscous with some whitish hairs. Palpi $1\frac{1}{4}$; covered with long loose fuscous hairs. Antennae fuscous; pectinations in ♂ 5. Thorax fuscous with some whitish hairs anteriorly. Abdomen fuscous. Legs grey; tarsi fuscous. Forewings elongate-triangular, costa straight almost to apex, apex rounded, termen rounded, dentate, slightly oblique; grey; markings dark-fuscous; median and dorsal short acute streaks from base; a fine antemedian line from one-third costa to one-third dorsum, angled outwards beneath costa, inwards above middle; a moderate median transverse fascia; a slender postmedian line from three-fourths costa to two-thirds dorsum, angled inwards beneath costa and above dorsum; following this a subterminal fascia; a terminal line; cilia fuscous, toward tornus grey in indentations. Hindwings with termen nearly straight, dentate; whitish; a fuscous antemedian discal dot; a broadly suffused fuscous terminal band, containing suffused straight blackish postmedian and terminal lines; cilia whitish, becoming fuscous near tornus. Under side of forewings fuscous; of hindwings whitish with blackish discal dot and large tornal blotch connected with costa beyond middle.

Differs from *L. hiracopis* in the grey colouring and dark-fuscous fasciae of forewings and the differently formed postmedian line; also in the tornal blotch on underside of hindwings.

Western Australia: Eradu, near Geraldton, in September (A. J. Nicholson); one specimen in Coll. Goldfinch.

145. LISSOMMA HIRACOPIS.

Hypographa hiracopis Meyr., PROC. LINN. SOC. N.S.W., 1889, 1211.—*H. bathrosema* Prout, *Ann. Mag. Nat. Hist.*, (8) viii, 1911, 702.

I have a ♂ example which corresponds nearly to Meyrick's description, but has in addition a fine, crenulate, whitish, subterminal line, strongly indented above middle and again above dorsum. Also a ♀ which lacks the whitish irroration of the ♂, is much darker, and more closely resembles *incongrua*. Antennae unipectinate in both sexes, pectinations in ♂ 10, in ♀ 3. These structural characters clearly distinguish it from that species.

South Australia. Western Australia: Perth.

146. LISSOMMA ATMOSCIA.

Hypographa atmoscia Meyr., PROC. LINN. SOC. N.S.W., 1889, 1213.

♂. 40 mm. Antennae of ♂ unipectinate, apical third simple, pectinations 5. Posterior tibiae of ♂ with two pairs of spurs, outer terminal spur short, inner

terminal spur very long, broad, flattened, and obtuse. These particulars are taken from an example in the Queensland Museum presented by Mr. G. H. Hardy.

Western Australia: Perth.

147. *LISSOMMA MACRODONTA*, n. sp.

μακροδοντος, with long teeth.

♀. 36-42 mm. Head grey mixed with whitish; face with strong rounded prominence densely covered with rough hairs. Palpi 2, second joint with long spreading hairs beneath; grey, apices of hairs paler. Antennae grey; in ♀ unipectinate, pectinations 5. Thorax and abdomen fuscous-grey mixed with whitish. Legs fuscous-grey irrorated with whitish. Forewings narrow, elongate, triangular, costa nearly straight but slightly sinuate, apex acute, termen rounded, oblique, dentate; fuscous-grey partly suffused with whitish, absence of this suffusion leaves a darker distal and dorsal area, which is variable in degree of development; a fine fuscous line from one-third costa to one-third dorsum, with a long acute indentation above middle, and another above dorsum; a similar line from two-thirds costa to two-thirds dorsum, with numerous, very long, acute dentations; fine fuscous streaks on veins in terminal area; an interrupted fuscous terminal line; cilia grey mixed with whitish. Hindwings elongate, termen only slightly rounded, dentate; grey becoming whitish-grey towards base; an interrupted fuscous terminal line; cilia white obscurely barred with grey.

South Australia: Mt. Lofty (Hope Valley) in May, one specimen in South Australian Museum. Western Australia: Quairading (L. J. Newman), a more sombre example with antemedian line of forewings obsolete and postmedian line only just traceable, in my own collection.

Genus 19. *ENCHOCRANA*, n. gen.

εγγοκρανος, spear-headed.

Face with a long, porrect, laterally compressed, very sharp, anterior, corneous spike. Palpi rather short, porrect; second joint shortly hairy; terminal joint minute. Antennae unipectinate in both sexes. Thorax moderate; beneath hairy. Femora smooth. Posterior tibiae with two pairs of spurs. Tarsi not spinulose. Forewings with 11 anastomosing with 12 and 10, areole long and narrow. Hindwings with 3 and 4 widely separate, 5 from well above middle of cell (three-fifths or two-thirds), 6 and 7 stalked, 12 very closely applied to cell from one-fourth to three-fourths.

Allied to *Dinophalus*. Although 12 of hindwings does not actually anastomose with the cell, it comes very close to doing so.

148. *ENCHOCRANA LACISTA*, n. sp.

λακιστος, torn.

♀. 30-32 mm. Head grey, with small white tufts at bases of antennae. Palpi grey mixed with whitish. Antennae grey; pectinations in ♀ 1½. Thorax, abdomen, and legs grey. Forewings elongate-triangular, costa gently and uniformly arched, apex acute, termen strongly oblique, sinuate, slightly crenulate; grey with slight fuscous irroration; very slender, oblique, darker lines faintly indicated; first from one-fourth dorsum towards one-third costa; second from mid-dorsum to midcosta; third from three-fourths dorsum to costa before apex, slightly dentate; cilia grey obscurely barred with whitish. Hindwings triangular, termen

not rounded, prominent and sharply toothed at apex, with a still longer acute median tooth on vein 4; colour, lines, and cilia as forewings, but without first line, and with median line obscurely double. Under side with fuscous discal dot and large circular subterminal spot on both wings, spot on hindwings connected by a subterminal line to dorsum.

The wing-shape, especially of hindwings, is very peculiar.

Western Australia: Cunderdin; three specimens received from Mr. R. Illidge.

Genus 20. HYPOGRAPHA.

Gn., *Lep.*, ix, p. 189; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1210; Prout, *Gen. Insect.*, *Oenochrom.*, p. 49.

Face not prominent, but with projecting hairs. Palpi moderately long, porrect or slightly ascending; second joint densely hairy; terminal joint moderate, cylindrical, obtuse. Tongue strongly developed. Antennae of ♂ unipectinate, towards apex simple, pectinations moderate or long. Thorax stout; posteriorly more or less crested; beneath densely hairy. Femora hairy. Posterior tibiae with two pairs of spurs. Tarsi spinulose. Forewings with 11 anastomosing with 12, 10 and 9 long-stalked, 9 anastomosing with 8 to form a long narrow areole, 7 from end or near end of areole. Hindwings with 5 from above middle of cell, 6 and 7 separate, connate, or stalked, 12 closely appressed to middle of cell.

Type, *H. phlegetonaria* Gn.

1. Forewings with white line from costa near apex to dorsum, twice strongly incurved
 *epiodes*. 149
 Forewings without such line 2
2. Forewings with strong sinuate dark-fuscous line from two-thirds costa to three-
 fifths dorsum *aristarcha*. 150
 Forewings without such line *phlegetonaria*. 151

149. HYPOGRAPHA EPIODES, n. sp.

ἡπιωδης, soft, gentle.

♂. 28 mm. Head grey. Palpi 1¼; grey. Antennae grey; pectinations in ♂ 8, ochreous-tinged. Thorax with a bifid posterior crest; pectus reddish-tinged. Abdomen grey, apices of segments paler; tuft and under side whitish. Legs grey; anterior and middle tibiae irrorated with crimson; posterior pair grey-whitish. Forewings short, triangular, costa bisinuate, apex acutely pointed, termen slightly rounded, very strongly crenulate or lobulate, scarcely oblique; whitish-grey, becoming darker towards costa, with some fuscous strigulae most pronounced on costa; a suffused grey-whitish spot on base of dorsum, followed by a small fuscous-brown spot in disc; a suffused grey-whitish line from beneath one-fourth costa to one-third dorsum, edged posteriorly by fuscous-brown spots above and below middle; a slender white line from costa before apex, inwardly oblique to three-fourths dorsum, with strong inwardly-curved projections above and below middle, edged posteriorly by a dark fuscous-brown line, which is strongly thickened to fill in these projections; cilia fuscous, between projecting crenulate lobules white. Hindwings with termen slightly rounded, crenulated as forewings; fuscous; a fine white transverse line edged anteriorly with blackish from two-thirds dorsum to two-thirds costa, toothed posteriorly in middle and at extremities; cilia as forewings but apices wholly white, on dorsum white. Under side of forewings as upper side but more whitish, and without basal markings and first line; of hindwings whitish with a bisinuate, reddish-fuscous, transverse, median line not

reaching dorsum, and a broad, pale-reddish, subterminal band, containing a large oval spot of dark-red mixed with dark-fuscous.

Type in Coll. Goldfinch. The lobulate termen of both wings is characteristic of the genus.

Western Australia: Kojareena (Waterhouse).

150. HYPOGRAPHA ARISTARCHA.

Prout, *Gen. Insect.*, Oenochrom., p. 50.

♂, ♀. 48-52 mm. Head and thorax fuscous mixed with whitish; face not prominent but covered with rough hairs. Palpi $1\frac{1}{4}$; second joint with loose spreading hairs beneath; fuscous mixed with whitish. Antennae fuscous; unipectinate in both sexes with apical fourth simple, pectinations in ♂ 6, in ♀ $1\frac{1}{2}$. Abdomen grey, towards apex mixed with dark-fuscous; terminal fringe of third segment and sometimes middle of tuft white; under side with some brownish or purple-reddish irroration. Legs fuscous mixed with whitish. Forewings elongate-triangular, costa straight to near apex, apex pointed, termen rounded, oblique, deeply dentate or lobulate; fuscous; costal edge and a terminal suffusion beneath apex sometimes whitish; costa finely strigulated with blackish; markings blackish; a costal spot at one-third, with a spot in disc beneath it, and a third above one-third dorsum represent antemedian line; a slight, oblique, median, subcostal, discal mark; a spot on two-thirds costa giving rise to a rather broad, oblique, sinuate line to three-fifths dorsum, not denticulate; this is followed by a more slender bisinuate postmedian line, and this again by a similar but less distinct subterminal line; veins between last three lines dark-fuscous; a fine interrupted terminal line; cilia fuscous, between dentations whitish. Hindwings with termen rounded, dentate; fuscous, with fine indistinct darker median and postmedian lines; cilia fuscous, on apex and between apical dentations whitish. Under side of forewings without antemedian line; similar to upper side, but with more white suffusion; of hindwings grey, more whitish in median area, profusely strigulated with blackish; waved blackish antemedian and postmedian lines; a whitish dentate subterminal line interrupted sometimes by a median blackish blotch.

My material for this description consists of a fine pair, including the type, loaned by the National Museum, Melbourne, and a ♀ loaned by the South Australian Museum.

Victoria: Beaconsfield. South Australia: Mt. Lofty.

151. HYPOGRAPHA PHLEGETONARIA.

Gn., *Lep.*, ix, p. 190, Pl. 19, f. 2.

♂, ♀. 38-42 mm. Head and thorax grey; face not prominent; but with some projecting hairs on lower edge. Palpi $1\frac{1}{2}$; second joint shortly rough-haired beneath; grey. Antennae fuscous; in ♀ simple, in ♂ unipectinate, apical fourth simple, pectinations 5. Abdomen grey irrorated with fuscous, or fuscous, bases of second and third segments whitish. Legs fuscous mixed with whitish. Forewings triangular, costa straight or slightly sinuate, apex acute, termen rounded, slightly oblique, deeply dentate or lobulate; fuscous-grey; markings dark-fuscous; a spot on one-fourth costa with faint indications of an antemedian line; a median, subcostal, discal spot; very fine dentate postmedian and subterminal lines; an interrupted terminal line; a slight reddish irroration on dentations; cilia fuscous, between dentations white. Hindwings with termen rounded, dentate; colour and

cilia as forewings; fine, faintly darker, antemedian and postmedian lines. Under side of forewings without antemedian line; as forewings but dentate lines more distinct; some white suffusion at apex and beneath middle of termen; of hindwings grey, with a moderate, curved, dark-edged fascia from costa before to dorsum beyond middle, and a whitish subterminal line preceded by a dark-fuscous suffusion.

This description is based on two examples. Guenée's type was from Tasmania and appears to have had the markings more distinctly developed. The best proof of the distinctness of this species from the preceding lies in the different antennal structure.

New South Wales: Newcastle, Sydney, Katoomba. Tasmania.

Genus 21. SARCINODES.

Gn., *Lep.*, ix, p. 188; Prout, *Gen. Insect.*, *Oenochrom.*, p. 56.

Face with anterior cone of scales. Palpi moderately long, obliquely ascending; second joint thickened with loosely appressed hairs; terminal joint short, stout, obtuse, porrect. Antennae of ♂ unipectinate, towards apex simple. Thorax and abdomen stout; the former densely hairy beneath. Femora hairy. Tarsi strongly spinulose. Forewings with 5 from near upper angle of cell, 9 and 10 long-stalked, 9 anastomosing with 8, but extreme base of 9 not always developed (see remarks under *Monoctenia*), 11 free. Hindwings with 5 closely approximated, connate, or short-stalked with 6 from upper angle of cell, 7 from shortly above angle, 12 closely approximated to cell to beyond middle, thence diverging.

A development of *Oenochroma*, but sharply differentiated by the close approximation of 5 at origin to 6, especially in the hindwings. An Indo-Malayan genus of about ten species. Type, *S. carnearia* Gn. from India. It may be inferred that the two genera had a common ancestor in Southern Asia before the separation of the Australian continent, where it gave rise to *Monoctenia*, *Oenochroma*, etc. In Asia the more generalized forms died out, leaving only the more specialized *Sarcinodes*, which has invaded Australia from New Guinea in recent geological time.

152. SARCINODES HOLZI.

Pagenst., *Jahrb. nassau. Ver. Naturk.*, xli, 1888, 167; *Sarcinodes subfulvida* Warr., *Novit. Zool.*, 1896, 280; *Sarcinodes compacta* Warr., *Novit. Zool.*, 1896, 355.

♀. 60 mm. Head, thorax, and abdomen pale-pinkish. Palpi 2½; pale pinkish with some grey irroration. Antennae pinkish, towards base mixed with dark-fuscous. Legs pinkish-grey; anterior pair grey. Forewings rather broadly triangular, costa nearly straight but slightly sinuate, apex pointed, slightly produced, termen moderately rounded; pale-pink; an interrupted brownish line from one-fifth costa to one-sixth dorsum, outwardly curved, dentate; a similar line from midcosta obliquely outwards, soon bent inwards and continued to one-third dorsum; a straight line of whitish dots on veins from costa just before apex to two-thirds dorsum; disc between lines suffused with brownish-ochreous, a similar broad suffusion on termen, the two confluent above middle; cilia reddish-brown. Hindwings with termen rounded; colour and markings as forewings, but without first line; a subterminal series of white dots. Under side paler; postmedian lines of fuscous dots on both wings; succeeded by more or less brown suffusion, especially on hindwings.

I am indebted to Mr. L. B. Prout for identifying this species and giving me the references.

North Queensland: Kuranda, near Cairns, in November and April; two specimens received from Mr. F. P. Dodd. Also from New Guinea and Amboyna.

Genus 22. MACROCTENIA, n. gen.

μακροκτενιος, long-combed.

Face smooth, rounded, slightly projecting. Palpi moderate, porrect; second joint thickened with short, loosely appressed hairs; terminal joint rather long, cylindrical, obtuse. Antennae long (three-fourths of forewings); in ♂ unipectinate, towards apex simple, pectinations long. Thorax stout, under side densely hairy. Femora hairy. Posterior tibiae with two pairs of spurs. Tarsi spinulose. Forewings with 11 free, 10 and 9 long-stalked from cell, 9 anastomosing with 8 soon after origin, forming a long narrow areole. Hindwings with 3 and 4 connate, 5 from only slightly above middle of cell, 6 and 7 connate, 12 anastomosing with cell from one-third to two-thirds, gradually diverging.

Similar in neuration to *Lissomma*, but vein 11 of forewings is free. I do not think it is nearly related to that genus, but to *Monoctenia*, the anastomosis of 12 of hindwings with cell being independently developed as in *Gerusia*. The unusually long antennae are a peculiar character.

153. MACROCTENIA EPAENETA, n. sp.

ἐπαινετος, praiseworthy.

♂. 57 mm. Head and thorax whitish-ochreous. Palpi 1½; whitish-ochreous. Antennae pale-ochreous; pectinations in ♂ 8, apical fourth simple. Abdomen ochreous-whitish, on dorsum pinkish-tinged. Legs ochreous-whitish; anterior pair pinkish-tinged. Forewings elongate-triangular, costa straight, apex pointed, termen slightly sinuate, oblique; whitish-ochreous somewhat brownish-tinged; a very slightly curved ochreous line, pale edged anteriorly, from three-fourths dorsum towards, but not reaching, apex; a few sparse fuscous strigulae mostly in terminal area; cilia ochreous. Hindwings with apex rounded, termen straight; pink, except ternal area which is coloured as forewings; cilia ochreous.

Type in Coll. Lyell.

Western Australia: Busselton in April; one specimen received from Mr. J. K. Ewers.

Genus 23. MONOCTENIA.

Gn., *Lep.*, ix, p. 183; Prout, *Gen. Insect.*, Oenochrom., p. 39.

Face smooth or slightly rough-scaled, flat, or with slight rounded prominence. Tongue well developed. Palpi short, porrect; second joint thickened with loosely appressed hairs; terminal joint short, stout, obtuse. Antennae of ♂ unipectinate, towards apex simple, pectinations long. Thorax densely hairy beneath. Femora hairy. Tarsi strongly spinulose. Forewings with 11 arising separately and free, 10 and 9 long stalked from cell, 9 anastomosing with 8 to form a long narrow areole, but sometimes the connection formed by the origin of 9 from 10 fails to develop, in this case the areole is lost by separation, and 9 appears to be stalked with 7, 8. Hindwings with 5 strongly approximated to 6 at origin (about three times as far from 4 as from 6), 6 and 7 separate but approximated at origin, 12 approximated to middle part of cell, diverging at about two-thirds.

Type, *M. falernaria* Gn.

A small genus readily distinguished from *Oenochroma* by the origin of 5 of hindwings, an important character. The species are nearly allied, the last three being extremely similar.

- | | | |
|---|-----------------------|-----|
| 1. Hindwings with basal half white | <i>postcarneata</i> . | 154 |
| Hindwings not white towards base | | 2 |
| 2. Forewings narrow, breadth much less than half length | | 3 |
| Forewings broad, breadth about half length | <i>falernaria</i> . | 157 |
| 3. Wings with termen dentate | <i>smerintharia</i> . | 155 |
| Wings with termen not dentate | <i>eximia</i> . | 156 |

154. MONOCTENIA POSTCARNEATA.

Oenochroma postcarneata Prout, *Gen. Insect.*, *Oenochrom.*, p. 42.

♀. 29 mm. Head and thorax whitish-ochreous. Palpi 2; whitish irrorated with pinkish. Antennae grey-whitish. Abdomen ochreous-whitish, under surface sparsely irrorated with fuscous. Legs ochreous-whitish; anterior pair pinkish-tinged. Forewings triangular, costa sinuate, apex acute, termen bowed, slightly oblique; whitish-ochreous faintly pinkish-tinged; a transverse row of slightly darker dots at three-fourths; cilia concolorous. Hindwings with termen gently rounded; whitish; a short transverse fuscous line in middle of disc at three-fifths; beyond this a broad terminal pinkish suffusion containing a transversely oval fuscous blotch in middle; cilia whitish with four or five fuscous bars opposite veins. Under side of forewings ochreous-whitish with a few fuscous scales and a pinkish suffusion before mid-termen; of hindwings like upper side, but with a few fuscous scales, and terminal pinkish suffusion restricted to neighbourhood of fuscous blotch.

Western Australia: Perth. Described from the type in the British Museum.

155. MONOCTENIA SMERINTHARIA.

Feld., *Reise Nov.*, 1875, Pl. 124, f. 18, 19.

♂, ♀. 62-66 mm. Head grey or ochreous-grey; face purple-fuscous or reddish-fuscous. Palpi 1½, subascending; pale-ochreous densely irrorated with fuscous, reddish on external surface. Antennae pale-reddish or pale-ochreous; pectinations in ♂ 8, pale-ochreous. Thorax grey; pectus purple-reddish. Abdomen grey or ochreous-grey; tuft purple-reddish. Legs pale ochreous mixed with purple-reddish. Forewings elongate-triangular, rather narrow, costa straight or slightly sinuate, apex acute, termen much longer than dorsum, strongly bowed beneath apex, dentate; grey-whitish or pale-reddish suffused with purple-grey; a pale-reddish sometimes dentate line from beneath costa before apex to dorsum at three-fifths or two-thirds, parallel to termen, sometimes preceded by a blackish shade, broad towards dorsum, becoming narrower towards costa, and followed by some fuscous irroration; cilia reddish, apices between dentations ochreous, darker on dentations. Hindwings with apex rounded, termen nearly straight, dentate; pale purple-reddish; sometimes a large fuscous suffusion towards tornus; a pale subterminal line becoming indistinct towards costa; cilia as forewings.

Victoria: Melbourne, Mount Korong. There are very few known examples of this species.

156. MONOCTENIA EXIMIA.

Low., *Trans. Roy. Soc. S. Aust.*, 1892, 7.—*Monoctenia calladelpa* Low., *ibid.*, p. 7.

♂. 65 mm. Head, thorax, abdomen, and legs pale-rosy. Palpi 1½; pale-rosy. Antennae pale-ochreous; pectinations in ♂ 12, apical third simple. Forewings narrowly triangular, costa straight, apex obtusely pointed, termen bowed above middle, strongly oblique; pale-rosy without markings; cilia rosy-ochreous. Hindwings with termen rounded; colour and cilia as forewings.

A good and distinct species, much more narrowly winged than *falernaria*. My description is from an example which had been compared with the type of *calladelpa* by Mr. N. B. Tindale, who informs me that *eximia* is the same species. It appears to be a variety differing only in the presence of a pale costal streak.

South Australia: Adelaide, Port Lincoln.

157. MONOCTENIA FALERNARIA.

Gn., *Lep.*, ix, p. 184; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1208; *Monoctenia fraternaria* Gn., *Lep.*, p. 184, Pl. 7, f. 3.

♂. 70 mm. ♀. 76-82 mm. Head pale-rosy; face dark-crimson. Palpi 1; crimson. Antennae pale-ochreous; pectinations in ♂ 12. Thorax, abdomen and legs pale-rosy, sometimes ochreous-tinged. Forewings broadly triangular, costa nearly straight, apex acute, slightly produced, termen sinuate beneath apex, strongly bowed above middle, oblique, slightly irregular; pale-rosy, sometimes ochreous-tinged; a slightly darker triangular area, sometimes outlined with fuscous, extending on costa from middle to four-fifths, and extending to beneath middle of disc, sometimes connected by one or more fuscous spots to dorsum beyond middle; cilia concolorous or fuscous. Hindwings with termen slightly rounded; colour and cilia as forewings; a suffused, pale-fuscous, median, transverse line.

New South Wales: Bathurst. Victoria: Melbourne, Gisborne, Lorne. Tasmania: Hobart. South Australia: Adelaide, Port Lincoln. Western Australia: Denmark.

Genus 24. PHALLARIA.

Gn., *Lep.*, ix, p. 186; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1203; Prout, *Gen. Insect.*, *Oenochrom.*, p. 43.

Face with slight rounded prominence, slightly rough-haired. Tongue strongly developed. Palpi moderate, porrect; second joint thickened with loosely appressed scales above and beneath; terminal joint moderate, cylindrical, obtuse. Antennae rather long (more than half), bipectinate to apex in both sexes, pectinations in ♂ moderately long, in ♀ short. Thorax stout; densely hairy beneath. Femora hairy. Tarsi strongly spinulose. Forewings with 11 free, 9 and 10 long-stalked from cell, 9 anastomosing with 8 to form a long narrow areole, but sometimes the connecting portion of 9 between 10 and 8 fails to develop. Hindwings with 3 and 4 widely separate, 3 arising from midway between 2 and 4, 5 from middle of cell, 6 and 7 separate but approximated at origin, 12 approximated to cell from one-fourth to three-fourths.

Allied to *Monoctenia*, differing in the longer antennae, bipectinated in both sexes. Monotypical.

158. PHALLARIA OPHIUSARIA.

Gn., *Lep.*, ix, 1858, 186; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1203.—*Oenochroma quaternaria* H-Sch., *Ausser. Schmet.*, i, 1858, p. 84, Pl. 95, f. 541.—*Smerinthus ? wayii* Tepp., *Trans. Roy. Soc. S. Aust.*, 1882, 29.

New South Wales: Sydney, Bathurst. Victoria: Geelong, Beaconsfield, Narracan, Warragul. South Australia: Mt. Lofty.

A REVISION OF THE AUSTRALIAN TELEASINAE
[HYMENOPTERA: PROCTOTRYPOIDEA].

By ALAN P. DODD.

[Read 26th March, 1930.]

The subfamily Teleasinae of the family Scelionidae is rich in species, poor in genera; Kieffer (Das Tierreich, 1926) listed 230 species under 9 genera. The group is a compact one, and the numerous species are very similar in general outline. Little is known of their host associations; one North American species has been reared from the eggs of a Carabid beetle, and the group may be restricted to parasitism of Coleopterous eggs.

In my experience, the Australian species are found usually in damp situations, either among the low shrubs and undergrowth of the coastal heavily-timbered country, or among grass growing near streams or swamps. They are particularly abundant during the wet season summer months in the mountain scrubs of Southern Queensland, where they can be collected in numbers running over the surface of leaves within a few feet of the ground; on the other hand they are not plentiful in the humid tropical jungles of North Queensland. Their actions are rather slow in comparison with the rapid jerky movements and quick short flight of the majority of the Scelionidae.

The chief characters of the subfamily are as follows: Head transverse, the vertex thin; ocelli situated close together, the lateral pair far removed from the eye margins; frons not depressed or excavated above the antennal insertion. Antennae inserted on a small prominence near the mouth; 12-jointed in both sexes; in the female with a compact 6-jointed club, the third and fourth funicle joints usually short; in the male, filiform, the flagellar joints usually long. Thorax stout; pronotum hardly visible from above; scutum with the parapsidal furrows either delicate or absent, deep and abbreviated in one genus; scutellum semi-circular, in one genus armed with a spine on either side; metanotum usually armed with from one to three teeth or spines; propodeum rather short, frequently armed with a tooth at the posterior angles, and sometimes with a small tooth at the anterior angles. Forewings often abbreviated; marginal vein very long, much longer than the stigmal vein, rarely as long as the submarginal, the stigmal vein usually short, the postmarginal absent. Abdomen rather short, rarely more than twice as long as its greatest width; broadly oval; narrowed at the base; lateral margins carinated on the ventral side; segment 1 sub-petiolate, sometimes with a basal prominence in the female; segment 3 the longest, except in *Gryon* Haliday; 4-6 short.

The Genera of the Teleasinae.

Kieffer recognized nine genera in his 1926 monograph, but he omitted *Gryonoides* Dodd (1919). *Teleas* Latreille, which occurs in Europe, Asia, and

North America, is replaced in Australia by the allied *Gryonella* Dodd. *Gryon* Haliday, with three European species, is known to me from description only, and its position in the Teleasinae appears doubtful.

Two characters regarded by Kieffer as of sufficient importance for the separation of genera, namely, the presence or absence of parapsidal furrows, and the presence of a basal abdominal prominence in the female, I am unable to accept. For example, *Hoplogryon* Ashmead is distinguished from *Trimorus* Forster merely by the parapsidal furrow character; in the Australian species, the furrows, when present, are usually delicate, and in several species are present in the male and not discernible in the female. Hence I must regard *Hoplogryon* as a synonym of *Trimorus*. On the other hand, in the Australian species of *Xenomerus* Walker, the furrows, although abbreviated, are deep and profound. The abdominal prominence may or may not be present in a closely-related group of Australian species. Kieffer has used this character to separate *Propentacantha* Kieffer (= *Pentacantha* Ashmead) from *Hoplogryon*, whereas Ashmead (1893) gives as an additional character "postscutellum with three spines." Most of the species placed by Kieffer in the former genus will no doubt fall more naturally into *Trimorus*. *Propentacantha* should fall as a synonym of *Trissacantha* Ashmead, and it is significant that, in writing of the latter, Ashmead (1893) states "it may be the opposite sex of *Pentacantha* but the mesonotum has two distinct furrows."

I recognize eight genera in the subfamily, which can be separated by means of the following key:

1. Second abdominal segment longer than the third *Gryon* Haliday.
Second abdominal segment shorter than the third 2.
2. Scutellum armed with a spine on either side *Gryonoides* Dodd.
Scutellum unarmed 3.
3. Legs stout, the femora thickened 4.
Legs slender, the femora not thickened 5
4. Metanotum with one tooth or spine *Teleas* Latreille.
Metanotum bidentate *Gryonella* Dodd.
5. Male antennae with whorls of long hairs; parapsidal furrows deep and abbreviated *Xenomerus* Walker.
Male antennae merely pubescent; parapsidal furrows absent or delicate 6.
6. Metanotum unarmed *Paragryon* Kieffer.
Metanotum with one tooth or spine *Trimorus* Forster.
Metanotum with three teeth or spines *Trissacantha* Ashmead.

There is yet the possibility of the grouping together of the last three genera in the above key under one head. In *Trimorus*, the metanotal tooth is very variable in size, and may be minute; in *Paragryon gracilipennis* Dodd, the metanotum is flat and quite unarmed, without even a median carina. The species herein described as *Trissacantha asperata* might well be placed in *Trimorus*, yet is undoubtedly closely related to *Trissacantha trifurcata* and *T. simulata*. The three genera, *Gryon*, *Gryonoides*, and *Teleas*, have not been recognized in this country, while *Gryonella* appears purely Australian.

TRIMORUS Forster.

Hym. Stud., 2, 1856, 101, 104.—*Hoplogryon* Ashmead, *Bull. U.S. National Museum*, 45, 1893, 200.

In this genus I have included species with or without parapsidal furrows, and with or without a prominence on the basal abdominal segment of the female.

Trimorus is the dominant genus of the subfamily, and, as in other parts of the world, the species are numerous in Australia, forty-three being recognized in this revision.

The sexes may differ markedly in colour and in sculpture; indeed, species whose females are readily separated can be distinguished with great difficulty in the male sex. Again, in certain forms the parapsidal furrows are evident in the male, but cannot be discerned in the female.

Generally, wing and antennal characters are very similar throughout the range of species. The type of sculpture, however, shows great diversity and appears to be constant in any species. Other distinguishing points may be found in the size and shape of the tooth or spine of the metanotum, and the shape of the posterior margin of the propodeum.

Trimorus norfolcensis Dodd (*Trans. Roy. Soc. S. Aust.*, 48, 1924, 176), a wingless form from Norfolk Island, should be transferred to the genus *Opisthacantha* Ashmead of the Scelioninae; the normally long vertex of the head, and the situation of the lateral ocelli close to the eye margins, show that it cannot be included in the Teleasinae.

Key to the Australian Species of Trimorus Forster.

- | | | |
|---|------------------------|----|
| 1. Females | | 2 |
| Males | | 39 |
| 2. Wings abbreviated or rudimentary | | 3 |
| Wings fully developed | | 7 |
| 3. Segment 3 of abdomen finely densely striate | <i>tenuistriatus</i> | |
| Segment 3 of abdomen reticulate | <i>howensis</i> | |
| Segment 3 of abdomen without distinct sculpture | | 4 |
| 4. Upper frons smooth | | 5 |
| Upper frons densely finely sculptured | | 6 |
| 5. Segment 3 of abdomen densely pubescent | <i>parvutinus</i> | |
| Segment 3 of abdomen not pubescent | <i>tantillus</i> | |
| 6. Forewings not extending beyond posterior margin of thorax; sculpture of scutum very fine | <i>lativentris</i> | |
| Forewings reaching posterior margin of second abdominal segment; sculpture of scutum definitely punctate | <i>parvipennis</i> | |
| 7. Large species with the apical antennal joints contrasting pale yellow | | 8 |
| Small to medium-sized species, the apical antennal joints not contrasting pale yellow | | 10 |
| 8. Scutellum with a short tooth posteriorly; segment 3 of abdomen coarsely striate | <i>citriclavus</i> | |
| Scutellum without a tooth; segment 3 of abdomen punctate or rugose | | 9 |
| 9. Propodeum without definite teeth or spines; segment 3 of abdomen with a strong wavy rugose sculpture | <i>tricoloricornis</i> | |
| Propodeum with strong teeth latero-posteriorly; segment 3 of abdomen strongly confluent punctate | <i>pallidiclavus</i> | |
| 10. Scutum smooth; parapsidal furrows forming broad sulci posteriorly .. | <i>nitescens</i> | |
| Scutum sculptured; parapsidal furrows absent or delicate | | 11 |
| 11. Forewings narrow, the marginal cilia long; a small black species with dark legs | <i>mymaripennis</i> | |
| Forewings broad or moderately broad, the marginal cilia not particularly long .. | | 12 |
| 12. Segment 3 of abdomen smooth, at the most striate at base; upper frons not striate, except in <i>nigrinotum</i> and <i>striatiscutum</i> | | 13 |
| Segment 3 wholly or in part punctate or rugose, or wholly striate; upper frons striate, except in <i>fuscicoxa</i> | | 25 |
| 13. Frons wholly striate | | 14 |
| Upper frons without striae | | 15 |
| 14. Basal segment of abdomen with a distinct prominence; metanotal tooth replaced by a thin lamella | <i>nigrinotum</i> | |

- Basal segment of abdomen without a prominence; metanotum with a minute tooth
 *striatiscutum*
15. Scutum showing a marked contrast in sculpture between the impressed reticulation
 and the posterior strong striae; a black species with dark legs and antennae
 *aterrimus*
 Scutum uniformly sculptured, or at least not showing a marked contrast between
 two types of sculpture 16
16. Basal segment of abdomen with a raised prominence *australicus*
 Basal segment of abdomen without a prominence 17
17. Funicle joints yellow, 1 and 2 elongate, 2 longer than 1 18
 Funicle joints dark, 1 and 2 rarely elongate, 2 never longer than 1 19
18. Posterior margin of propodeum uniformly gently concave, without lateral teeth;
 funicle joints 3 and 4 longer than wide *varicornis*
 Posterior margin of propodeum gently concave medially, straight laterally, armed
 with strong lateral teeth; funicle joints 3 and 4 wider than long
 *bicoloricornis*
19. Scutum with some fine striae posteriorly *atripes*
 Scutum without striae posteriorly 20
20. Sculpture of scutum of fine impressed reticulation; spine of metanotum short .. 21
 Sculpture of scutum densely punctate; spine of metanotum usually long 22
21. Scutum uniformly reticulate, the parapsidal furrows not evident *sordidus*
 Reticulation of scutum failing laterally and posteriorly; parapsidal furrows evident
 *assimilis*
22. Spine of metanotum short; upper frons reticulate *pulchrihorax*
 Spine of metanotum long and acute; upper frons smooth or finely punctate 23
23. Upper frons with dense fine punctures and pubescence; posterior margin of pro-
 podeum straight *punctatus*
 Upper frons smooth, with scattered pin-punctures and pubescence; posterior margin
 of propodeum somewhat concave 24
24. Abdomen slender, the basal segment not much shorter than its posterior width
 *concoloricornis*
 Abdomen short and broad, the basal segment much shorter than its posterior width
 *breviventris*
25. Segment 3 of abdomen uniformly striate, without other sculpture *striatellus*
 Segment 3 densely punctate or reticulate, if partially striate, other sculpture or
 punctures are present either medially or laterally 26
26. Posterior angles of propodeum armed with an outwardly-curved tooth, in front of
 which is a smaller tooth; segment 3 of abdomen longitudinally rugose-striate
 *novispinus*
 Posterior angles of propodeum acute or armed with a straight tooth, the smaller
 tooth absent 27
27. Scutum with strong longitudinal striae or rugae posteriorly; segment 3 of abdomen
 strongly longitudinally punctate and striate *rugulosus*
 Punctuation of scutum reticulate or with a longitudinal tendency, but there are no
 definite posterior rugae or striae 28
28. Segment 3 of abdomen with large scattered punctures, shortly foveate-striate at
 base; head abruptly smooth behind the line of the ocelli *pilosicornis*
 Segment 3 of abdomen not sculptured as above; head rarely smooth behind the
 line of the ocelli 29
29. Segment 3 of abdomen striate medially, densely punctate laterally *fuscicoxa*
 Segment 3 finely striate and punctate *delicatus*
 Segment 3 densely punctate or reticulate, the striae never present medially .. 30
30. Segment 3 with impressed reticulation *impressus*
 Segment 3 with dense punctures or raised reticulation 31
31. Segment 3 strongly punctate 32
 Segment 3 finely punctate for the greater part 35
32. Metanotal spine narrowly acute, situated high above base of abdomen; posterior
 margin of propodeum straight laterally with strong outwardly-projecting lateral
 teeth *acutispinus*
 Metanotal spine broad and blunt, not situated high above base of abdomen; posterior
 margin of propodeum regularly concave, the lateral angles acute and hardly
 projecting outwardly 33

33. Segment 2 of abdomen strongly punctate between the striae medially; segment 3 smooth medially on posterior third *castaneithorax*
 Segment 2 without punctures between the striae medially; segment 3 punctate except narrowly along posterior margin 34
34. Posterior margin of propodeum lightly concave; base of abdomen without a raised prominence *crassispinus*
 Posterior margin of propodeum deeply concave to receive base of abdomen which bears a raised prominence *validispinus*
35. Segment 3 regularly punctate, without lateral striae, the lateral margins broadly smooth 36
 Segment 3 striate laterally 37
36. Size larger; posterior margin of propodeum not regularly concave, the posterior angles projecting outwardly *tenuipunctatus*
 Size smaller; posterior margin of propodeum regularly concave, the posterior angles not projecting outwardly *rufithorax*
37. Segment 1 of abdomen without a raised prominence; funicle 1 no longer than the pedicel *condensus*
 Segment 1 with a raised prominence; funicle 1 longer than the pedicel 38
38. Segment 1 of abdomen twice as wide posteriorly as basally; funicle joints dark *latispinus*
 Segment 1 one-half wider posteriorly than basally; funicle joints yellow *nigriventris*
39. Segment 3 of abdomen densely punctate or strongly sculptured; frons striate .. 40
 Segment 3 smooth, at the most very shortly striate at base or with a few punctures; frons usually not striate 49
40. Size very large; segment 3 of abdomen coarsely sculptured 41
 Size medium to rather small; segment 3 finely striate or punctate 42
41. Segment 3 with a wavy rugose sculpture ? *pallidiclavus*
 Segment 3 regularly striate and punctate ? *tricoloricornis*
42. Scutum with definite striae or rugae posteriorly *rugulosus*
 Scutum without definite striae or rugae 43
43. Segment 3 with fine impressed striae; vertex smooth behind the eyes *delicatus*
 Segment 3 finely punctate 44
44. Posterior margin of propodeum concave medially, almost straight laterally 45
 Posterior margin of propodeum uniformly concave 46
45. Metanotal tooth short; propodeum not conspicuously pubescent; temples and cheeks smooth or nearly so *tenuipunctatus*
 Metanotal tooth rather long; propodeum conspicuously pubescent; temples and cheeks strongly striate *acutispinus*
46. Vertex smooth behind the eyes *condensus*
 Vertex striate behind the eyes 47
47. Punctate area of segment 3 of abdomen shorter medially than laterally *castaneithorax*
 Punctate area of segment 3 not shorter medially than laterally 48
48. Funicle joints gradually decreasing in length *nigriventris*
 Funicle joints subequal *crassispinus*
49. Funicle joints with long pubescence; segment 3 of abdomen with definite scattered punctures laterally; frons striate; scutum and scutellum very coarsely reticulate-punctate *pilosicornis*
 Funicle joints shortly pubescent; segment 3 without definite punctures laterally; sculpture of scutum and scutellum not coarse 50
50. Forewings narrow, the longest marginal cilia equal to the greatest width of the wing *mymaripennis*
 Forewings broad or moderately broad, the longest marginal cilia much shorter than the wing width 51
51. Scutum striate posteriorly; frons not striate *australis*
 Scutum without striae 52
52. Funicle 1 of antennae somewhat shorter than 3 53
 Funicle 1 somewhat longer than 3; frons not striate *assimilis*
53. Thorax wholly black 54
 Thorax partly red 55

54. Frons wholly striate *nigrinotum*
 Upper frons not striate *punctatus*
55. Abdomen black, except at base 56
 Segments 2 and 3 mostly yellowish 57
56. Metanotal tooth slender; abdomen slender, twice as long as its greatest width *varicornis*
 Metanotal tooth rather stout; abdomen stout, less than one-half longer than its greatest width *breviventris*
57. Scutum black, the punctures dense; antennae twice as long as the body *speciosus*
 Scutum red, the punctures sparse; antennae one-half longer than the body *pulcherrimus*

TRIMORUS TENUISTRIATUS, n. sp.

♀. Length, 0.80 mm. Golden-brown, the abdomen dusky apically, the scutum and scutellum faintly dusky; antennae dull yellow-brown, the scape bright yellow; legs bright yellow; eyes black.

Head normal; vertex very finely closely transversely striate; frons with similar longitudinal striae, but broadly smooth above the antennal insertion; cheeks smooth; a few fine hairs are scattered over the surface. Antennal scape long and slender; pedicel slender, fully twice as long as its greatest width; funicle 1 as wide as and a little shorter than the pedicel, 2 slightly shorter than 1 but plainly somewhat longer than wide, 3 and 4 very short and transverse; club compact, joints 1-5 transverse. Thorax stout; scutum and scutellum with fine impressed reticulation and fine pubescence; metanotum with a very short tooth at meson; posterior angles of the propodeum with a minute tooth. Forewings vestigial, not extending beyond the posterior margin of the thorax. Abdomen stout, not one-half longer than its greatest width; segment 1 transverse; 3 occupying most of the surface and not much wider than long; 1 and 2 rather strongly striate; 3 very finely closely striate; 4 and 5 short and transverse, minutely punctate and with fine pubescence.

♂. Unknown.

Habitat.—South Australia: Mt. Lofty; one female collected in moss by R. J. Burton.

Holotype in the South Australian Museum.

A small species with vestigial wings, easily distinguished by the fine striae of the head and segment 3 of the abdomen, and the golden-brown colour.

TRIMORUS HOWENSIS Dodd.

Hoplogryon howensis Dodd, *Trans. Roy. Soc. S. Aust.*, 48, 1924, 177.

♀. Length, 1.25 mm. Head dark brown or fuscous; thorax deep reddish-brown; abdomen fuscous, the basal segment bright red, its lateral line pale yellow; legs yellow-brown, the tarsi clear yellow; antennae dusky-black, the scape and pedicel dull yellow.

Head slightly wider than the thorax, the vertex thin, the frons broad; eyes large, bare, wide apart; frons with a short median carina above the antennae; frons and vertex with dense close impressed reticulation and scattered short fine hairs, the lower face with longitudinal striae; cheeks very narrow dorsally, with fine surface reticulation; ocelli very small, the lateral pair somewhat nearer to the median ocellus than to the eyes. Antennal scape long and slender, as long as the next four joints united; pedicel one-third longer than its greatest width; funicle joints as wide as the pedicel, 1 one-half longer than pedicel, twice as long as wide, 2-4 gradually shortening, 4 a little longer than wide; club 6-jointed,

rather slender, joint 1 as long as wide, 2-5 rather distinctly wider than long. Thorax as wide as long; scutum and scutellum with fine dense surface reticulation and fine dense pubescence; parapsidal furrows not indicated; metanotum with a small acute tooth medially; propodeum very short, visible as small lateral areas, the posterior angles with a small raised tooth. Forewings vestigial, very narrow, hardly extending beyond posterior margin of the thorax. Legs slender. Abdomen somewhat wider than the thorax, not greatly narrowed at base, broadly rounded posteriorly, one-third longer than its greatest width; segment 1 extremely short and transverse; 2 much longer than 1; 3 three times as long as 2, almost as long as its greatest width; 4-6 short; 1 and base of 2 striate; 2 and 3 with dense impressed reticulation and fine scattered pubescence; 4-6 with very fine sculpture and pubescence.

♂. Unknown.

Habitat.—Lord Howe Island, the type female collected by A. M. Lea.

Holotype in the South Australian Museum, I.14572.

Readily distinguished from the other wingless species by the reticulate third abdominal segment and the longer funicle joints of the antennae.

TRIMORUS PARVULINUS, n. sp.

♀. Length, 0.75 mm. Head dull brownish-black; thorax dull reddish-brown; abdomen black, the base reddish-yellow; legs brown, the tarsi and base and apex of femora and tibiae yellowish; antennae piceous, the first two joints dull yellow-brown.

Head somewhat distinctly wider than the thorax, the frons distinctly convex; eyes small, wide apart, weakly pubescent; vertex between the ocelli and toward the occipital margin coriaceous; frons smooth, with scattered fine hairs, the lower face densely finely striate; median carina of frons delicate but complete; cheeks smooth with a few fine hairs. Antennal scape long and slender; pedicel one-third longer than its greatest width; funicle 1 as wide as and a little shorter than the pedicel, a little longer than wide, 2 as wide as long, 3 and 4 small and transverse; club compact, the joints much wider than long. Thorax stout; scutum finely densely pubescent and densely very finely reticulate-punctate; scutellum densely punctate and pubescent at base, smooth posteriorly; metanotum with a short erect median tooth; propodeum very short, margined posteriorly, the posterior margin concave, the posterior angles weakly acute. Forewings vestigial, linear, not extending beyond the posterior margin of the second abdominal segment. Abdomen short, broad, strongly convex, distinctly wider than the thorax, one-fourth longer than its greatest width; segment 1 widening posteriorly, shorter than its basal width; 3 fully twice as long as 1 and 2 united; 4-6 very short; 1 and 2 strongly striate; 3-5 smooth, with numerous scattered pin-punctures bearing fine hairs and forming a noticeable pubescence.

♂. Unknown.

Habitat.—Victoria: Dandenong Ranges, two females in December, A. P. Dodd; Warragul, one female in June, F. E. Wilson.

Holotype in the Queensland Museum. Paratypes in the collections of Mr. F. E. Wilson and the author.

This species differs from *lativentris* in the darker colouring of the thorax, legs, and basal joints of the antennae, and in the coriaceous sculpture of the head being confined to the vertex; it differs from *tantillus* in the definitely pubescent third segment of the abdomen.



TRIMORUS TANTILLUS, n. sp.

♀. Length, 0.95 mm. Head and abdomen, except the basal segment, black; thorax dull reddish-brown; basal segment of abdomen bright yellow; legs, including the coxae, golden-yellow; antennal scape yellow, dusky toward apex, the remaining joints fuscous.

Vertex behind the ocelli with fine impressed reticulation and fine pubescence; frons smooth, polished, with a median carina, the lower face densely finely striate; cheeks smooth. Antennal scape slender, longer than the pedicel and funicle joints united; pedicel one-half longer than its greatest width; funicle 1 a little shorter than the pedicel, 2 as long as 1, 3 and 4 abruptly shorter and transverse; club compact, the joints transverse. Thorax normal; scutum with fine raised reticulation and scattered fine pubescence; scutellum smooth, faintly sculptured at base; metanotum with a minute tooth medially; posterior angles of the propodeum each with a small blunt tooth. Wings vestigial, not reaching beyond the posterior margin of the thorax. Abdomen stout, wider than the thorax, barely one-half longer than its greatest width; segment 1 short, transverse; 3 occupying most of the surface, slightly wider than long; 1 and 2, except posteriorly, strongly striate, the remaining segments smooth; 3 with scattered fine hairs posteriorly, 4 and 5 with scattered hairs.

♂. Unknown.

Habitat.—Tasmania: Waratah; one female taken in moss and lichens by A. M. Lea.

Holotype in the South Australian Museum.

Resembles *lativentris*, but in that species the upper frons is sculptured, and segment 3 of the abdomen is definitely pubescent and with numerous scattered minute punctures.

TRIMORUS LATIVENTRIS, n. sp.

♀. Length, 0.75 mm. Head dull brown, the eyes black; thorax and basal segment of abdomen golden-yellow; abdomen black; legs bright golden-yellow; antennal scape and pedicel yellow, the funicle and club fuscous.

Head somewhat wider than the thorax, the frons convex; upper half of frons and the vertex finely coriaceous, with fine pubescence; lower frons smooth medially, finely pubescent laterally; median carina of frons complete; vertex somewhat depressed medially; eyes small, wide apart, shortly pubescent; ocelli very minute. Antennal scape moderately short, but fully as long as the next five joints united; pedicel slightly longer than its greatest width; funicle 1 and 2 globose, subequal, as wide as long; 3 and 4 minute, transverse; club compact, the joints transverse. Thorax not much longer than its greatest width; scutum and scutellum very finely, densely, indefinitely punctate-coriaceous and pubescent; metanotum with a minute medial tooth; propodeum very short, its posterior margin gently concave, its posterior angles subacute. Wings vestigial, narrow flaps that extend as far as the posterior margin of the thorax. Abdomen much wider than the thorax, rotund, as wide as long; segment 1 short and transverse; 2 somewhat longer than 1 but very transverse; 3 almost twice as long as 1 and 2 united; 4-6 very short, combined not one-third as long as 3; 1 and 2 longitudinally striate; remaining segments with a rather conspicuous pubescence of fine hairs arising from minute punctures.

♂. Unknown.

Habitat.—South Queensland: Mt. Tambourine, 2,000 feet, two females in February, A. P. Dodd.

Holotype in the Queensland Museum. Paratype in the author's collection.

TRIMORUS PARVIPENNIS, n. sp.

♀. Length, 0.95 mm. Head brownish-black; thorax dull reddish-brown; abdomen black, the basal segment bright reddish-yellow; antennae piceous, the scape reddish basally; legs dull brown, the tarsi and apex of the femora and tibiae yellow.

Head slightly wider than the thorax, the frons a little convex; eyes feebly pubescent; upper frons and vertex to the occiput densely coriaceous-reticulate and weakly pubescent; lower half of frons smooth and shining, the median carina delicate, one-half complete, not extending into the upper coriaceous area; face below the ventral line of the eyes finely densely striate; cheeks smooth, with scattered fine punctures. Antennal scape long and slender; pedicel slightly longer than its greatest width; funicle 1 fully as wide as the pedicel, a little longer than wide, 2 as wide as long, 3 and 4 small and very transverse; club compact, joints 1-5 much wider than long. Scutum densely finely reticulate-punctate; scutellum with similar sculpture but smooth posteriorly at the median line; metanotum with a very short tooth medially; propodeum very short, its posterior border margined and gently concave, its posterior angles subacute. Forewings abbreviated, reaching to the base of segment 3 of the abdomen; slender; venation normal, extending almost to the apex. Abdomen somewhat wider than the thorax, one-third longer than its greatest width; segment 1 very short, one-half as long as its basal width; 3 twice as long as 1 and 2 united; 4-6 very short; 1 and 2, except posteriorly, striate; 3 with numerous scattered minute punctures bearing fine hairs; 4-6 densely finely punctate and pubescent.

♂. Unknown.

Habitat.—Victoria: Dandenong Ranges, one female in December, A. P. Dodd.

Holotype in the Queensland Museum.

The wings are longer than in the other abbreviated-winged forms except *parvulinus*; nearest to *lativentris* but differs in the darker colour of the thorax, legs, and antennae, and in the more distinct punctation of the scutum.

TRIMORUS CITREICLAVUS, n. sp.

♀. Length, 2.60 mm. Black, the thoracic sutures showing reddish, the teeth of the propodeum red; legs, including the coxae, bright reddish-yellow; antennal scape brown, reddish at base, the next six joints brownish-yellow, the five apical joints intense pale yellow; mandibles red, the teeth black.

Head normal; frons with a complete median carina from the antennal insertion to the frontal ocellus; vertex and upper half of frons very densely finely punctate and pubescent, the hairs short, fine and whitish; frons laterally with longitudinal striae and short whitish pubescence, the striae failing dorsally; cheeks with fine longitudinal striae, fine dense punctures, and fine pubescence; eyes faintly pubescent; mandibles large, tridentate, the teeth long and acute. Antennal scape long and slender; pedicel one-half longer than its greatest width; funicle 1 somewhat longer than the pedicel, twice as long as its greatest width, 2 as long as 1, 3 quadrate, 4 transverse; club compact, the joints transverse. Thorax no longer than its greatest width; scutum and scutellum finely very densely reticulate-

punctate and with fine pubescence; on either side against the posterior margin of the scutum are several irregular longitudinal striae or rugae; scutellum just before the posterior margin medially with a small acute tooth; metanotal spine very long, slender, curved, longitudinally striate, extending over the basal abdominal segment; propodeum short, declivous, coarsely punctate and finely pubescent, without carinae, the posterior margin gently concave, armed latero-posteriorly on either side with a strong acute projecting tooth or spine. Forewings extending a little beyond apex of abdomen; broad, smoky-brown; venation dull brown; submarginal vein attaining the costa at one-half the wing length, the marginal vein one-third as long as the submarginal, the stigmal vein short. Abdomen two-thirds longer than its greatest width; segment 1 one-half wider posteriorly than basally, a little shorter than its greatest width; 2 one-half longer than 1; 3 twice as long as 2 or as 4-6 united; 1 and 2 very strongly sparsely longitudinally striate; 3 more densely striate, the striae straight and regular, the surface between smooth; 4 and 5 with fine impressed reticulation and a few scattered small punctures; posterior margin of 2-5 narrowly smooth; 3-5 pubescent laterally; 4 and 5 with scattered hairs dorsally.

♂. Unknown.

Habitat.—Queensland; exact locality unknown; one female taken by A. A. Girault.

Holotype in the Queensland Museum.

A large distinct species with pale antennae and strongly striate third segment of abdomen; the small tooth on the scutellum can hardly be considered more than a good specific character.

TRIMORUS TRICOLORICORNIS, n. sp.

♀. Length, 2.5-3.0 mm. Head and abdomen black; thorax dull black laterally and ventrally, chestnut-red dorsally, the scutellum and median third of the scutum black; coxae blackish, the legs bright reddish-yellow, the posterior tarsi dusky; antennal scape deep red, the next seven joints fuscous, the apical four very pale yellow.

Head transverse, the vertex thin; behind the line of the ocelli very densely rather finely reticulate-punctate and with fine pubescence; frons rather strongly longitudinally striate, finely sculptured between the striae; median carina of frons complete; a small smooth area above the antennal prominence; cheeks densely punctate above, becoming striate toward the mouth. Antennal scape long and slender; pedicel a little longer than its greatest width; funicle 1 twice as long as the pedicel; 2 a little shorter than 1; 3 and 4 short, wider than long; club compact, joints 1-5 transverse. Thorax stout; scutum and scutellum very densely rather strongly reticulate-punctate, with a tendency toward longitudinal rugae on the scutum medio-posteriorly; metanotal spine very long, rather slender, subacute, its surface rugose; propodeum short, finely rugose-punctate and pubescent, its posterior margin concave for its entire length, its posterior angles without defined spines and not projecting outward. Forewings reaching apex of abdomen; broad; rather deeply smoky; marginal vein somewhat less than one-half as long as the submarginal; stigmal vein slender, long for the genus; one-fourth as long as the marginal; basal and median veins represented by yellow lines. Abdomen a little less than twice as long as its greatest width; segment 1 a little longer than its basal width, one-half wider posteriorly than basally; 2 one-third longer than 1; 3 one-third longer than 2, almost twice as

wide as long; 4 less than one-half as long as 3; 5 and 6 quite short; 1 and 2 very strongly sparsely striate, smooth between the striae; 3 rather strongly longitudinally rugose-striate, which medially, especially toward base, runs to a curious wavy or zigzag rugose pattern, the lateral margins densely punctate; 4 and 5 densely punctate and pubescent, the punctures confluent laterally; lateral margins of 2 and 3 pubescent; 3-5 each with a smooth posterior path; 4 with a narrow smooth basal path.

♂. See remarks below.

Habitat.—South Queensland: Mt. Tambourine, 2,000 feet, two females in February, A. P. Dodd.

Holotype in the Queensland Museum. Paratype in the author's collection.

A fine large species, distinguished by the pale apical antennal joints, and the sculpture of segment 3 of the abdomen.

A male from the Blackall Range, Qld., has similar sculpture on segment 3, but is much larger, 4 mm., and the posterior angles of the propodeum bear short stout teeth which project outward.

TRIMORUS PALLIDICLAVUS, n. sp.

♀. Length, 2.75 mm. Black, the thoracic sutures and teeth and the base of the abdomen dark red; coxae black, the trochanters and base of the femora bright yellow, the rest of the legs dusky-brown, the posterior tibiae and tarsi almost black; antennae brownish-black, the scape red at base, the apical five joints pale intense yellow; mandibles yellow, the teeth dark.

Head normal, the vertex thin; vertex behind the line of the ocelli irregularly transversely striate, finely densely punctate, and with short pubescence, the striae continued down the cheeks, which are densely punctate; frons densely rather finely longitudinally striate and with short whitish pubescence, hardly sculptured between the striae; median carina of frons complete; eyes large, weakly pubescent; mandibles large, tridentate; antennal scape long and slender; pedicel a little longer than its greatest width; funicle 1 fully twice as long as the pedicel, rather more than twice as long as wide; 2 as long as 1; 3 quadrate; 4 transverse; club compact, joints 1-5 wider than long. Scutum and scutellum rather strongly reticulate-punctate, the posterior half, except laterally, of the scutum with irregular longitudinal rugae; with fine pubescence; spine of metanotum very long, slender, pointed, its surface rugose; propodeum short, rugose-punctate and pubescent, its posterior margin not carinate, gently concave medially, straight laterally, its posterior angles with a stout subacute tooth which projects outwardly. Forewings reaching apex of abdomen; broad; smoky-black, the basal third subhyaline; venation dark; marginal vein hardly one-half as long as the submarginal, the stigmal vein slender; basal vein faintly marked; hindwings lightly smoky, the base hyaline. Abdomen two-thirds longer than its greatest width; segment 1 as long as its basal width, one-half wider posteriorly than basally; 2 one-third longer than 1; 3 one-third longer than 2, twice as wide as long; 4 one-half as long as 3; 5 and 6 very short; 1 and 2 strongly sparsely striate, smooth between the striae; lateral margins of 2 strongly punctate; 3 and 4 strongly confluent punctate with a longitudinal tendency, against lateral margins with dense pubescence; 5 confluent punctate at base; 4 and 5 with scattered long hairs; 3-5 each with a smooth posterior path.

♂. See remarks below.

Habitat.—South Queensland: Mt. Tambourine, 2,000 feet, two females in February, A. P. Dodd.

Holotype in the Queensland Museum. Paratype in the author's collection.

A fine large species with very long metanotal spine; as in *tricoloricornis*, the antennae are pale apically, but in that species the sculpture of segment 3 of the abdomen is quite different, and the posterior margin of the propodeum is concave for its whole length and does not bear lateral spines.

A male taken by H. Hacker in January at Stanthorpe, Qld., probably belongs to this species. It measures 3.5 mm.; the head and abdomen are black; thorax bright chestnut-red, black ventrally; coxae black, the legs bright reddish-yellow; antennae black, the scape reddish-yellow. Behind the line of the vertex the sculpture is densely punctate medially, punctate and irregularly longitudinally striate laterally; there are no longitudinal rugae on the scutum; the wings are subhyaline; the much finer punctures of segment 3 of the abdomen are divided into longitudinal rows by blunt striae.

TRIMORUS NITESCENS Dodd.

Trans. Roy. Soc. S. Aust., 40, 1916, 29.

♀. Length, 1.40 mm. Shining black; antennae black, the scape reddish at extreme base; coxae fuscous, the legs dusky brownish-yellow.

Head normal, transverse, the frons somewhat convex so that the line of the vertex is rounded; frons and vertex smooth and shining with a few fine hairs; behind the line of the ocelli is a narrow path of fine impressed reticulation; median carina of frons delicate and complete; lower frons longitudinally striate, the lateral striae continued for some distance along inner margin of eyes; cheeks finely longitudinally striate; eyes large, with scattered short hairs. Antennal scape long and slender; pedicel one-third longer than its greatest width; funicle 1 as long and as wide as the pedicel, 2 slightly shorter than 1, 3 and 4 small and transverse; club compact, joints 1-5 each twice as wide as long. Thorax no longer than its greatest width; scutum more transverse than usual, smooth and shining, with scattered long hairs, the posterior margin of the median lobes with a row of punctures; parapsidal furrows consisting of a row of punctures, but widening posteriorly to form broad shallow rugose sulci; margins of parapsides foveate; scutellum large, smooth, its margins foveate; metanotum with a broadly triangular acute tooth or spine which is finely punctate; propodeum rather short, foveate along margins, smooth centrally, narrowly divided at meson, the posterior margin carinate and uniformly gently concave, the posterior angles acute in the form of short teeth. Forewings reaching apex of abdomen; moderately broad; somewhat less than the basal half sub-hyaline, the rest rather deeply clouded; marginal vein about two-thirds as long as the submarginal; the stigmal vein very short. Abdomen two-thirds longer than its greatest width; segment 1 one-half wider posteriorly than basally, a little shorter than its basal width; 2 one-third longer than 1; 3 one-half longer than 1 and 2 united, three times as long as 4-6 united, three-fourths as long as wide; 1 finely densely striate; 2 striate, smooth laterally and posteriorly; 3-5 smooth; scattered fine hairs are present on 4 and 5 and lateral margins of 3.

♂. Unknown.

Habitat.—New South Wales: Hawkesbury River, the holotype female taken in November by A. A. Girault.

Holotype in the South Australian Museum, I.5429.

Readily distinguished by the smooth scutum, and the broad rugose sulci at the posterior end of the parapsidal furrows.

TRIMORUS MYMARIPENNIS Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 81.

♀. Length, 0.70 mm. Black, the base of the abdomen reddish; legs black, reddish at base and apex of femora and tibiae, the tarsi brown; antennae wholly black.

Head normal, transverse; eyes faintly pubescent; smooth, shining, with scattered fine hairs, without sculpture except for a narrow path of polygonal reticulation immediately behind the ocelli. Antennae short; scape moderately long and slender; pedicel one-half longer than its greatest width; funicle joints smaller than the pedicel, 1 slightly longer than wide, 2 as wide as long, 3 and 4 transverse; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum with fine pubescence and fine impressed reticulation; parapsidal furrows delicate but complete; scutellum with fine pubescence, smooth, finely sculptured at base; metanotum with a subacute, triangular, moderately short tooth; propodeum smooth, foveate along margins, the posterior margin gently concave and terminating in short subacute lateral angles. Forewings extending well beyond apex of abdomen; narrow, the apex sharply rounded, four times as long as their greatest width; longest marginal cilia equal to one-half the greatest wing width; distinctly brownish; venation terminating at one-half the wing length, the marginal vein somewhat shorter than the submarginal. Abdomen stout; one-third longer than its greatest width; segment 1 shorter than its basal width; 3 somewhat longer than 1 and 2 united; 4-6 short; 1 and 2 striate, the remainder smooth; 4 and 5, and 2 and 3 laterally, with fine scattered hairs.

♂. Antennae wholly black; somewhat longer than the body; pedicel no longer than wide; funicle 1 twice as long as wide; 2 a little longer than 1; 3 a little longer than 2; 3-9 subequal. Forewings rather more slender than in the female, the apex more pointed, the longest marginal cilia equal to the greatest wing width.

Habitat.—North Queensland: Cairns district, one male (type) in May, A. A. Girault. New South Wales: Sydney, several females in October, A. P. Dodd. Victoria: Dandenong Ranges, one female in December, A. P. Dodd.

Holotype in the South Australian Museum, I.2002.

A small black species, with very dark legs; distinguished by the slender wings with their long marginal cilia.

TRIMORUS NIGRINOTUM Dodd.

Pentacantha nigrinotum Dodd, *Proc. Roy. Soc. Q'land*, 26, 1914, 128.

♀. Length, 1.45-1.65 mm. Dull black; thorax dull red, the scutum and scutellum almost black; basal segment of abdomen, except its prominence, deep red; legs, including the coxae, golden-yellow; antennae fuscous, the scape reddish at base; mandibles yellow.

Head transverse, the vertex thin; with fine silvery pubescence; vertex finely densely coriaceous-reticulate; frons finely densely longitudinally striate, but almost smooth above the antennal insertion; cheeks with scattered minute punctures; eyes bare; mandibles large, apparently bidentate, the teeth acute.

Antennal scape long and slender; pedicel one-half longer than its greatest width; funicle 1 as wide as and slightly longer than the pedicel, almost twice as long as wide, 2 slightly shorter than 1, 3 and 4 small and transverse; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum finely densely pubescent, shallowly but rather strongly reticulate-punctate, the parapsidal furrows absent; scutellum more definitely reticulate-punctate and with less pubescence; metanotum medially with a short thin convex lamella in lieu of the usual tooth; propodeum densely punctate laterally, its posterior margin deeply concave to its base, the delimiting carinae of the margin widely separated at its base, the posterior angles subacute but not toothed. Forewings hardly extending beyond apex of abdomen; broad; lightly brownish; marginal vein plainly shorter than the submarginal, the stigmal vein short. Abdomen a little less than twice as long as its greatest width; segment 1 plainly longer than its basal width, almost twice as wide posteriorly as basally, at base with a suberect horn or prominence that projects forward as far as the base of the propodeum; 2 no longer than 1; 3 as long as 1 and 2 united, three-fourths as long as wide, twice as long as 4-6 united; 1 strongly striate, its horn smooth; 2 striate, but rather broadly smooth posteriorly; 3 smooth, with scattered pubescence laterally; 4-6 with scattered pubescence.

♂. Head and thorax black; abdomen fuscous, the basal segment brownish-yellow, 2 light brown except laterally, 3 brown except laterally and posteriorly; legs, including the coxae, golden-yellow, the femora and tibiae lightly washed with brown, the tarsi dusky; antennae black, the scape fuscous but reddish at base.

Frons with scattered fine pubescence, wholly regularly and rather strongly striate; scaly reticulation confined to the line of the ocelli, the declivous portion behind the ocelli to the occiput bearing numerous fine pubescent punctures. Punctuation of the scutum shallower and less reticulate, the lateral lobes almost smooth posteriorly; parapsidal furrows delicate, wide apart, well-marked but failing anteriorly; scutellum punctate, smooth posteriorly; metanotum medially with a short stout blunt tooth; propodeum short, its posterior margin gently concave, the delimiting carinae almost meeting at its base medially. Forewings very broad and long, extending well beyond apex of abdomen. Antennae one-half longer than the body; scape rather short and stout, no longer than funicle 4; pedicel no longer than wide; funicle 1-3 subequal, 4-9 subequal, each about one-fourth longer than 3.

Habitat.—Queensland: Herbert River, one female (type), A. P. Dodd; Brisbane, two females, two males, A. P. Dodd.

Holotype in the South Australian Museum, I.11037.

The male differs considerably from the female and may possibly represent a distinct species; as in *punctatus* and *varicornis*, the parapsidal furrows are evident in the male and absent in the female. The combination of the two characters, a striate frons and smooth third segment of abdomen, occurs in *nigrinotum* and *striatiscutum* only; the latter may be separated from *nigrinotum* by the absence of the basal prominence of the abdomen, the minute metanotal tooth, and the presence of striae on the scutum.

TRIMORUS STRIATISCUTUM, n. sp.

♀. Length, 1.50 mm. Black; antennae wholly black; legs fuscous, the trochanters, base of tibiae, and the tarsi, clear yellow.

Head normal, transverse, with scattered white hairs; eyes large, faintly pubescent; frons wholly, rather strongly, longitudinally striate, the median carina not showing; vertex behind the line of the ocelli more finely, subobliquely striate; cheeks finely longitudinally striate. Antennal scape moderately long and slender, its articulate joint long; pedicel twice as long as its greatest width; funicle 1 one-third longer than the pedicel, 2 plainly shorter than 1 and one-half longer than wide, 3 and 4 a little wider than long; club rather slender, not much wider than the funicle, joints 1-5 not greatly wider than long. Thorax stout; scutum rather strongly, somewhat irregularly, longitudinally striate and with scattered white hairs; scutellum striate laterally, smooth medially, with scattered white hairs; metanotum broadly smooth medially, with a very small acute tooth; propodeum clothed with dense silvery pubescence, divided medially by two straight carinae, the posterior margin uniformly concave, the posterior angles rounded and unarmed. Forewings reaching somewhat beyond apex of abdomen; moderately broad; smoky-brown; marginal vein two-thirds as long as the submarginal, the stigmal vein very long for the genus, one-third as long as the marginal vein. Abdomen two-thirds longer than its greatest width; segment 1 as long as its basal width, not much wider posteriorly than basally; 2 one-half longer than 1; 3 hardly longer than 1 and 2 united, less than twice as long as 4-6 united; 1 and base of 2 striate, the rest smooth; 4 and 5 and lateral margins of 2 and 3 with scattered white hairs.

♂. Unknown.

Habitat.—North Queensland: Innisfail, one female in April, A. P. Dodd.

Holotype in the Queensland Museum.

A distinct black species, with dark legs, strongly striate head and scutum, very small metanotal tooth, densely pubescent propodeum, and smooth third segment of abdomen.

TRIMORUS ATERRIMUS, n. sp.

♀. Length, 1.20 mm. Black; legs concolorous, the trochanters, knees, and tarsi testaceous; antennae black.

Head transverse, with a few scattered fine hairs; vertex, upper frons, and along eye margins of frons, with scaly reticulation, the middle frons smooth, the lower frons striate; cheeks narrow, finely reticulate against the eyes, smooth posteriorly and ventrally; median carina of frons complete; frons faintly convex; vertex precipitous behind the line of the ocelli; eyes large, bare. Antennal scape slender, as long as the next five joints combined; pedicel slender, two and a half times as long as its greatest width; funicle 1 as wide as and slightly shorter than the pedicel; 2 a little shorter than 1, but plainly longer than wide; 3 small, as wide as long; 4 wider than long; club rather slender, the joints less than twice as wide as long. Thorax as wide as long; parapsidal furrows faintly marked; scutum with scattered white hairs, with fine polygonal scaly reticulation, the posterior third, except laterally, with short strong longitudinal striae; scutellum smooth, with scattered fine hairs, the margins strongly foveate; metanotum foveate, very transverse, its posterior margin very broadly triangular to form a short acute tooth medially; propodeum short, smooth, foveate along its margins, shortly narrowly divided medially, the posterior margin gently concave, the posterior angles prominent in the form of short acute teeth. Forewings reaching well beyond apex of abdomen; moderately broad; distinctly smoky; longest marginal cilia equal to one-third the greatest wing-width; venation termin-

ating a little beyond middle of costa, the marginal vein somewhat shorter than the submarginal. Abdomen almost twice as long as its greatest width; segment 1 widening posteriorly, a little shorter than its basal width; 2 a little longer than 1; 3 a little longer than 1 and 2 united, less than twice as long as 4-6 united; 1 weakly striate at base and laterally, smooth posteriorly; 2 striate, but smooth posteriorly; 3-6 smooth; all segments with a few fine hairs.

♂. Unknown.

Habitat.—New South Wales: Sydney; four females in October, A. P. Dodd. Holotype in the Queensland Museum. Paratypes in the author's collection.

A small black species with dark legs, distinguished by the sharp contrast between the scaly reticulation and strong striation on the mesoscutum.

TRIMORUS AUSTRALICUS Dodd.

Pentacantha australica Dodd, *Trans. Roy. Soc. S. Aust.*, 38, 1914, 82.

♀. Length, 1.00 mm. Dull black or brownish-black, the base of the abdomen yellow; legs, including the coxae, yellow or yellow-brown; antennae wholly dark.

Head smooth, with scattered fine hairs; a narrow line of polygonal sculpture immediately behind the ocelli; lower frons finely striate; frons more strongly convex than usual; eyes pubescent, small, not extending to the line of the vertex or behind the line of the lateral ocelli, their posterior margin straight. Antennal scape long and slender; pedicel one-third longer than its greatest width; funicle 1 as long and as wide as the pedicel, 2 a little shorter than 1, 3 and 4 small and transverse; club joint 1 small and transverse, 2-5 each twice as wide as long. Thorax stout; scutum with fine pubescence and shallow confluent punctures, on the posterior third with fine longitudinal striae which are obscure on account of the punctate sculpture; scutellum smooth, with fine pubescence; metanotum with a short acute tooth; propodeum short, punctate laterally, the posterior angles slender, subacute, curved a little inwardly. Forewings extending a little beyond apex of abdomen; lightly clouded; moderately broad; marginal vein distinctly shorter than the submarginal, the stigmal vein short. Abdomen two-thirds longer than its greatest width; segment 1 widening a little posteriorly, as long as its basal width, at base with a short blunt erect horn; 3 somewhat longer than 1 and 2 united, twice as long as 4-6 united; 1 and 2 striate, the horn smooth; 3 smooth; 4 and 5 with fine pubescence.

♂. Unknown.

Habitat.—North Queensland: Cairns district; a small series.

Holotype in the South Australian Museum, I.2003.

A small species related to *sordidus*, *assimilis*, and their allies, but at once distinguished by the presence of the prominence on the basal abdominal segment; the sculpture of the scutum is stronger than in *atripes* and the striation less distinct.

TRIMORUS VARICORNIS Dodd.

Hoplogryon varicornis Dodd, *Trans. Roy. Soc. S. Aust.*, 38, 1914, 75.—*H. bicolor* Dodd, *ibid.*, p. 76.

♀. Length, 1.50-1.75 mm. Dull black, the base of the abdomen deep-red; legs, including the coxae, golden-yellow; antennal scape and pedicel fuscous, the scape yellowish at base, the next five joints golden-yellow, the apical five joints fuscous.

Head normal, transverse; eyes large, shortly pubescent; median carina of frons one-half complete from the antennal insertion; lower frons densely striate; upper frons, vertex and cheeks smooth, with a noticeable pubescence of fine short hairs; a very small coriaceous area on either side of the lateral ocelli. Antennal scape long and slender, as long as the next five joints combined; pedicel one-half longer than its greatest width; funicle 1 one-half longer than the pedicel; 2 one-third longer than 1, fully three times as long as wide; 3 slightly more than one-half as long as 2; 4 a little longer than wide; club slender, the joints not or hardly wider than long. Thorax stout; scutum densely pubescent and rather finely confluent punctate; scutellum pubescent and very finely punctate at base, smooth posteriorly; spine on metanotum slender, thorn-like, somewhat curved, suberect; propodeum moderately long, smooth, its margins foveate, narrowly divided medially by parallel carinae, the lateral carinae complete and distinct, the posterior margin carinate and uniformly concave, the posterior angles acute, but not definitely toothed. Forewings extending somewhat beyond apex of abdomen; moderately broad; lightly stained; marginal vein two-thirds as long as the submarginal, the stigmal vein very short. Abdomen a little less than twice as long as its greatest width; segment 1 one-half wider posteriorly than basally, as long as its basal width; 2 one-half longer than 1; 3 a little longer than 1 and 2 united, more than twice as long as 4-6 united; 1 and basal two-thirds of 2 strongly striate, the rest smooth; 4 and 5, and 2 and 3 laterally, with a noticeable fine pubescence.

♂. Differs from the female in the rich chestnut-red colour of the thorax, the scutellum and the median lobe of the scutum being black; punctuation of the scutum somewhat reticulate, the scutellum very narrowly punctate at base; parapsidal furrows very delicate but complete. Antennae black; almost twice as long as the body; pedicel short and stout; funicle 1 a little shorter than 2.

Habitat.—North Queensland: Cairns district, a small series.

Holotype in the South Australian Museum, I.1988.

A medium-sized species with smooth head and third segment of abdomen, long funicle joints, and slender erect spine on the metanotum. The male, which differs markedly in colour, and in the presence of parapsidal furrows, was originally described as a distinct species.

TRIMORUS BICOLORICORNIS, n. sp.

♀. Length, 1.85 mm. Head and abdomen, except the first segment which is reddish, black; thorax dull reddish-brown, the scutum and scutellum dusky; antennal scape bright reddish-yellow, the pedicel brown, the funicle joints golden-yellow, the club black; legs, including the coxae, golden-yellow.

Head transverse; smooth and polished, with a pubescence of fine white hairs; lower frons longitudinally striate; median carina of frons strong and complete; eyes shortly pubescent. Antennal scape long and slender, as long as the next five joints combined; pedicel one-half longer than its greatest width; funicle 1 one-third longer than the pedicel; 2 a little, yet distinctly, longer than 1, almost three times as long as wide; 3 abruptly shorter, as wide as long; 4 wider than long; club compact, the joints not greatly wider than long. Thorax stout; scutum confluent punctate, the punctures of moderate size, and with some pubescence; scutellum with similar sculpture, but narrowly smooth posteriorly; spine on metanotum slender, thorn-like, rather long, suberect; propodeum moderately short, strongly longitudinally striate and sulcate, its posterior margin gently concave

medially, then, at half the distance to the posterior angles, obtusely angled, the posterior angles armed with a strong, oblique, suberect tooth. Forewings extending somewhat beyond apex of abdomen; moderately broad; lightly yellowish; marginal vein two-thirds as long as the submarginal, the stigmal vein short. Abdomen twice as long as its greatest width; segment 1 one-half wider posteriorly than basally, a little longer than its basal width; 2 a little longer than 1; 3 slightly longer than 1 and 2 united, twice as long as 4-6 united; 1 and 2 strongly striate, 2 smooth posteriorly and laterally; 3-5 smooth; 3-5, and 1 and 2 laterally, with scattered fine hairs.

♂. Unknown.

Habitat.—Queensland: locality unknown; one female taken by A. A. Girault. Holotype in the Queensland Museum.

A medium-sized species, with smooth head and third segment of abdomen; as in *varicornis*, funicle 1 is shorter than 2; distinguished from *varicornis* by the shape of the posterior margin of the propodeum with its strong lateral teeth.

TRIMORUS ATRIPES, n. name.

Trimorus nigripes Dodd, *Trans. Roy. Soc. S. Aust.*, 38, 1914, 79 (preoccupied by *T. nigripes* Ashmead = *Prosacantha nigripes* Ashm., 1893).

♀. Length, 1.20 mm. Dull black, the first abdominal segment reddish; coxae fuscous, the legs dusky yellow-brown; antennae black.

Mandibles broad, tridentate, the teeth subequal and acute. Antennal scape slender, longer than the next four joints united; pedicel one-third longer than its greatest width; funicle 1 as long and as wide as the pedicel, 2 as wide as long, 3 and 4 narrower than 2, transverse; club compact, joint 1 small, 2-5 each twice as wide as long. Thorax scarcely longer than its greatest width; scutum pubescent, with faint delicate parapsidal furrows, the lateral lobes almost smooth, the median lobe with fine raised polygonal reticulation and on the posterior third with fine longitudinal striae; scutellum smooth, with scattered hairs; metanotum armed medially with a short acute tooth; propodeum short, hardly sculptured except for the foveate margins, narrowly divided at base, the carinae curving away very obliquely to form the strongly margined posterior border which is gently concave, the posterior angles strong and acute but not toothed. Forewings lightly clouded; moderately broad, the apex rather broadly rounded; marginal vein somewhat shorter than the submarginal. Abdomen one-half longer than its greatest width; segment 1 plainly shorter than its basal width; 2 slightly longer than 1; 3 one-half longer than 1 and 2 united, three times as long as 4-6 united; 1 and 2 striate, 3 smooth, 4-6 with fine pubescence.

♂. Unknown.

Habitat.—North Queensland: Cairns district, the type female. Holotype in the South Australian Museum, I.1997.

A small dark species related to *sordidus* from which it differs in the presence of fine striae on the scutum posteriorly and in the faint delicate parapsidal furrows.

TRIMORUS SORDIDUS Dodd.

Hoplogryon sordida Dodd, *Trans. Roy. Soc. S. Aust.*, 38, 1914, 76.

♀. Length, 0.90-1.10 mm. Head black; thorax and abdomen brownish-black, the first abdominal segment reddish-yellow; legs, including the coxae, testaceous; antennae fuscous, the scape yellowish at base.

Head transverse; eyes rather small, shortly pubescent; frons gently convex, smooth, with a noticeable fine pubescence; median carina of frons failing to reach the anterior ocellus; lower frons shortly striate; extreme line of the vertex finely sculptured, the declivous portion smooth and finely pubescent; cheeks smooth and not pubescent. Antennal scape moderately long and slender; pedicel a little longer than its greatest width; funicle 1 and 2 subequal, hardly longer than wide, 3 and 4 small and wider than long; club compact, the joints much wider than long. Thorax stout; scutum with fine pubescence and fine raised reticulation, the parapsidal furrows not showing; scutellum with similar sculpture but smooth posteriorly; metanotum with a short acute broadly-triangular tooth; propodeum short, finely striate, the posterior margin gently concave, the posterior angles not prominent or acute. Forewings extending well beyond apex of abdomen; moderately broad; lightly stained; marginal vein a little more than one-half as long as the submarginal, the stigmal vein very short. Abdomen one-half longer than its greatest width; segment 1 much wider posteriorly than basally, shorter than its basal width; 2 somewhat longer than 1; 3 as long as 1 and 2 united, more than twice as long as 4-6 united; 1 striate; 2 striate except laterally and posteriorly; 3 shortly striate at base, smooth for the rest, with scattered hairs laterally; 4 and 5 with scattered hairs.

♂. Unknown.

Habitat.—North Queensland: Cairns district, four females in May and June. Holotype in the South Australian Museum, I.1989.

A small species with smooth head and third segment of abdomen, distinguished by the fine raised reticulation of the scutum.

TRIMORUS ASSIMILIS Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 79.—*T. auratus* Dodd, *id.*, 40, 1916, 30.—*T. leai* Dodd, *id.*, 48, 1924, 176.

♀. Length, 1.00–1.20 mm. Head black; thorax varying from yellow-brown to dull black; abdomen black or deep brown, the basal segment bright red or yellow; legs rarely clear yellow, generally more or less dusky; antennae black or piceous, the scape usually more or less yellowish.

Head transverse, slightly wider than the thorax, the frons lightly convex, the vertex shortly precipitous from immediately behind the ocelli; smooth and polished, with scattered fine hairs; extreme line of the vertex with a narrow transverse path of very fine polygonal sculpture; median carina of frons fine and complete; eyes faintly pubescent; lower frons with striae converging to the mouth. Antennal scape long and slender, as long as the next six or seven joints united; pedicel two-thirds longer than its greatest width; funicle 1 as long as or slightly longer than the pedicel, 2 hardly shorter than 1, 3 and 4 small, 3 as wide as long, 4 wider than long; club compact, joints 1-5 almost twice as wide as long. Thorax stout; parapsidal furrows delicate but complete; scutum with fine dense pubescence and numerous pin-punctures, the median lobe with very fine open impressed reticulation which fails posteriorly, the lateral lobes hardly sculptured, the sculpture coarser and punctate on the declivous anterior portion of the median lobe; scutellum smooth, with scattered fine hairs, with fine sculpture at its extreme base; metanotum with a small acute tooth medially; propodeum short, smooth except along the foveate margins, faintly concave posteriorly, the carinate posterior margin narrowly divided medially and running obliquely to the acute posterior angles. Forewings extending well beyond apex of abdomen; moderately

broad; marginal cilia short; lightly stained or noticeably brownish; marginal vein plainly shorter than the submarginal. Abdomen stout, hardly one-half longer than its greatest width; segment 1 widening posteriorly, not as long as its basal width; 3 one-half longer than 1 and 2 united, twice as long as 4-6 united; 1 and 2, except posteriorly, striate; 3 wholly smooth, or shortly striate at base; 4-6 with scattered pubescence.

♂. Scutum densely punctate anteriorly on the median lobe, smooth for the rest, except for pin-punctures bearing fine hairs; abdomen more slender, two-thirds longer than its greatest width, segment 1 as long as its basal width. Antennae not much longer than the body; black, the scape suffused with yellow; funicle 1 hardly one-half as long as the scape, 1 and 2 subequal, each slightly longer than 3, 3-9 subequal.

Habitat.—Queensland: Cairns district (type); Blackall Range; Brisbane; a small series. Norfolk Island, one female, A. M. Lea.

Holotype in the South Australian Museum, I.1996.

A small species, variable in colour, and to a lesser degree in the size of the metanotal tooth, which however is always small, and the stoutness of the abdomen; segment 3 of the abdomen may be wholly smooth or shortly striate at base. The type is a male from Cairns; *auratus* is a yellow female from Cairns; *leai*, a female from Norfolk Island, does not seem distinct.

Trimorus assimilis is close to *sordidus*, but in the latter species the frons and eyes are noticeably pubescent, the parapsidal furrows are not marked, and the reticulate sculpture of the scutum and scutellum is coarser and raised.

TRIMORUS PULCHRITHORAX Dodd.

Hoplogryon pulchrithorax Dodd, *Trans. Roy. Soc. S. Aust.*, 38, 1914, 78.

♀. Length, 1.00 mm. Head dull black; thorax varying from bright chestnut-red with the scutellum and the centre of the scutum blackish to deep dull red; abdomen dull brownish-black, the first segment bright reddish-yellow; antennal scape yellow or somewhat dusky, the pedicel brown, the funicle and club fuscous.

Head normal, transverse, the frons gently convex; eyes moderately large, bare; upper frons and vertex with fine close reticulation and fine pubescence, the middle frons smooth, the lower frons striate; median carina of frons delicate, failing to reach the anterior ocellus; cheeks smooth, with a few fine hairs. Antennal scape long and slender, as long as the next six joints combined; pedicel one-half longer than its greatest width; funicle 1 as long as the pedicel, 2 a little shorter than 1, 3 and 4 small, wider than long; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum finely confluent punctate and with fine dense pubescence; scutellum with similar sculpture, but smooth posteriorly; metanotum with a rather short, subacute, broadly triangular tooth; propodeum foveate along its margins, short, the posterior margin gently concave, the posterior angles subacute but not truly toothed. Forewings extending well beyond apex of abdomen; lightly stained; moderately broad; marginal vein not greatly shorter than the submarginal, the stigmal vein short. Abdomen short and broad; one-third longer than its greatest width; segment 1 much wider posteriorly than basally, much shorter than its basal width; 2 almost twice as long as 1; 3 two-thirds longer than 1 and 2 united; 4-6 very short; 1 striate; 2 striate, except posteriorly and laterally; 3-5 smooth; 3 with scattered hairs laterally and posteriorly; 4 and 5 with fine hairs.

♂. Unknown.

Habitat.—Queensland: Cairns district, one female (type) in September; Brisbane, two females in December; Mt. Tambourine, six females in March.

Holotype in the South Australian Museum, I.1994.

A small species with finely punctate scutum and reticulate upper frons, characters which separate it from *sordidus* and *assimilis*; very similar to *breviventris*, but in that species the upper frons is smooth and the metanotal spine or tooth is much longer.

TRIMORUS PUNCTATUS Dodd.

Hoplogryon punctata Dodd, *Trans. Roy. Soc. S. Aust.*, 38, 1914, 77.—*Trimorus niger* Dodd, *ibid.*, p. 79.—*T. nigrellus* Dodd, *ibid.*, p. 81.

♀. Length, 1.50–1.75 mm. Black; legs, including the coxae, golden-yellow, the femora and tibiae washed with brown; antennae fuscous, the scape reddish at base.

Head normal, transverse; vertex and upper half of frons densely finely punctate and pubescent; immediately behind the ocelli are traces of weak cross-striae; against the occiput the surface is smooth and shining; above the antennal insertion is a broad smooth area; lower frons with strong striae converging to the mouth, the lateral striae being continued on either side of the smooth area; median carina of frons strong and complete; cheeks with fine pubescence and sparse fine punctures; eyes large, shortly pubescent. Antennal scape long and slender; pedicel one-third longer than its greatest width; funicle 1 slightly longer than the pedicel, 2 hardly shorter than 1, 3 and 4 small, 3 wider than long, 4 transverse; club compact, joints 1-5 each less than twice as wide as long. Thorax stout; parapsidal furrows not evident; scutum finely confluent indefinitely punctate with a reticulate tendency, and with fine dense pubescence; scutellum with similar stronger sculpture, but smooth posteriorly; spine on metanotum long, narrowly triangular, acute, horizontal, projecting over basal segment of abdomen; propodeum short, densely punctate and with fine pubescence, its posterior margin not carinate, almost straight, armed at the posterior angles with a stout tooth that projects outwardly. Forewings hardly reaching beyond apex of abdomen; broad; subhyaline or lightly brownish; marginal vein a little more than one-half as long as the submarginal, the stigmal vein short. Abdomen two-thirds longer than its greatest width; segment 1 twice as wide posteriorly as basally, no longer than its basal width; 3 one-third longer than 1 and 2 united, twice as long as 4-6 united; 1 and 2 (except posterior margin) strongly striate; 3 shortly or about one-third striate; the rest smooth; 4 and 5, and 3 laterally and posteriorly, with scattered hairs.

♂. Femora, tibiae, and tarsi more dusky than in the female; upper frons and vertex with scattered hairs, almost devoid of sculpture except for a small area between the lateral ocelli and the eyes; parapsidal furrows complete and distinct; sculpture of scutum finer, that of the lateral lobes subobsolete; propodeum very narrowly divided at meson, the dividing carinae subparallel for a short distance, then curving sharply to form the almost straight posterior margin. Antennae one-half longer than the body; black, the scape red at base; scape rather short, no longer than funicle 3; pedicel as wide as long; funicle 1 and 2 subequal, 3 one-half longer than 2, 3-9 subequal.

Habitat.—Queensland: Cairns district (type), three females, two males, April–November; Westwood, three males in December and June; Brisbane, two females in September; Chinchilla, one male in January.

Holotype in the South Australian Museum, I.1992.

As in *varicornis*, the parapsidal furrows are distinct in the male, obsolete in the female. In the specimens from Westwood, Brisbane, and Chinchilla, the metanotal spine is more slender and less horizontal, and the propodeum is more strongly pubescent.

TRIMORUS CONCOLORICORNIS, n. sp.

♀. Length, 1.90 mm. Black, the antennae concolorous; legs deep yellow-brown, the anterior coxae fuscous.

Head normal, transverse; eyes large, lightly pubescent; surface smooth, with a scattered pubescence of fine white hairs; behind the line of the vertex is a path of fine reticulation which is continued behind the eyes; frons above the antennal insertion broadly devoid of hairs; lower frons longitudinally striate; median carina of frons delicate; cheeks with fine pubescence. Antennal scape long and slender; pedicel almost twice as long as its greatest width; funicle 1 one-third longer than the pedicel, 2 as long as 1, 3 short, quadrate, 4 wider than long; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum finely confluent punctate and with fine dense pubescence; scutellum with scattered long hairs, punctate at base, smooth for the rest; metanotal spine long, slender, thorn-like, suberect; propodeum short, foveate along its margins, smooth centrally, the posterior margin gently concave or broadly oblique from the median line, the posterior angles projecting outwardly in the form of acute teeth. Forewings extending a little beyond apex of abdomen; moderately broad; lightly stained; marginal vein hardly more than one-half as long as the submarginal, the stigmal vein short. Abdomen twice as long as its greatest width; segment 1 not much wider posteriorly than basally, as long as its basal width; 2 one-half longer than 1; 3 as long as 1 and 2 united, almost twice as long as 4-6 united; 1 and basal two-thirds of 2 strongly striate, the rest smooth; 4 and 5, lateral and posterior margins of 3, and lateral margins of 1 and 2 with fine scattered hairs.

♂. Unknown.

Habitat.—Queensland: Brisbane, one female in February, A. P. Dodd.

Holotype in the Queensland Museum.

A medium-sized species with smooth head, slender erect metanotal spine, and smooth third segment of abdomen; differs from *punctatus* in the longer first and second funicle joints of the antennae, smooth upper frons, concave posterior margin of the propodeum, and segment 1 of abdomen not widening greatly posteriorly; differs from *breviventris* in the longer abdomen and longer first and second funicle joints.

TRIMORUS BREVIVENTRIS, n. sp.

♀. Length, 1.35 mm. Black, the thorax showing dull reddish, the basal abdominal segment bright reddish-yellow; legs reddish-yellow, the coxae darker; antennae piceous, the first two joints washed with brown.

Head normal; line of the vertex narrowly coriaceous and pubescent, this sculpture continued for a short distance behind the eyes; between the coriaceous area and the posterior margin is a narrow smooth area; median carina of frons complete; frons smooth, shining, the upper frons with a few scattered pubescent punctures, the lower frons densely striate from just above the ventral end of the eyes to the mouth; cheeks smooth, with a few fine hairs. Antennal scape long

and slender; pedicel one-third longer than its greatest width; funicle 1 as wide as the pedicel and plainly longer, twice as long as wide, 2 a little longer than wide, 3 and 4 small and transverse; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum finely confluent punctate and pubescent, in some lights showing faint parapsidal furrows; scutellum finely punctate and pubescent at base, smooth posteriorly; metanotal spine rather long, triangular, slender and pointed at apex, from lateral aspect horizontal and situated high above the base of the abdomen; propodeum very short medially, its posterior border margined and rather deeply concave, its posterior angles in the form of subacute teeth that do not project outwardly. Forewings somewhat variable in length and width; reaching beyond or barely to apex of abdomen; moderately broad or rather narrow; marginal cilia rather short; marginal vein one-half as long as the submarginal, the stigmal vein short. Abdomen short and broad; one-third longer than its greatest width, much narrowed at base; segment 1 short, much wider posteriorly than basally, no longer than its basal width; 3 one-half longer than 1 and 2 united, twice as long as 4-6 united, three-fourths as long as wide; 1 and 2 strongly striate, the rest smooth; 4 and 5, and 2 and 3 laterally, with fine scattered hairs.

♂. Differs from the female as follows: thorax dorsally chestnut-red, the scutellum blackish; legs washed with brown, the posterior tibiae and tarsi dusky; parapsidal furrows delicate but distinct; lateral lobes of the scutum smooth with scattered punctures; scutellum smooth; metanotal tooth shorter, stouter, and suberect; propodeum longer, its posterior angles subacute but not toothed; segment 1 of abdomen one-half wider posteriorly than basally, but no longer than its basal width; forewings extending well beyond apex of abdomen. Antennae almost twice as long as the body; black, the scape brownish-yellow; funicle 1 and 2 each somewhat shorter than 3, which is as long as the scape; 3-9 about subequal.

Habitat.—South Queensland: Mt. Tambourine, 2,000 feet, four females in March and April, A. P. Dodd; Bunya Mountains, 2,500 feet, one male in April, A. P. Dodd. Victoria: Dandenong Ranges, four females in December, A. P. Dodd.

Holotype and allotype in the Queensland Museum. Paratypes in the author's collection.

A medium-sized species, with smooth frons, densely punctate scutum, and smooth third segment of abdomen; differs from *punctatus* and *pulchrithorax* in the smooth upper frons; distinguished from *concoloricornis* in colour and the short broad abdomen.

TRIMORUS STRIATELLUS, n. sp.

♀. Length, 1.00 mm. Deep brown or brownish-black, the basal abdominal segment reddish-yellow; antennae piceous, the scape suffused with yellow; legs, including the coxae, bright yellow a little suffused with dusky.

Head normal, the frons somewhat convex; frons very densely finely striate and with scattered fine hairs, smooth above the antennal insertion, the median carina delicate but complete; vertex to the posterior margin finely densely coriaceous; weak striae occur behind the eyes; cheeks smooth, with a few fine hairs. Antennal scape long and slender; pedicel one-third longer than its greatest width; funicle 1 as wide as the pedicel and slightly shorter, a little longer than wide, 2 as long as wide, 3 and 4 very small and transverse; club compact, joints 1-5 transverse. Thorax stout; scutum densely finely pubescent, the anterior half very finely transversely reticulate, the posterior half finely densely reticulate;

scutellum very finely densely reticulate-granulate; metanotal spine moderately long, broadly triangular, its apex slender and pointed; propodeum short, its posterior margin concave at meson, almost straight for most of its length, the posterior angles armed with a short acute tooth which projects somewhat outwardly. Forewings extending a little beyond apex of abdomen; moderately broad; lightly tinted; marginal vein hardly more than one-half as long as the submarginal, the stigmal vein rather long for the genus. Abdomen short and broad, one-half longer than its greatest width; segment 1 much wider posteriorly than basally, hardly as long as its basal width; 3 almost twice as long as 1 and 2 united; 4-6 united not one-half as long as 3; 1 and 2 strongly striate; 3 with fine dense striae which fail toward posterior and lateral margins; 4 and 5, and lateral margins of 3, with scattered hairs.

♂. Unknown.

Habitat.—South Queensland: Brisbane, two females, A. P. Dodd.

Holotype in the Queensland Museum. Paratype in the author's collection.

A small species with finely striate frons, distinguished by the regular striae of segment 3 of the abdomen.

TRIMORUS NOVISPINUS, n. sp.

♀. Length, 1.25 mm. Head black; thorax fuscous above, blackish laterally, the metanotum and its spine bright red; abdomen black, the first segment reddish; coxae blackish, the legs bright orange-yellow; antennae fuscous, the scape yellow for its basal half, brownish for apical half, the pedicel contrasting clear yellow.

Head normal, the frons a little convex; frons finely densely longitudinally striate and with a noticeable fine pubescence, the upper frons finely sculptured between the striae; above the antennal insertion is a rather small smooth area; median carina of frons complete; line of the vertex finely granulate-reticulate, this sculpture continued for a short distance behind the eyes; behind the granulate sculpture the surface is smooth and shining to the occiput; cheeks smooth, except for scattered fine pubescence; eyes very widely separated, small, shortly pubescent. Antennal scape long and slender; pedicel one-third longer than its greatest width; funicle 1 a little, yet distinctly, longer than the pedicel, two-thirds longer than wide; 2 a little shorter than 1; 3 and 4 small, wider than long; club compact, the joints transverse. Thorax stout; scutum and scutellum very densely finely reticulate-punctate and finely densely pubescent; spine of metanotum long, slender, and acute, with a median carina on its basal half, from lateral aspect the spine is curved and is situated high above the base of the abdomen; propodeum short, strongly reticulate, the posterior margin gently concave, the posterior angles in the form of strong acute teeth which curve obliquely outwardly; there is a small acute tooth on the lateral margins a little in front of the posterior angles. Forewings extending well beyond apex of abdomen; broad; lightly brownish; marginal vein one-half as long as the submarginal, the stigmal vein moderately short. Abdomen one-third longer than its greatest width; segment 1 less than one-half as wide basally as posteriorly, shorter than its basal width; 3 one-half longer than 1 and 2 united, much longer than 4-6 united, slightly more than one-half as long as wide; 1 and 2 strongly striate, polished; 3 finely irregularly longitudinally striate and indefinitely punctate, pubescent laterally, the sculpture failing medially toward the posterior margin; 4 smooth posteriorly, at base densely finely punctate and with long fine pubescence, the punctate area very short medially; 5 with a line of dense fine pubescent punctures at base.

♂. Unknown.

Habitat.—South Queensland: Mt. Tambourine, 2,000 feet, one female in March, A. P. Dodd.

Holotype in the Queensland Museum.

A species with striate frons, long slender metanotal spine, and densely sculptured third segment of abdomen; the additional small tooth on the lateral margins of the propodeum, just in advance of the curved posterior-lateral tooth, will serve to separate it from similarly sculptured species.

TRIMORUS RUGULOSUS Dodd.

Hoplogryon rugulosa Dodd, *Trans. Roy. Soc. S. Aust.*, 38, 1914, 77.

♀. Length, 1.50–1.75 mm.

Head black; thorax deep red, the scutum and scutellum wholly or partly blackish, the pleurae sometimes more or less blackish; abdomen black, the basal segment red; legs bright reddish-yellow, the coxae fuscous; antennae fuscous or dusky-brown, the club sometimes lighter brown.

Head normal, transverse; eyes moderately large, lightly pubescent; frons longitudinally striate except for a smooth central area above the antennal insertion, and with fine pubescence, the upper frons indefinitely sculptured between the striae, the median carina complete; line of the vertex coriaceous; behind the line of the vertex the surface is smooth with fine suboblique striae, which are often faint or absent except laterally; cheeks finely striate, smooth between the striae dorsally, densely sculptured ventrally; mandibles broad, with three strong subequal teeth. Antennal scape long and slender, as long as the next six joints combined; pedicel one-third longer than its greatest width; funicle 1 somewhat longer than the pedicel, twice as long as wide, 2 hardly shorter than 1, 3 and 4 short, wider than long; club compact, joints 1-5 almost twice as wide as long. Thorax stout; scutum with fine pubescence, finely confluent punctate, the punctures failing toward the posterior margin and being replaced by rather strong somewhat irregular longitudinal striae; scutellum finely confluent punctate and pubescent, but smooth medio-posteriorly; spine of metanotum long, rather slender, narrowly triangular, acute, from lateral aspect situated high above base of the abdomen; propodeum short, shining, with several strong striae or carinae, the posterior margin carinate and almost straight, the posterior angles in the form of stout acute teeth that hardly project outwardly. Forewings extending well beyond apex of abdomen; broad; lightly stained brownish; marginal vein a little more than one-half as long as the submarginal, the stigmal vein oblique and moderately long for the genus. Abdomen one-third longer than its greatest width; segment 1 much wider posteriorly than basally, somewhat shorter than its basal width; 2 one-half longer than 1; 3 somewhat longer than 1 and 2 united, fully twice as long as 4-6 united; 1 and 2 strongly striate, smooth between the striae; 3 coarsely longitudinally irregularly striate, rugose-punctate between the striae, the sculpture somewhat variable, the posterior margin narrowly smooth, the surface with scattered hairs; 4 densely punctate or rugose-punctate and with fine pubescence, the posterior margin smooth; 5 narrowly punctate and pubescent at base.

♂. Like the female, but the thorax is mainly bright chestnut-red, the scutum and scutellum somewhat blackish; the posterior tibiae and tarsi are dusky; sculpture of segment 3 of abdomen much finer, 4 and 5 with fine close impressed

reticulation, indefinite punctures and long fine hairs. Antennae almost twice as long as the body; black, the scape dusky-brown, red at base, the pedicel reddish; scape short and stout, no longer than funicle 3; pedicel no longer than wide; funicle 1 and 2 subequal; 3 a little yet distinctly longer than 2; 3-9 subequal.

Habitat.—Queensland: Cairns district (type); Blackall Range; Brisbane; Mt. Tambourine; many females, one male.

Holotype in the South Australian Museum, I.1991.

A medium-sized species with striate frons and coarsely sculptured third segment of abdomen; distinguished by the irregular strong striae on the scutum posteriorly.

TRIMORUS PILOSICORNIS, n. sp.

♀. Length, 1.50 mm. Black; thorax deep dull red, the scutum and scutellum blackish; basal segment of abdomen reddish; antennae fuscous, the scape reddish-yellow; legs dull yellow-brown, the coxae darker.

Head transverse, the frons gently convex, the vertex convex from eye to eye; eyes rather small, very wide apart, sparsely pubescent; frons wholly strongly sparsely longitudinally striate and with sparse fine hairs, the median carina complete; behind the line of the vertex the surface is smooth and shining, with a few fine hairs; cheeks smooth, with a few fine hairs. Antennal scape long and slender; pedicel two-thirds longer than its greatest width; funicle 1 as long as the pedicel, 2 hardly shorter than 1, 3 and 4 small, wider than long; club compact, joints 1-5 much wider than long. Thorax stout; scutum and scutellum coarsely reticulate-punctate or rugose-punctate; spine on metanotum long, slender, narrowly triangular, acute, from lateral aspect curved and situated high above base of abdomen; propodeum short, declivous, smooth with several strong striae or carinae, the posterior margin straight, the posterior angles produced in the form of strong acute teeth which do not project outwardly. Forewings reaching well beyond apex of abdomen; broad; faintly stained; marginal vein two-thirds as long as the submarginal, the stigmal vein long for the genus. Abdomen one-third longer than its greatest width; segment 1 much wider posteriorly than basally, a little shorter than its basal width; 2 a little longer than 1; 3 somewhat longer than 1 and 2 united, fully twice as long as 4-6 united; 1 and 2 strongly striate; 3 strongly foveate-striate at base and without punctures for median third, the lateral third on either side with numerous moderate-sized punctures bearing fine hairs and with traces of impressed striae; 4 and 5 densely punctate and pubescent; 3-5 each with a smooth posterior path.

♂. Agrees with the female, but the punctures on segment 3 of the abdomen are small and scattered, the median striae or foveae very short; segments 4 and 5 with one row of setigerous punctures at base; segment 1 fully as long as its basal width, one-half wider posteriorly than basally. Antennae one-half longer than the body; black, the scape and pedicel testaceous; funicle joints with a pubescence of rather long hairs without a regular arrangement; scape rather short and stout; pedicel no longer than wide; funicle joints subequal, each two-thirds as long as the scape.

Habitat.—Queensland: one female, without further locality, A. A. Girault; Cairns district, one male in August, A. P. Dodd.

Holotype and allotype in the Queensland Museum.

A medium-sized species with striate frons, smooth vertex, coarsely sculptured scutum and scutellum, and long slender metanotal spine; the punctation of segment 3 of the abdomen readily distinguishes it; the long pubescence of the male antennae is an unusual feature.

TRIMORUS FUSCICOXA Dodd.

Hoplogryon fuscicoxa Dodd, *Trans. Roy. Soc. S. Aust.*, 39, 1915, 450.

♀. Length, 1.50 mm. Head black; thorax red-brown, blackish on the pleurae, the scutum medially, and the scutellum; abdomen black, reddish at base; coxae fuscous, the legs reddish-yellow, the tibiae a little dusky apically; antennae wholly black.

Head normal, transverse; vertex and upper frons finely closely reticulate-punctate, without pubescence; median carina of frons strong and complete; lower half of frons smooth, narrowly striate laterally, densely striate against the mouth; cheeks finely densely punctate. Antennal scape long and slender; pedicel one-half longer than its greatest width; funicle 1 one-half longer than the pedicel, two and a half times as long as its greatest width; 2 as long as 1; 3 one-third as long as 2, slightly longer than wide; 4 wider than long; club rather slender, the joints not greatly wider than long. Thorax stout; scutum and scutellum very densely finely reticulate-punctate and with light pubescence, the posterior margin of the scutellum narrowly smooth; tooth of metanotum rather long, moderately slender, acute, its surface finely sculptured; propodeum finely punctate and pubescent, smooth medially, its posterior angles armed with a suberect tooth that projects slightly outwardly. Forewings extending well beyond apex of abdomen: broad; rather deeply smoky; stigmal vein rather long for the genus. Abdomen stout, one-half longer than its greatest width; segment 1 twice as wide posteriorly as basally, shorter than its basal width; 3 two-thirds as long as wide; 1 and 2 strongly striate; 3 densely punctate and pubescent laterally, the median half with strong striae which, except at the median line, are convex outwardly, the striae falling broadly toward the posterior margin which is broadly semi-circularly smooth; 4 and 5 densely punctate and pubescent at base, smooth posteriorly.

♂. Unknown.

Habitat.—North Queensland: Cairns district, 2,500 feet, two females in May, A. P. Dodd.

Holotype in the South Australian Museum, I.5174.

This species may be recognized by the sculpture of segment 3 of the abdomen, in conjunction with the non-striate upper frons.

TRIMORUS DELICATUS, n. sp.

♀. Length, 1.25 mm. Head and abdomen black, the base of the abdomen reddish-yellow; thorax fuscous or dull reddish-brown; legs reddish-yellow, the coxae fuscous; antennae dull brown or fuscous, the scape dusky yellow.

Head normal; frons rather sparsely striate and with scattered pubescence, broadly smooth above the antennal insertion, with fine indefinite punctures between the striae on the upper frons, the median carina complete; vertex densely reticulate-granulate and pubescent, smooth toward the foveate posterior margin; cheeks smooth except for a few minute pubescent punctures; eyes very wide apart, rather small, sparsely pubescent. Antennal scape long and slender; pedicel one-

half longer than its greatest width; funicle 1 as long as the pedicel, 2 a little shorter than 1, 3 and 4 very small and transverse; club compact, the joints transverse. Thorax stout; scutum and scutellum densely, rather finely, reticulate-punctate and pubescent, the sculpture more open and inclined to fail medially against the posterior margin of the scutellum; metanotal spine moderately long, acute, rather narrowly triangular, its surface rugose, from dorsal surface projecting beyond the posterior margin of the propodeum, from lateral aspect horizontal and situated rather well above the base of the abdomen; propodeum short, rugose-striate, its posterior margin uniformly rather deeply concave, its posterior angles blunt and curved a little inwardly. Forewings extending a little beyond apex of abdomen; moderately broad; lightly stained; marginal vein one-half as long as the submarginal, the stigmal vein short. Abdomen a little less than twice as long as its greatest width; segment 1 one-half as wide basally as posteriorly, as long as its basal width; 3 two-thirds as long as wide, a little longer than 1 and 2 united, twice as long as 4-6 united; 1 and 2 strongly striate; 3 with fine striae, between which are fine shallow punctures, the sculpture weaker and inclined to fail medially, without pubescence except for scattered hairs toward lateral margins which are broadly smooth, the posterior margin narrowly smooth, but broadly smooth medially; 4 densely finely granulate and with long pubescence, smooth along posterior margin and narrowly at meson; 5 at base finely granulate and pubescent.

♂. Like the female, but the legs are suffused brownish, delicate parapsidal furrows are evident, and segment 3 of the abdomen is more broadly smooth laterally and posteriorly. Antennae black, the scape dusky-yellow; somewhat longer than the body; pedicel short and stout; funicle 1 one-half as long as the scape; funicle joints, except the last which is distinctly longer, subequal or almost so.

Habitat.—South Queensland: Mt. Tambourine, 2,000 feet, five females, two males, in March, A. P. Dodd.

Holotype and allotype in the Queensland Museum. Paratypes in the author's collection.

A rather small species with striate frons and rather long metanotal spine; distinguished by the sculpture of segment 3 of the abdomen, fine striae between which are shallow punctures.

TRIMORUS IMPRESSUS, n. sp.

♀. Length, 1.00 mm. Head black; thorax dull reddish-brown; abdomen brownish-black, reddish-yellow at base; antennal scape golden-yellow, the next five joints brownish-yellow, the club fuscous; legs golden-yellow, the coxae brown.

Head transverse, the frons distinctly convex; eyes rather small, widely separated, shortly pubescent; frons very finely densely longitudinally striate and with scattered fine hairs, broadly smooth above the antennal insertion; median carina of frons delicate; vertex narrowly granulate-reticulate, smooth toward the occipital margin; cheeks smooth, with a few hairs. Antennal scape long and slender; pedicel two-thirds longer than its greatest width; funicle 1 plainly shorter than the pedicel, slightly longer than wide, 2 as wide as long, 3 and 4 small and transverse; club stout, compact, the joints transverse. Thorax stout; scutum and scutellum finely densely reticulate-punctate and with fine pubescence; spine of metanotum moderately long, acute, rather narrowly triangular; propodeum short, finely sculptured, the posterior margin gently concave, the posterior angles subacute

and not projecting outwardly. Forewings extending slightly beyond apex of abdomen; moderately broad; faintly tinted; marginal vein one-half as long as the submarginal, the stigmal vein normally short. Abdomen two-thirds longer than its greatest width; segment 1 much wider posteriorly than basally, hardly as long as its basal width; 3 almost twice as long as 1 and 2 united, three times as long as 4-6 united, almost as long as wide; 1 and 2 striate; 3 with a network of impressed polygonal reticulation, broadly smooth and with scattered hairs laterally, narrowly smooth posteriorly; 4 smooth posteriorly and narrowly medially, with fine reticulation and fine hairs at base; 5 with a basal line of similar sculpture.

♂. Unknown.

Habitat.—South Queensland: Bunya Mountains, 2,500 feet, two females in April, A. P. Dodd.

Holotype in the Queensland Museum. Paratype in the author's collection.

A small species with finely striate frons, distinguished by the impressed reticulation of segment 3 of the abdomen.

TRIMORUS ACUTISPINUS, n. sp.

♀. Length, 2.00 mm. Head black; thorax deep dusky reddish-brown, the scutum more or less bright red around its margins; abdomen black, the basal segment reddish; coxae fuscous, the legs bright golden-yellow; antennal scape and pedicel dusky-brown, the scape red at base, the funicle joints contrasting golden-yellow, the club black.

Head normal, transverse, the eyes large and faintly pubescent; median carina of frons complete; frons rather strongly longitudinally striate, without a smooth area above the antennal insertion; between the ocelli the surface is rugose-reticulate; behind the line of the vertex to the occipital margin medially are irregular transverse striae, but laterally there are strong suboblique striae which are continued behind the eyes down the cheeks; cheeks strongly sparsely striate; frons, except medially above the antennae, vertex and cheeks with a pubescence of very fine short white hairs. Antennal scape long and slender, as long as the next six joints combined; pedicel one-half longer than its greatest width; funicle 1 one-half longer than the pedicel, more than twice as long as its greatest width, 2 slightly shorter than 1, 3 somewhat wider than long, 4 transverse; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum rather finely confluent or reticulately punctate, the sculpture coarser against the posterior margin medially, with fine pubescence; scutellum with similar punctation and pubescence; metanotal spine subhorizontal, situated high above the base of the abdomen, long, rather narrowly triangular, narrowly acute at apex; propodeum densely finely pubescent and punctate, the posterior margin gently concave at meson, then obtusely angled and straight to the posterior angles which are armed with a strong suberect acute tooth which projects obliquely outwardly. Forewings extending beyond apex of abdomen; broad; lightly brownish; marginal vein one-half as long as the submarginal, the stigmal vein perpendicular, long for the genus, one-fourth as long as the marginal. Abdomen two-thirds longer than its greatest width; segment 1 almost twice as wide posteriorly as basally, no longer than its basal width; 2 one-half longer than 1; 3 slightly longer than 1 and 2 united, somewhat longer than 4-6 united; 1 and 2 strongly striate, their extreme lateral margins punctate and pubescent; 3 uniformly

strongly confluent punctate with a slight longitudinal tendency, the lateral margins densely finely punctate and pubescent, the posterior margin narrowly smooth; 4 with similar large confluent punctures but narrowly smooth at the median line, smooth posteriorly; 5 with rather large punctures at base; 4 and 5 with fine pubescence.

♂. Scutum and scutellum bright chestnut-red; posterior tarsi dusky, the tibiae dusky toward apex. Surface between and behind the ocelli irregularly longitudinally striate and somewhat rugose, but laterally behind the line of the vertex the striae are strong, regular, somewhat oblique and continued down the cheeks; pubescence of propodeum stronger, white and conspicuous, the teeth at the posterior angles shorter than in the female; segment 1 of abdomen one-half wider posteriorly than basally; 3 not as long as 1 and 2 united; 1 and 2 striate, the latter smooth laterally; 3 for its basal two-thirds medially with small dense or confluent punctures, on either side with a few striae, the lateral margins rather broadly smooth except for scattered punctures; 4 and 5 with numerous scattered setigerous punctures, densely coriaceous and pubescent laterally, smooth posteriorly; lateral margins of 1-3 with scattered fine hairs. Antennae very long, twice as long as the body; black, the scape and pedicel reddish-yellow; scape moderately long and stout, no longer than funicle 1; funicle joints almost subequal, 2 and 3 slightly the longest.

Habitat.—South Queensland: Mt. Tambourine, 2,000 feet, one male, three females in February, A. P. Dodd.

Holotype and allotype in the Queensland Museum. Paratypes in the author's collection.

A moderately large species with striate frons and strongly confluent punctate segment 3 of the abdomen. The sculpture of segment 3 is similar in *crassispinus*, but in that species the metanotal spine is of a different shape and is not placed high above the base of the abdomen, the posterior margin of the propodeum is uniformly gently concave and its toothed posterior angles are not suberect, and funicle joints 1 and 2 of the antennae are shorter.

TRIMORUS CASTANEITHORAX Dodd.

Hoplogryon castaneithorax Dodd, *Trans. Roy. Soc. S. Aust.*, 39, 1915, 450.

♀. Length, 1.85 mm. Head black; thorax brownish-black, reddish along the margins of some of the sclerites; abdomen black; coxae fuscous, the legs reddish-yellow, the femora a little dusky; antennae wholly fuscous.

Head normal, transverse; eyes large, wide apart, shortly pubescent; frons striate and with fine scattered hairs, the upper frons definitely punctate between the striae; a broad smooth area occurs above the antennal insertion; median carina of frons distinct and complete; vertex medially between and behind the ocelli finely reticulate-punctate; extending from just behind each lateral ocellus to the eyes is a narrow coriaceous-reticulate area; toward the occipital margin the surface is smooth with scattered long hairs, but laterally weak oblique striae are continued behind the eyes; cheeks smooth with numerous pubescent punctures of moderate size. Antennal scape long and slender; pedicel one-half longer than its greatest width; funicle 1 somewhat longer than the pedicel, almost twice as long as wide, 2 a little longer than wide, 3 and 4 small and transverse; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum and scutellum rather finely confluent reticulate-punctate and with fine pubescence; metanotal tooth strongly

reticulate, large, stout, blunt at apex, projecting a little over the base of the abdomen, from lateral aspect horizontal and not situated high above the base of the abdomen; propodeum short, densely punctate and hardly pubescent, the posterior border margined, uniformly distinctly but not deeply concave, the posterior angles acute in the form of stout teeth which do not project outwardly. Forewings extending a little beyond the apex of the abdomen; broad; rather deeply brownish; marginal vein one-half as long as the submarginal, the stigmal vein rather long and oblique for the genus. Abdomen two-thirds longer than its greatest width; segment 1 one-half as wide basally as posteriorly, as long as its basal width, slightly raised at base; 2 one-half longer than 1; 3 almost twice as long as 2, one-half longer than 4-6 united; 1 strongly striate, with large punctures between the striae laterally; 2 irregularly striate and strongly punctate medially, more definitely punctate laterally; 3 confluent punctate with a marked tendency toward longitudinal arrangement, the punctures moderately large, the median line with small punctures but rather broadly smooth on the posterior third, the posterior margin narrowly smooth, the lateral margins broadly pubescent; 4 with dense moderate-sized punctures bearing long hairs, smooth at the median line and along the posterior margin; 5 densely punctate, shortly so medially, and with long hairs.

♂. Thorax dorsally rich chestnut-red, the scutum and scutellum dusky medially; first segment of abdomen bright red; antennae black, the scape and pedicel brownish-yellow.

Posterior angles of the propodeum subacute, without teeth; segment 1 of abdomen not widening greatly posteriorly, as long as its basal width; 2 wholly striate; 3 with rather dense small punctures, broadly smooth medio-posteriorly and along the posterior margin, smooth laterally except for scattered punctures. Antennae almost twice as long as the body; funicle joints long and subequal, each two-thirds as long as the scape.

Habitat.—North Queensland: Cairns district, 2,500 feet, several males, one female in April and May, A. P. Dodd.

Holotype in the South Australian Museum, I.5175.

Very close to *crassispinus*, but the females differ in several particulars; in *crassispinus* the median carina of the frons is not distinct for its entire length, there is no coriaceous area on the vertex, the punctuation of the scutum and scutellum is coarser, segment 2 of the abdomen is not punctate medially, and segment 3 is not smooth medio-posteriorly.

TRIMORUS CRASSISPINUS, n. sp.

♀. Length, 1.75-2.00 mm. Head black; thorax deep dusky reddish-brown, the scutum and scutellum almost black; abdomen black, deep reddish at base; coxae fuscous, the legs clear reddish-yellow; antennal scape and pedicel dusky-brown, the scape reddish at base, the funicle joints contrasting rather clear yellow, the club fuscous.

Head normal, transverse; eyes large, wide apart, shortly pubescent; frons rather strongly striate, smooth between the striae except for fine punctures bearing fine hairs; a smooth area is present above the antennal insertion; median carina of frons delicate above, not showing on the smooth area; vertex with long fine hairs, medially between and behind the eyes reticulate-punctate, laterally the surface is smooth with a few oblique striae which are continued behind the eyes; cheeks striate and with fine scattered hairs. Antennal scape long and slender;

pedicel one-half longer than its greatest width; funicle 1 as wide and a little longer than the pedicel, 2 as long as the pedicel, 3 and 4 abruptly short, wider than long; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum and scutellum rather strongly confluent reticulate-punctate, with a slight longitudinal tendency on the scutum, and with fine pubescence; metanotal tooth strongly reticulate, large, stout, blunt at apex; projecting beyond the posterior margin of the propodeum, from lateral aspect horizontal and not situated high above the base of the abdomen; propodeum short, densely punctate and finely pubescent; its posterior margin not carinate, uniformly gently concave, the posterior angles in the form of short acute teeth which hardly project outwardly. Forewings extending a little beyond apex of abdomen; broad; rather deeply brownish; marginal vein one-half as long as the submarginal, the stigmal vein long and oblique for the genus, one-fourth as long as the marginal. Abdomen two-thirds longer than its greatest width; segment 1 hardly one-half as wide basally as posteriorly, as long as its basal width; 2 one-half longer than 1; 3 twice as long as 2, one-half longer than 4-6 united; 1 and 2 strongly striate, the latter reticulate-punctate latero-posteriorly; 3 rather strongly regularly confluent punctate with a slight longitudinal tendency, narrowly smooth against the posterior margin, and small punctures are present medially against this smooth path; 4 and 5 with similar punctures, but the smooth posterior path is relatively longer, 5 being very shortly punctate medially; 4 and 5 and lateral margins of 2 and 3 with fine pubescence.

♂. Thorax dorsally rich chestnut-red, the scutum and scutellum dusky medially; antennae black, the scape and pedicel clear yellow.

Frons wholly striate, without a smooth area above the antennal insertion, the median carina complete; posterior border of propodeum delicately margined, the posterior angles subacute but without teeth; forewings extending well beyond apex of abdomen; segment 1 of abdomen not greatly wider posteriorly than basally, as long as its basal width; 2 wholly striate; 3 with small dense punctures which are sometimes divided into longitudinal rows by fine striae, broadly smooth laterally and posteriorly, with scattered hairs laterally; 4 and 5 with larger punctures bearing long hairs, smooth posteriorly. Antennae one-half longer than the body; funicle joints almost subequal in length, each two-thirds as long as the scape.

Habitat.—South Queensland: Mt. Tambourine, 2,000 feet, a series, December-March, A. P. Dodd; Bunya Mountains, 2,500 feet, one female in April, A. P. Dodd.

Holotype and allotype in the Queensland Museum. Paratypes in the author's collection.

The contrast between the sculpture of segment 3 of the abdomen in the sexes is striking.

TRIMORUS VALIDISPINUS, n. sp.

♀. Length, 1.75-2.00 mm. Head black; thorax deep dusky brown, marked here and there with dull red; abdomen fuscous, showing reddish at base; coxae fuscous, the legs reddish-yellow, the tibiae a little dusky; first six antennal joints dusky brown, the scape reddish at base, the club fuscous.

Head normal, transverse; eyes large, wide apart, shortly pubescent; frons rather strongly striate and with scattered hairs, the upper frons definitely shallowly punctate between the striae; a rather narrow smooth area occurs above the antennal insertion; median carina of frons not evident; vertex between

the ocelli and medially to the occipital margin densely reticulate-punctate and with irregular short longitudinal striae, laterally the surface is smooth with oblique striae continued behind the eyes; cheeks densely punctate and with some irregular striae. Antennal scape long and slender; pedicel one-half longer than its greatest width; funicle 1 somewhat longer than the pedicel, almost twice as long as wide, 2 a little longer than wide, 3 and 4 transverse; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum and scutellum moderately-strongly confluent punctate or reticulate-punctate, and with fine pubescence; metanotal tooth as in *crassispinus* and *castaneithorax*; propodeum densely punctate and faintly pubescent, its posterior border lightly margined and deeply concave to receive the base of the abdomen, the posterior angles subacute and not projecting outwardly. Forewings extending a little beyond apex of abdomen; broad; somewhat brownish; venation as in *crassispinus*. Abdomen three-fourths longer than its greatest width; segment 1 much wider posteriorly than basally, as long as its basal width, with a short suberect horn or prominence at base; 2 somewhat longer than 1; 3 twice as long as 2, one-half longer than 4-6 united; 1 strongly striate; 2 strongly striate medially, strongly shallowly punctate laterally; 3 with moderately large confluent punctures with a tendency toward longitudinal arrangement, the extreme median line with some small punctures, pubescent toward lateral margin; 4 and 5 densely strongly punctate and with long hairs, the posterior margin, and sometimes the median line of 4, narrowly smooth.

♂. Unknown.

Habitat.—South Queensland: Bunya Mountains, 2,500 feet, three females in April, A. P. Dodd; Mt. Tambourine, 2,000 feet, one female in February, A. P. Dodd.

Holotype in the Queensland Museum. Paratypes in the author's collection.

It is doubtful whether this species is distinct from *crassispinus* which occurs in the same localities; the main difference lies in the posterior margin of the propodeum, which is broad and feebly concave in *crassispinus*, deeply concave in *validispinus*; the horn or prominence on the base of the abdomen in the latter would seem a specific character; the funicle joints of the antennae are dusky-brown in *validispinus*, but in the other species are paler than the scape and pedicel.

TRIMORBUS TENUIPUNCTATUS, n. sp.

♀. Length, 1.40 mm. Head black; abdomen black, the first segment red; thorax dusky reddish-brown, the margins of the scutum and scutellum, and the metanotum, bright reddish; antennae piceous, the scape and pedicel dusky yellow-brown; legs bright orange-yellow, the coxae fuscous, the tarsi dusky.

Head normal; frons regularly striate up to the line of the vertex, and with scattered pubescence; between the ocelli the surface is reticulate; vertex behind the line of the ocelli obliquely striate, the striae stronger behind the eyes; median carina of frons complete and rather strong; a smooth non-striate area occurs above the antennal insertion on either side of the median carina; cheeks smooth, with scattered hairs; eyes large, lightly pubescent. Antennal scape long and slender; pedicel one-half longer than its greatest width; funicle 1 distinctly longer than the pedicel, fully twice as long as wide, 2 a little shorter than 1, 3 as wide as long, 4 transverse; club compact, joints 1-5 transverse. Thorax stout; scutum and scutellum densely rather finely reticulate-punctate and pubescent, the scutellum with a small smooth area medially against the posterior margin; spine of

metanotum moderately long, acute, very broadly triangular, plainly shorter than its basal width, from lateral aspect suberect; propodeum foveate-striate, very short medially, the posterior border margined, gently concave medially, almost straight for its lateral two-thirds, the posterior angles with suberect teeth which project outwardly somewhat. Forewings extending beyond apex of abdomen; moderately broad; distinctly stained with brown; marginal vein one-half as long as the submarginal, the stigmal vein long for the genus. Abdomen one-half longer than its greatest width; segment 1 one-half wider posteriorly than basally, no longer than its basal width; 3 one-half longer than 1 and 2 united, fully twice as long as 4-6 united; 1 and 2 strongly striate, 2 smooth posteriorly; 3 with dense fine non-pubescent punctures, broadly smooth and impunctate laterally, more narrowly smooth posteriorly; 4 densely finely punctate at base, smooth medially and posteriorly; 4 and 5, and lateral margins of 3, with scattered fine hairs.

♂. Like the female except that the femora and tibiae are lightly washed with brown; the teeth at the posterior angles of the propodeum are small; segment 3 of the abdomen is no longer than 1 and 2 united and is more broadly smooth posteriorly. Antennae one-half longer than the body; black, the scape and pedicel brownish-yellow; funicle joints subequal, each about two-thirds as long as the scape.

Habitat.—South Queensland: Mt. Tambourine, 2,000 feet, five females, two males, in February and March, A. P. Dodd.

Holotype and allotype in the Queensland Museum. Paratypes in the author's collection.

A medium-sized species with striate frons and densely finely punctate third segment of abdomen; very similar to *rufithorax*, but larger, the thorax, coxae, and antennal scape darker, the posterior margin of the propodeum not deeply concave, its posterior angles with projecting teeth.

TRIMORUS RUFITHORAX Dodd.

Hoplogryon rufithorax Dodd, *Trans. Roy. Soc. S. Aust.*, 38, 1914, 77.

♀. Length, 1.00 mm. Head black; thorax bright orange or brownish-yellow, the scutum and scutellum a little dusky; abdomen brownish-black, bright yellow at base; antennal scape yellow, the pedicel and funicle dusky-brown, the club fuscous; legs, including the coxae, bright golden-yellow.

Head normal; frons finely longitudinally striate, with scattered short fine setae, smooth above the antennal insertion; median carina of frons fine and complete; vertex finely reticulate-punctate, behind the eyes showing a few transverse striae, with scattered pubescence; cheeks smooth, with a few fine short hairs. Antennal scape slender, fully as long as the next five joints united; pedicel one-third longer than its greatest width; funicle 1 a little longer than the pedicel, 2 slightly shorter than 1, 3 wider than long, 4 transverse; club compact, the joints transverse. Thorax stout; scutum and scutellum densely finely reticulate-punctate; metanotal tooth short, broadly triangular, finely pointed at apex, its surface finely punctate; from lateral aspect the tooth is situated high above the base of the abdomen; propodeum very short at meson, its posterior margin deeply concave, the posterior angles blunt and not projecting outwardly. Forewings reaching well beyond apex of abdomen; moderately broad; sub-hyaline; marginal vein two-thirds as long as the submarginal, the stigmal vein moderately long and somewhat oblique. Abdomen stout, one-half longer than its greatest

width; segment 1 much wider posteriorly than basally, shorter than its basal width; 2 somewhat longer than 1; 3 somewhat longer than 1 and 2 united, twice as long as 4-6 united; 1 and 2 strongly striate; 3 finely densely punctate, the punctures without a reticulate tendency and without pubescence, with a slight tendency toward arrangement in longitudinal lines, the posterior and lateral margins smooth, with fine hairs laterally; 4 finely sculptured at base and with a few fine hairs.

♂. Unknown.

Habitat.—North Queensland: Cairns district, four females in April-July, A. P. Dodd.

Holotype in the South Australian Museum, I.1993.

A small species with striate frons and finely punctate third segment of abdomen; distinguished from the related species, except *tenuipunctatus*, by the regular punctuation of segment 3 without larger punctures or striae laterally.

TRIMORUS CONDENSUS, n. sp.

♀. Length, 1.25-1.40 mm. Head black; thorax deep dusky red-brown, blackish dorsally; abdomen brownish-black, reddish at base; mandibles red; coxae fuscous, the legs golden-yellow; first six antennal joints dusky brown, the scape reddish at base, the club fuscous.

Head transverse, the vertex descending sharply to the occipital margin, the frons gently convex; eyes large, shortly pubescent; frons finely densely striate and with scattered fine hairs, broadly smooth above the antennal insertion, the median carina delicate on the upper frons, absent on the smooth area; vertex immediately behind the lateral ocelli with a few fine transverse striae which are continued behind and against the eyes; behind these striae the surface is smooth, with numerous fine pubescent punctures which are absent laterally; cheeks smooth, with scattered fine hairs. Antennal scape long and slender; pedicel one-half longer than its greatest width; funicle 1 as long and as wide as the pedicel, 2 a little shorter than 1, 3 wider than long, 4 transverse; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum and scutellum finely pubescent, rather strongly reticulate-punctate, with a tendency toward longitudinal arrangement on the scutum; metanotal tooth reticulate, moderately long, broadly triangular, acute at apex, from lateral aspect horizontal and not situated high above the base of the abdomen; propodeum short, finely sculptured, its posterior margin rather deeply concave, its posterior angles not toothed and not projecting outwardly. Forewings hardly extending beyond apex of abdomen; moderately broad; lightly cloudy; marginal vein two-thirds as long as the submarginal, the stigmal vein normally short. Abdomen one-half longer than its greatest width; segment 1 twice as wide posteriorly as basally, as long as its basal width; 2 slightly longer than 1; 3 one-half longer than 1 and 2 united, twice as long as 4-6 united; 1 and 2 striate; 3 with fine dense non-pubescent punctures which give way laterally to fine longitudinal striae between which are shallow pubescent punctures, the lateral margins narrowly smooth and pubescent, the posterior margin rather broadly smooth; 4 and 5 finely densely punctate and pubescent, smooth posteriorly and at the median line.

♂. Metanotum, margins of scutum and scutellum, and segment 1 of abdomen, bright chestnut-red; coxae fuscous, the legs brownish-yellow.

Posterior margin of propodeum gently concave; abdomen two-thirds longer than its greatest width; segment 1 one-half wider posteriorly than basally, fully

as long as its basal width; 3 no longer than 1 and 2 united, more broadly smooth laterally and posteriorly, the lateral striae fine and faint; forewings extending well beyond apex of abdomen. Antennae two-thirds longer than the body; black, the scape and pedicel brownish-yellow; funicle 1 two-thirds as long as the scape, 2 a little shorter than 1, 3 as long as 1, 3-9 subequal.

Habitat.—South Queensland: Mt. Tambourine, 2,000 feet, many females, two males, in February and March, A. P. Dodd.

Holotype and allotype in the Queensland Museum. Paratypes in the author's collection.

This species may be distinguished from *tenuipunctatus* and *rufithorax* by the presence of lateral striae on segment 3 of the abdomen, the lateral margins not being broadly smooth; from *nigriventris* it differs in its smaller size, absence of a basal prominence on the abdomen, shorter first and second funicle joints, and the greater width of segment 1 of the abdomen posteriorly; it differs from *latispinus* in the absence of the basal abdominal hump, in funicle 1 being no longer than the pedicel, in the shorter abdomen, and the finer punctures of segment 4 and of segment 3 laterally. The male is very similar to *nigriventris* and *crassispinus*, but differs in the absence of strong striae behind the eyes.

TRIMORUS LATISPINUS, n. sp.

♀. Length, 1.80 mm. Black; antennae fuscous, the scape reddish at base; coxae fuscous, the legs reddish-yellow.

Head normal, transverse; eyes large, wide apart, lightly pubescent; frons and vertex shining and with sparse fine pubescence; frons rather strongly striate, indefinitely punctate between the striae on the upper frons, broadly smooth above the antennal insertion; median carina of frons delicate on the smooth area, not discernible on the upper frons; cheeks with scattered punctures bearing fine hairs, with several striae against the eye margins; behind the line of the vertex the surface is punctate and with a few fine subcircular striae, laterally are several strong striae continued behind the eyes, smooth between the striae; between the ocelli the surface is reticulate-punctate. Antennal scape long and slender; pedicel one-half longer than its greatest width; funicle 1 distinctly longer than the pedicel, twice as long as wide, 2 a little yet distinctly shorter than 1, 3 and 4 short and transverse; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum and scutellum rather strongly reticulate-punctate and with fine pubescence; metanotal tooth strongly reticulate, large, stout, as long as its basal width, from lateral aspect horizontal, projecting over and close to the base of the abdomen; propodeum short, finely densely punctate, its posterior margin uniformly rather deeply concave to receive the base of the abdomen, the posterior angles finely acute and not projecting outwardly. Forewings not extending beyond apex of abdomen; moderately broad; lightly clouded; marginal vein one-half as long as the submarginal, the stigmal vein rather long and oblique for the genus. Abdomen three-fourths longer than its greatest width; segment 1 twice as wide posteriorly as basally, as long as its basal width, with a raised hump at base; 2 one-half longer than 1; 3 twice as long as 2 or as 4-6 united; 1 striate; 2 striate but strongly reticulate-punctate laterally; 3 at median third with small close punctures which fail on the posterior third medially, on either side with somewhat larger punctures separated by fine irregular longitudinal striae, the lateral margins

broadly punctate and pubescent, the posterior margin narrowly smooth; 4 and 5 with dense moderate-sized pubescent punctures, smooth along the posterior margin.

♂. Unknown.

Habitat.—Victoria: Dandenong Ranges, two females in December, A. P. Dodd.

Holotype in the Queensland Museum. Paratype in the author's collection.

Close to *nigriventris*, from which it differs in the colour and shorter length of the funicle joints, the less coarse sculpture without a longitudinal arrangement on the scutum, and the shorter basal abdominal segment widening greatly posteriorly; the metanotal tooth is regularly triangular in *latispinus*, its lateral margins diverging broadly from the apex, whereas in *nigriventris* the lateral margins are hardly divergent from the apex, but suddenly diverge toward its base.

TRIMORUS NIGRIVENTRIS Dodd.

Hoplogryon nigriventris Dodd, *Proc. Roy. Soc. Q'land*, 26, 1914, 127.

♀. Length, 2.00 mm. Head black; thorax deep dusky red-brown, touched with red here and there, blackish laterally, the scutum more or less broadly red laterally; coxae fuscous, the legs clear reddish-yellow or lightly washed with brown; antennal scape and club fuscous, the scape reddish at base, the pedicel and funicle joints contrasting clear yellow.

Head normal, transverse; eyes large, wide apart, sparsely pubescent; frons and vertex shining, with scattered fine hairs; median carina of frons present, but not stronger than the striae; frons regularly longitudinally striate, without sculpture between the striae; between the ocelli the surface is reticulate-punctate; behind the line of the ocelli laterally there are oblique striae continued behind the eyes, but medially the surface may be densely punctate with short irregular longitudinal striae to the occipital margin, or sparsely punctate with fine transverse striae; cheeks largely smooth, with a few punctures and traces of fine striae. Antennal scape long and slender; pedicel one-half longer than its greatest width; funicle 1 very distinctly longer than the pedicel, two and a half times as long as wide, 2 a little shorter than 1, 3 abruptly shorter, a little wider than long, 4 transverse; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum and scutellum with fine pubescence; scutum rather strongly reticulate-punctate with a pronounced longitudinal arrangement; spine of metanotum rather long, stout, reticulate-punctate, blunt at apex, its sides subparallel, but broadly diverging at base, from lateral aspect horizontal, situated close to and projecting over the base of the abdomen; propodeum short, finely reticulate and pubescent, the posterior margin regularly moderately deeply concave, the posterior angles subacute and curved a little inwardly. Forewings long, but hardly extending beyond apex of abdomen; broad; rather deeply clouded; marginal vein one-half as long as the submarginal, the stigmal vein normally short. Abdomen twice as long as its greatest width; segment 1 one-half wider posteriorly than basally, a little longer than its basal width, with a raised prominence or horn at base; 2 one-third longer than 1; 3 almost twice as long as 2 or as 4-6 united, three-fourths as long as wide; 1 strongly striate, its prominence smooth at apex; 2 striate, smooth between the striae; 3 with small dense punctures, laterally with irregular longitudinal striae, between which are shallow punctures bearing fine hairs, the lateral margins smooth, the posterior margin narrowly smooth, but more broadly smooth medially; 4 and 5 densely punctate and pubescent, smooth posteriorly and narrowly at the median line.

♂. Agreeing with the female, but the metanotum is bright reddish; segment 1 of abdomen with sub-parallel lateral margins, a little longer than its greatest width, without a prominence; 3 more broadly smooth posteriorly, the punctures somewhat less dense and separated by fine irregular striae, the lateral striae absent, the lateral margins more broadly smooth; punctures on 4 and 5 somewhat sparser. Antennae a little longer than the body; black, the scape and pedicel clear testaceous; funicle 1 a little more than one-half as long as the scape; 2-9 very slightly decreasing in length.

Habitat.—New South Wales: Tweed River, the type male in May. South Queensland: Mt. Tambourine, three females in December; Bunya Mountains, one female in April.

Holotype in the South Australian Museum, I.11036.

TRIMORUS AUSTRALIS Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 79.

♂. Length, 1.40 mm. Dull black; antennal scape and the legs, including the coxae, dull yellow-brown; first abdominal segment reddish.

Frons not striate, except against the mouth. Antennae no longer than the body; scape moderately long and stout; pedicel short, no longer than wide; funicle 1 about three times as long as wide, 2 as long as 1, 3 slightly shorter than 2, 4 a little yet plainly shorter than 3, 4-9 subequal, 10 almost twice as long as 9, one-third longer than 1, a little shorter than the scape. Thorax one-third longer than its greatest width; parapsidal furrows very delicate, wide apart; median lobe of scutum with fine raised longitudinal striae which give way anteriorly to dense fine punctures, the lateral lobes almost smooth; scutellum smooth, except for a few hairs and anterior and posterior foveate lines; metanotum very transverse, not raised, its posterior margin straight, with short straight delimiting lateral carinae, and a short raised median carina in lieu of the usual tooth; propodeum moderately long, densely punctate, its posterior border rather deeply concave, medially with two delicate well-separated carinae that form obtuse angles with the posterior margin, the posterior angles subacute. Forewings broad; lightly brownish; marginal vein somewhat shorter than the submarginal, the stigmal vein normally short. Abdomen two-thirds longer than its greatest width; segment 1 one-third wider posteriorly than basally, as long as its posterior width; 2 slightly longer than 1; 3 as long as 1 and 2 united, somewhat longer than 4-6 united; 1 and 2 striate; 3 smooth but with faint striae at base; 4-6 with scattered hairs.

♀. Unknown.

Habitat.—North Queensland: Cairns district, several males.

Holotype in the South Australian Museum, I.1995.

This species may be the male of either *australicus* Dodd or *atripes* Dodd, which are both from the same locality.

TRIMORUS SPECIOSUS Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 80.

♂. Length, 1.75 mm. Head black; thorax rich chestnut-red, the scutum jet black; abdomen dusky-black, segment 1, 2 except laterally, and 3 except lateral and posterior margins, bright yellow-brown; legs bright orange-yellow; antennae black, the scape deep brown.

Mandibles large, tridentate, the middle tooth small, the outer teeth long and acute. Antennae twice as long as the body; scape moderately long, one-half longer than funicle 1; pedicel no longer than wide; funicle joints very long, 1-4 gradually lengthening, 4 one-third longer than 1, 4-10 subequal. Thorax stout, slightly longer than its greatest width; parapsidal furrows delicate, complete, wide apart; median lobe of scutum with dense rather small punctures, posteriorly with also a few fine irregular longitudinal striae, the lateral lobes punctate anteriorly, smooth posteriorly; scutellum confluent punctate at base, smooth for the rest; metanotal tooth rather stout, acutely triangular; propodeum short, finely rugose, rather narrowly divided at base, the carinate posterior margin running straight and very obliquely from its base medially, the posterior angles not prominent or armed. Forewings very broad, as in *pulcherrimus*. Abdomen three-fourths longer than its greatest width; segment 1 widening posteriorly, a little longer than its basal width; 2 hardly longer than 1; 3 no longer than 1 and 2 united, two-thirds longer than 4-6 united; 1 and 2 striate, the rest smooth; 4-6 and lateral margins of 3 with scattered pubescence.

♀. Unknown.

Habitat.—North Queensland: Cairns district; the type male in September, A. P. Dodd.

Holotype in the South Australian Museum, I.2000.

This species is very similar to *pulcherrimus*, but differs in the black scutum, the denser punctures of the scutum, the punctate base of the scutellum, the different form of the metanotal tooth, and the longer antennae. No female that can be associated with *speciosus* is known. The head of the unique example is mounted on a slide, hence the sculpture could not be ascertained.

TRIMORUS PULCHERRIMUS Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 80.

♂. Length, 1.70 mm. Head black; thorax uniform rich chestnut-red; abdomen yellow-brown at base, segments 2 and 3 bright yellow, segments 4-6 and lateral margins of 2 and 3 brownish-black; legs bright orange-yellow; antennae black, the scape yellow-brown, dusky at apex.

Mandibles large, tridentate, the middle tooth small, the outer teeth long and acute. Antennae one-half longer than the body; scape moderately stout, one-half longer than funicle 1; pedicel hardly longer than wide; funicle joints elongate, 1-4 gradually increasing in length, 4 one-third longer than 3, 4-10 subequal. Thorax stout, a little longer than its greatest width; parapsidal furrows delicate, complete, wide apart; scutum with light pubescence, with numerous small rather scattered punctures, the lateral lobes smooth for their posterior half; posteriorly on the median lobe are a few fine irregular longitudinal striae; scutellum smooth, polished, with foveate margins; metanotum very transverse, rugose, armed medially with an excavated lamella whose posterior margin is raised and projects slightly in the form of a very short blunt tooth; propodeum short, finely rugose, rather narrowly divided at base, the delimiting carinae of the posterior margin straight and running very obliquely from the base medially, the posterior angles rounded and unarmed. Forewings long, very broad, two and a half times as long as their greatest width; lightly stained yellowish; marginal vein plainly shorter than the submarginal, the stigmal vein rather long for the genus. Abdomen one-half longer than its greatest width; segment 1 much wider posteriorly than basally, almost as long as its basal width; 2 one-half longer than

1; 3 a little longer than 1 and 2 united, one-half longer than 4-6 united; 1 and 2, except posteriorly, striate, the rest smooth; 4-6 and lateral margins of 3 with scattered pubescence.

♀. Unknown.

Habitat.—North Queensland: Cairns district, the type male in September, A. P. Dodd.

Holotype in the South Australian Museum, I.1999.

The type is unique; no female is known that can be referred to this species. As the head of the only specimen is mounted on a slide, its sculpture could not be ascertained.

PARAGRYON Kieffer.

Ann. Soc. Sci. Brussels, 32, 1908, 199.

This genus differs from *Trimorus* Forster only in the fact that the metanotum is unarmed; however, as the spine of the metanotum may be reduced to a minute tooth, the character would hardly appear of generic significance. Kieffer (1926) includes in the genus twelve species, in eight of which the wings are wanting or vestigial; the genotype is *P. pedestris* Kieffer (1908), a wingless insect from Europe. In the one Australian species, the wings are well developed; the metanotum is quite flat, and without a tooth or even a median carina.

PARAGRYON GRACILIPENNIS Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 83.

♀. Length, 1.00-1.50 mm. Black, the base of the abdomen bright reddish-yellow; legs, including the coxae, bright golden-yellow, the posterior tibiae and tarsi somewhat dusky; antennal scape yellow at base, dusky toward apex, the antennae otherwise black.

Head normal, transverse, slightly wider than the thorax; smooth and shining, with a few scattered fine hairs; on either side between the lateral ocelli and the eyes there is a small finely reticulate area; frons without a median carina; mouth with a few short converging striae; eyes large, bare, wide apart. Antennal scape long and slender, its articulate joint long, one-third as long as the scape; pedicel twice as long as its greatest width; funicle 1 one-third longer than the pedicel, 2 slightly longer than 1, 3 less than one-half as long as 2, but plainly longer than wide, 4 quadrate; club slender, joints 1-5 slightly wider than long. Thorax stout, from lateral aspect no longer than high, from dorsal aspect a little longer than its greatest width; scutum with scattered fine hairs, with fine surface reticulation, smooth laterally and posteriorly, foveate along lateral and anterior margins; parapsidal furrows absent; scutellum smooth, with a few hairs, its margins foveate; metanotum very transverse, not raised or armed, foveate at base, smooth posteriorly; propodeum moderately short, with rather dense white pubescence, narrowly divided at base medially, the posterior margin gently concave, the posterior angles not armed or prominent. Forewings very long, projecting far beyond apex of abdomen; slender, four and a half times as long as their greatest width, the apex broadly rounded; longest marginal cilia equal to one-fourth the greatest wing width; marginal vein somewhat shorter than the submarginal, the stigmal vein very oblique for the group. Legs slender, the tibiae and tarsi long. Abdomen strongly narrowed at base; three-fifths longer than its greatest width, which is somewhat distinctly greater than that of the

thorax; segment 1 shorter than its basal width, not much wider posteriorly than basally; 2 one-half longer than 1; 3 twice as long as 2, three-fourths as long as wide; 4-6 short, together one-half as long as 3; 1 strongly striate, 2 strongly striate but smooth along lateral and posterior margins; 3 shortly striate at base; remainder of the abdomen smooth; 4 and 5, and 2 and 3 laterally, with scattered fine hairs.

♂. Unknown.

Habitat.—Queensland: Cairns district, the holotype female in May, A. P. Dodd; Chinchilla, one female in February, A. P. Dodd.

Holotype in the South Australian Museum, I.2004.

The Chinchilla specimen is smaller than the holotype, but agrees in other characters.

TRISSACANTHA Ashmead.

Entom. Americana, 3, 1887, 101.—*Pentacantha* Ashmead, *Canad. Entom.*, 20, 1888, 51.—*Propentacantha* Kieffer, *Das Tierreich*, 1926, 241.

This genus may be distinguished from *Trimorus* Forster by the fact that the metanotum bears three teeth. As in certain species of *Trimorus*, it is possible that the parapsidal furrows are present in the male and absent in the female of the same species; the four species previously included in the genus were described from males only. Kieffer (1926) recognized four species, all from North America, and twenty-two species of *Propentacantha* from Europe, Africa, North America, and Australia; the two Australian species, *P. nigrinotum* Dodd and *P. australica* Dodd, are transferred in this paper to *Trimorus*, and possibly certain other species should be similarly treated. The genotype is *T. americana* Ashmead (1887).

My collection contains six specimens, four males and two females, that are described herewith as three species. These forms are closely related, but it is to be noted that in *T. asperata* the lateral teeth of the metanotum are so reduced that the species could be included in *Trimorus* without altering materially the limits of that genus. There are minor characters in the three species that are not found in the Australian species of *Trimorus*; thus, the lateral margins of the propodeum are oblique and converge distinctly toward the posterior angles, and the marginal vein is less than one-half as long as the submarginal; these two characters occur in *Gryonella*, but in *Trimorus* the propodeum is not greatly wider across the anterior angles than at the posterior angles, and the marginal vein is longer.

Key to the Species.

1. Lateral teeth of the metanotum hardly developed; segment 3 of abdomen punctate for at least its basal half *asperata*
Lateral teeth of metanotum apparent; segment 3 of abdomen punctate at base only 2
2. Size larger; scutellum partly sculptured; lateral teeth of metanotum stout *trifurcata*
Size smaller; scutellum smooth; lateral teeth of metanotum small *simulata*

TRISSACANTHA ASPERATA, n. sp.

♀. Length, 1.60 mm. Head black; thorax reddish-brown, the scutum and scutellum dusky-black; abdomen dull reddish-brown, blackish laterally and posteriorly, its basal prominence dark; legs, including the coxae, clear testaceous; antennal scape and pedicel brownish-yellow, the funicle joints dusky-brown, the club fuscous.

Head normal, transverse, the frons a little convex; eyes moderately large, very wide apart, sparsely pubescent; line of the vertex with a delicate transverse groove extending across from the posterior margin of the eyes through the lateral ocelli; frons up to the transverse groove strongly longitudinally striate, smooth between the striae, with a few fine hairs; median carina of frons complete; between the ocelli the surface is reticulate-punctate; vertex behind the transverse groove smooth, with scattered hairs; temples and cheeks smooth with scattered hairs. Antennal scape moderately long and slender; pedicel one-half longer than its greatest width; funicle 1 as long as the pedicel, 2 somewhat shorter and as long as wide, 3 and 4 small and transverse; club compact, joints 1-5 each twice as wide as long. Thorax stout; scutum and scutellum very strongly reticulate and with scattered hairs; metanotum very transverse, rugose, its posterior border straight and finely margined, its posterior angles rounded and faintly prominent, armed medially with a fine rather short suberect acute tooth which bears a median carina; propodeum very short, broad posteriorly, punctate and faintly pubescent, the posterior margin gently concave, the posterior angles acute in the form of very short teeth. Forewings hardly extending beyond apex of abdomen; moderately broad; lightly brownish: marginal vein short for the group, one-third as long as the submarginal, the stigmal vein oblique and moderately short. Abdomen two-thirds longer than its greatest width; segment 1 twice as wide posteriorly as basally, as long as its basal width, with a short suberect blunt prominence at base; 2 no longer than 1; 3 three times as long as 2, twice as long as 4-6 united, three-fourths as long as wide; 1 closely striate, its prominence reticulate, but smooth apically; 2 rather sparsely striate, smooth between the striae; 3 with small dense non-pubescent punctures, laterally with a few fine longitudinal striae, the lateral margins punctate and pubescent, the posterior margin smooth; 4 and 5 densely finely punctate and pubescent, smooth at the median line and along the posterior margin.

♂. Differs from the female as follows: abdomen black, the first two segments reddish; sculpture of scutum densely reticulate-punctate, not as coarse as in the female, the punctures sparse against the lateral margins; parapsidal furrows indicated but obscure; scutellum with confluent punctures on the basal half, smooth on the posterior half; forewings extending well beyond apex of abdomen; segment 1 of abdomen without a prominence, a little longer than its basal width; segment 3 twice as long as 2, punctate for its basal half at the median line, the punctate area laterally and the few lateral striae extending for two-thirds its length, the lateral margins broadly smooth, except for a few pubescent punctures and a small coriaceous area toward the posterior margin; punctures on 4 and 5 sparser than in the female. Antennae one-half longer than the body; black, the scape brownish-yellow; pedicel no longer than wide; funicle joints about subequal, each two-thirds as long as the scape.

Habitat.—South Queensland: Brisbane, one female, A. P. Dodd; Mt. Tambourine, one female in March, A. P. Dodd; Blackall Range, one male in January, A. P. Dodd.

Holotype and allotype in the Queensland Museum. Paratype in the author's collection.

Distinguished from *trifurcata* and *simulata* by the greater extent of the punctation of segment 3 of the abdomen, and the non-development of the lateral teeth of the metanotum. In the key to the species of *Trimorus*, this species would

fall near *nigriventris*, *condensus* and *latispinus*, from which it may be distinguished by the slender metanotal spine, abruptly smooth head behind the line of the vertex, the strongly reticulate scutum, and the shorter marginal vein.

TRISSACANTHA TRIFURCATA, n. sp.

♂. Length, 2.15 mm. Black, the base of the abdomen showing reddish; coxae fuscous, the legs bright reddish-yellow; antennae black, the scape dusky-brown, red at base; mandibles red.

Head slightly wider than the thorax, very transverse; vertex thin, descending sharply to the occipital margin; frons hardly convex; eyes moderately large, bare, very wide apart; mandibles very large, tridentate, the middle tooth small; frons strongly striate and with scattered white hairs, the striae diverging somewhat from the delicate median carina; line of the vertex with two or three fine transverse striae, behind these striae with numerous scattered punctures bearing fine hairs, the punctures smaller laterally; cheeks with scattered pubescent punctures and, against the eyes, with fine striae. Antennae one-half longer than the body; pedicel no longer than wide; funicle 1 two-thirds as long as the scape, a little yet distinctly longer than 2, 2.9 subequal. Thorax stout; scutum very strongly reticulate-punctate and with scattered fine hairs, the punctures smaller medio-anteriorly; scutellum strongly reticulate-punctate laterally, densely punctate at base, smooth medio-posteriorly; metanotum reticulate, transverse, with three teeth, the middle tooth slender and moderately long, the lateral teeth stouter, shorter and blunt; propodeum short, reticulate, with three short longitudinal carinae on either side of the median line, shortly narrowly divided at base, the posterior margin carinate and gently concave, terminating at the lateral angles in a short acute upturned tooth. Forewings extending well beyond apex of abdomen; broad; lightly brownish, more deeply clouded beneath the marginal vein; marginal vein two-fifths as long as the submarginal, three times as long as the stigmal vein, which is long and oblique for the group. Abdomen a little less than one-half longer than its greatest width; segment 1 as long as its basal width, almost twice as wide posteriorly as basally; 2 a little longer than 1; 3 twice as long as 2, or as 4-6 united; 1 and 2 strongly striate, the striae failing laterally on 2; 3 broadly smooth laterally, except for a few pubescent punctures, shortly punctate and with a few fine striae at base, the punctures small, close, and arranged in longitudinal rows, the rest of the segment smooth and shining; 4 and 5 with numerous punctures bearing fine hairs.

♀. Unknown.

Habitat.—South Queensland: Chinchilla, one male in January, A. P. Dodd. Holotype in the Queensland Museum.

This species differs from *simulata* in its larger size, the well-developed lateral teeth of the metanotum, the scutum not being smooth laterally, and the scutellum being partly sculptured.

TRISSACANTHA SIMULATA, n. sp.

♂. Length, 1.55 mm. Black, the metanotum, margins of the pleurae, and base of abdomen showing reddish; coxae dusky yellow-brown, the legs bright yellow washed with brown, the tarsi dusky; antennae black, the scape and pedicel dusky-brown, the former reddish at base; mandibles yellow.

Head transverse, the frons a little convex, the line of the vertex thin, thence descending abruptly to the occipital margin; eyes large, with a few scattered

hairs, very wide apart; mandibles very large, tridentate; frons strongly striate and with scattered fine hairs, the striae diverging somewhat from the median carina which is complete; vertex to the occipital margin smooth, with scattered fine hairs, and with traces of fine transverse striae at the line of the lateral ocelli; cheeks smooth, with scattered fine hairs. Antennae one-half longer than the body; scape moderately long and slender; pedicel no longer than wide; funicle joints subequal in length, each two-thirds as long as the scape, with short dense pubescence. Thorax stout; scutum with numerous long fine white hairs, and with open shallow reticulate punctures or open reticulation, the sculpture closer and more definitely punctate anteriorly, absent against the lateral margins; parapsidal furrows not evident; scutellum smooth, with scattered indefinite punctures bearing long fine hairs, with a few punctures on either side at its base; metanotum transverse, the posterior angles prominent and obtuse, the posterior margin finely carinate and somewhat concave to the slender short median tooth, from lateral aspect the posterior angles are raised in the form of blunt teeth; propodeum short, pubescent laterally, with several short striae or carinae medially, shortly narrowly divided at the median line, the posterior margin gently concave and terminating laterally in a short tooth. Forewings extending well beyond apex of abdomen; broad; lightly brownish; marginal vein two-fifths as long as the submarginal, three times as long as the stigmal vein which is rather long and oblique. Abdomen stout, one-half longer than its greatest width; segment 1 two-thirds wider posteriorly than basally, as long as its basal width; 2 one-fourth longer than 1; 3 as long as 1 and 2 united, twice as long as 4-6 united; 1 and 2 rather finely striate, the latter smooth laterally and against its posterior margin; 3 at base medially shortly punctate, the punctures small and close, on either side finely striate for about one-half its length, otherwise smooth, including the lateral margins broadly; 4 and 5, and lateral margins of 2 and 3, with numerous long fine white hairs arising from small punctures.

♀. Unknown.

Habitat.—Queensland: Gogango, 40 miles west of Rockhampton, two males in November, A. P. Dodd.

Holotype in the Queensland Museum. Paratype in the author's collection.

GRYONELLA Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 84.

This genus differs from *Teleas* Latreille in having the metanotum bidentate. The large mandibles, swollen posterior femora, and spiny legs distinguish it from the other Australian genera. Five species are recognized here; of these, four are known in the female sex, and one in the male sex; it is possible, however, that *G. crawfordi* may be the male of either *G. bruesi* or *G. affinis*. The genotype is *G. crawfordi* Dodd.

Key to the Species.

1. Vertex broadly rounded; scutum and scutellum with fine sculpture; forewings rather narrow *platythorax*
Vertex sharp; scutum strongly reticulate or with large punctures; forewings broad 2
2. Femora yellow; punctures of scutum not reticulate; metanotal teeth large *magnidens*
Femora dark; punctures of scutum reticulate; metanotal teeth small 3
3. Frons longitudinally striate; male *crawfordi*
Frons transversely striate; females 4

4. Posterior margin of propodeum gently concave; segment 1 of abdomen less than twice as wide posteriorly as basally; segment 3 with weak striae at base *bruesi*
- Posterior margin of propodeum rather deeply concave; segment 1 of abdomen more than twice as wide posteriorly as basally; segment 3 with weak punctures at base *affinis*

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GRYONELLA CRAWFORDI Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 84.

♂. Length, 1.40-1.80 mm. Black; antennae wholly black; coxae black, the femora and tibiae dusky-black, the tarsi dusky-yellow, the trochanters and base and apex of femora and tibiae bright yellow; mandibles yellowish.

Head transverse, no wider than the thorax, the vertex thin and descending sharply to the occiput, the frons gently convex; ocelli rather large, close together; eyes very wide apart, bare; frons rather finely longitudinally striate, the striae converging above towards the ocelli; on the lower half of the frons several of the inner striae encircle the antennal insertion; line of the vertex with irregular transverse striae; behind the ocelli to the occiput the surface is smooth; cheeks smooth; head with scattered long fine hairs; mandibles long, bidentate. Antennae slightly longer than the body; scape rather short, one-third longer than funicle 1; pedicel no longer than wide; funicle 1 slightly longer than 2, 2-9 almost subequal. Thorax stout, a little longer than wide; pronotum narrowly visible at the lateral angles; scutum with scattered hairs, the parapsidal furrows delicate, complete, wide apart, and a little curved; lateral lobes of scutum finely shallowly rugose inwardly, almost smooth laterally; median lobe of scutum with an open network of very large shallow reticulate punctures, but on the posterior half on either side laterally there are two or three irregular striae or rugae parallel with the parapsidal furrows; scutellum reticulate at base, smooth for the rest, with scattered hairs; metanotum punctate, transverse, its posterior margin concave and bidentate, the teeth small and well-separated; propodeum short, hidden medially by the metanotum, broad at base and sloping inwardly to the posterior angles, the posterior margin uniformly concave, the posterior angles subacute or shortly toothed. All femora somewhat swollen; posterior femora much swollen, two and a half times as long as their greatest width, their tibiae spinose at apex, their tarsi short. Forewings reaching well beyond apex of abdomen; moderately broad, the apex broadly rounded; lightly stained brownish; venation dark; marginal vein somewhat less than one-half as long as the submarginal, about four times as long as the short stigmal vein. Abdomen hardly wider than the thorax, one-half longer than its greatest width; segment 1 narrowed at base, as long as its basal width, almost twice as wide posteriorly as basally; 2 no longer than 1; 3 two-thirds as long as wide, as long as 1 and 2 united, less than twice as long as 4-6 united; 1 and 2 densely striate, the lateral and posterior margins of 2 smooth; 3 smooth, its basal one-third to one-half medially with rather dense short narrow longitudinal punctures; 4-6 smooth, with scattered long fine hairs; similar scattered hairs occur on 1-3 laterally and 3 posteriorly.

♀. Unknown.

Habitat.—Queensland: Proserpine, the type male in October; Westwood, two males in November and December. New South Wales: Muswellbrook, four males in October.

Holotype in the South Australian Museum, I.2008.

GRYONELLA BRUESI Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 85.

♀. Length, 1.50 mm. Black; antennae wholly black, the prominence yellow; coxae and femora black or fuscous, the tibiae and tarsi clear yellow.

Head transverse, the vertex thin and descending sharply to the occipital margin, the frons somewhat convex; eyes moderately large, very wide apart, lightly pubescent; frons transversely striate, the striae curving sharply to become longitudinal laterally, dense on the lower frons, on the upper frons sparse and with shallow punctures between, bearing fine white hairs; line of the vertex with transverse striae, the declivous area behind the ocelli smooth, with scattered fine punctures bearing fine white hairs and with traces of fine striae; cheeks smooth, with a few hairs; mandibles very long, bidentate. Antennal scape moderately long; pedicel one-half longer than its greatest width; funicle 1 a little longer than wide, 2 as wide as long, 3 and 4 small and transverse; club six-jointed, compact, the joints much wider than long. Thorax hardly longer than its greatest width, somewhat convex above; pronotum narrowly visible at the lateral angles; scutum with an open network of large reticulate punctures and laterally on either side with several irregular longitudinally-oblique striae; scutellum with similar reticulate punctures and with irregular longitudinal striae; punctures of scutum and scutellum bearing long fine white hairs; metanotum reticulate-punctate, transverse, its lateral margins oblique, its posterior margin gently concave and shortly bidentate, the teeth well apart; propodeum finely sculptured, short, very short medially, the posterior margin gently concave, the posterior angles subacute, the lateral margins sloping obliquely inwardly to the posterior angles. Posterior femora much swollen, about twice as long as their greatest width. Forewings hardly extending beyond apex of abdomen; moderately broad, lightly stained brownish; venation distinct, the marginal vein one-third as long as the submarginal. Abdomen somewhat wider than the thorax, one-third longer than its greatest width; segment 1 almost as long as its basal width, less than twice as wide posteriorly as basally; 3 a little longer than 1 and 2 united, two-thirds as long as wide, twice as long as 4-6 united; 1 and 2 rather strongly striate; 3 weakly striate at base; the rest smooth; 4 and 5, 2 and 3 laterally, and 3 posteriorly, with scattered long fine hairs.

♂. Unknown.

Habitat.—North Queensland: Cairns district, the holotype female in January. Holotype in the South Australian Museum, I.2009.

GRYONELLA AFFINIS, n. sp.

♀. Length, 1.50 mm. Black; antennae wholly black; coxae and femora dusky-black, the tibiae and tarsi bright yellow; antennal prominence and the mandibles yellow.

In general appearance and structure very similar to *bruesi*. Vertex of head more rounded than in *bruesi* and descending less sharply to the occiput; sculpture of frons similar; vertex smooth laterally from the ocelli; behind the ocelli to the occiput smooth, with scattered minute punctures bearing fine white hairs; cheeks smooth with a few hairs. Antennal scape moderately long; pedicel one-half longer than its greatest width; funicle 1 a little longer than its greatest width, 2 as wide as long, 3 and 4 transverse; club compact, the joints much wider than long. Scutum with the reticulate punctures much larger and less numerous than in *bruesi* and with about two irregular oblique striae on either side laterally;

scutellum with large reticulate punctures; scutum and scutellum with sparse long fine white hairs; metanotum very transverse, armed posteriorly with two short blunt teeth which are widely separated, the posterior margin deeply concave; posterior margin of propodeum rather deeply concave, the posterior angles fine but not toothed. Forewings hardly extending beyond apex of abdomen; moderately broad; lightly brownish; venation thick, deep brown; marginal vein one-third as long as the submarginal. Abdomen distinctly wider than the thorax, one-third longer than its greatest width; segment 1 as long as its basal width, greatly widening posteriorly, where it is more than twice as wide as at base; 2 no longer than 1; 3 plainly longer than 1 and 2 united; 1 rather finely densely striate; 2 finely densely striate, but smooth laterally; 3 at base medially with a number of weak narrow punctures; the rest smooth; 4 and 5, 2 and 3 laterally, and 3 posteriorly, with scattered long fine hairs.

♂. Unknown.

Habitat.—North-west New South Wales: Moonie River, one female in October, A. P. Dodd.

Holotype in the Queensland Museum.

Differs from *bruesi* in several minor characters, namely: the smooth area between the lateral ocelli and the eyes; the larger less numerous reticulate punctures on the scutum; the more deeply concave metanotum with the teeth more pronounced; the rather deeply concave posterior margin of the propodeum; the greater width of the first abdominal segment posteriorly; and the absence of striae at the base of segment 3.

GRYONELLA MAGNIDENS, n. sp.

♀. Length, 1.85 mm. Black; antennal scape bright reddish-yellow, the pedicel and funicle joints suffused with yellow, the club black; legs bright reddish-yellow, the coxae fuscous; mandibles red.

From lateral aspect the frons is gently convex to the line of the ocelli, the vertex precipitous from the ocelli to the occiput; from frontal aspect, the head is one-third wider than long, the frons very broad; head shining; lower half of frons transversely striate, the striae curving laterally to the ventral margin; upper frons with broad sub-obsolete transverse striae between which are numerous small punctures bearing fine short hairs; behind the line of the vertex the surface bears fine transverse striae between which are fine scattered punctures bearing fine hairs; cheeks smooth with scattered pubescence; mandibles very large; eyes large, very wide apart, with a few hairs. Antennal scape moderately long and stout; pedicel one-half longer than its greatest width; funicle 1 somewhat distinctly longer than the pedicel, twice as long as its greatest width; 2 shorter than 1, scarcely longer than wide; 3 and 4 transverse; club compact, six-jointed, joints 1-5 transverse. Thorax as wide as long, its dorsal surface somewhat convex; scutum with numerous hairs, medially with large shallow sub-obsolete punctures, which are small, dense, and distinct toward the declivous anterior margin, and with a few irregular transverse striae toward the posterior margin; laterally there are irregular longitudinally-oblique striae and shallow punctures, the innermost striae on either side almost meeting at the posterior margin; scutellum smooth, with a few pubescent punctures; metanotal plate with two stout blunt coarsely-striate teeth, the posterior margin rather deeply concave almost to its base; propodeum very short, hidden medially by the metanotum, its lateral margins oblique, its posterior

margin uniformly gently concave to the subacute posterior angles, its surface finely sculptured. Forewings not extending beyond apex of abdomen; moderately broad; lightly brownish; venation fuscous, distinct; marginal vein one-fourth as long as the submarginal. Posterior femora greatly swollen. Abdomen one-third longer than its greatest width, a little wider than the thorax; segment 1 broad, its basal width almost twice its length and two-thirds its posterior width; 2 no longer than 1; 3 one-third longer than 1 and 2 united, two-thirds longer than 4-6 united, two-thirds as long as wide; 1 strongly densely striate, reticulate at base; 2 densely striate, smooth posteriorly, with dense pubescence laterally; 3 densely minutely punctulate at base medially, smooth for the rest, with scattered short fine hairs posteriorly, with longer denser pubescence laterally; 4 and 5 smooth basally and posteriorly, in between the smooth areas with dense pubescence and fine surface sculpture.

♂. Unknown.

Habitat.—South Queensland: Bunya Mountains, 2,500 feet, Dalby district, one female in April, A. P. Dodd.

Holotype in the Queensland Museum.

Distinguished from *crawfordi*, *bruesi*, and *affinis*, by the yellow femora, non-reticulate scutum, large stout metanotal teeth, and the broad base of the abdomen.

GRYONELLA PLATYTHORAX, n. sp.

♀. Length, 1.80 mm. Black; antennal scape black, the remaining joints dusky yellow-brown; mandibles red; coxae and femora black, tibiae dusky-brown, trochanters, base and apex of tibiae, and the tarsi, bright reddish-yellow.

Vertex of head rounded, not sloping sharply behind the lateral ocelli; from frontal aspect the head is one-half wider than long; frons very gently convex; vertex finely densely transversely striate and coriaceous, and with an extremely short inconspicuous fine pubescence, the striae failing toward the occipital margin; frons densely transverse-circularly striate, coriaceous above, shining on the lower half, on either side ventrally with a patch of longer pubescence; cheeks with similar fine sculpture to the vertex, but the striation is longitudinal; mandibles very long. Antennal scape long and slender; pedicel one-half longer than its greatest width; funicle 1 distinctly longer than the pedicel, twice as long as its greatest width, 2 slightly longer than wide, 3 and 4 very transverse; club compact, six-jointed, joints 1-5 very transverse. Thorax flat dorsally, no longer than its greatest width; pronotal angles rounded and prominent; parapsidal furrows absent; pronotum, scutum, and scutellum very densely finely reticulate and with a number of small scattered punctures, without pubescence; metanotal plate broad, projecting, its lateral margins oblique, its posterior margin lightly concave and bidentate, its surface densely longitudinally striate; propodeum short, visible laterally, finely sculptured, the posterior margin concave, the posterior angles acute and tooth-like. Forewings not reaching beyond apex of abdomen; rather narrow, three and a half times as long as their greatest width, the apex broadly rounded; lightly stained brownish; marginal cilia extremely short; venation deep brown, the marginal vein one-fourth as long as the submarginal. Posterior femora much swollen. Abdomen no wider than the thorax, one-third longer than its greatest width; segment 1 broad at base, one-half wider posteriorly than basally, one-half as long as its basal width; 2 one-half longer than 1; 3 one-half as long as wide, no longer than 1 and 2 united, one-half longer than 4-6 united; 1 densely,

rather finely, striate, but finely pubescent laterally; 2 with a median basal area of short very strong striae; rest of 2, and 3, smooth, with a rather dense pubescence of fine short hairs arising from minute punctures; pubescence longer on 4 and 5.

♂. Unknown.

Habitat.—Queensland: Gogango, 40 miles west of Rockhampton, one female in February, A. P. Dodd.

Holotype in the Queensland Museum.

A very distinct species, readily distinguished by the more rounded vertex of the head, the flat dorsal surface and fine sculpture of the thorax, and the narrower forewings.

XENOMERUS Walker.

Entom. Mag., London, 3, 1836, 355.

Walker erected this genus on the male sex of *X. ergenna* Walker from England; the female of this species has apparently not yet been discovered; the genus is unknown outside England and Australia; *Xenomerus* can be distinguished from *Trimorus* by the pedicellate-nodose flagellar joints of the male antennae, and the deep abbreviated parapsidal furrows. The Australian species are closely related, and can be separated by means of the following key:

1. Thorax brownish; scutum smooth *flavicornis*
Thorax black; scutum with impressed reticulation, except posteriorly 2
2. Head much wider than the thorax; metanotal tooth rather long; funicle 2 in female plainly shorter than 1 *laticeps*
Head a little wider than the thorax; metanotal tooth short; funicle 2 in female hardly shorter than 1 *varipes*

XENOMERUS VARIPES Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 83.—*X. dubius* Dodd, *ibid.*, p. 84.

♂. Length, 1.25 mm. Black; coxae fuscous, the legs golden-yellow, the posterior tibiae and tarsi dusky; antennal scape and pedicel yellow, the flagellar joints fuscous with their stalks pale yellow; mandibles yellow.

Head somewhat wider than the thorax, very transverse, smooth or nearly so; lower half of frons longitudinally striate; eyes large, bare, wide apart; mandibles rather long, tridentate. Antennae long and slender, somewhat longer than the body; scape long and slender; pedicel a little longer than wide; funicle joints pedicellate-nodose, bearing very long hairs which are twice as long as the joints; funicle 1 one-half longer than wide, slightly swollen but without a stalk; 2 twice as long as 1, 2-4 subequal, 5-9 subequal, each a little longer than 2; 2-4 each with a slender basal stalk and terminal node; 5 with a shorter stalk at each end, the node depressed medially; 6-9 without a basal stalk, with two nodes separated by a short stalk and with a long terminal stalk; apical joint no longer than the penultimate, a little swollen at its base. Thorax no longer than its greatest width, a little longer than high; scutum sharply declivous anteriorly, foveate along the lateral margins, its surface with fine impressed reticulation, but smooth for the posterior third; parapsidal furrows present on the posterior half, as deep abbreviated grooves wide apart; scutellum smooth, foveate along anterior and posterior margins; metanotum transverse, armed medially with a short acute broadly triangular tooth; propodeum short, unarmed, pubescent, narrowly divided medially, the posterior margin gently concave. Legs slender,

the tibiae and tarsi long. Forewings extending well beyond apex of abdomen; broad; hyaline; discal cilia fine and sparse; venation terminating at one-half the wing length, the marginal vein somewhat shorter than the submarginal, the stigmal vein rather oblique. Abdomen one-third longer than its greatest width, no wider than the thorax; segment 1 much wider posteriorly than basally, hardly as long as its basal width; 3 one-half longer than 1 and 2 united, twice as long as 4-6 united; 1 strongly striate; 2 striate at base, smooth laterally and posteriorly; 3 shortly striate at base; the rest smooth; 4-6, and 2 and 3 laterally, with scattered hairs.

♀. Length, 1.35 mm. Posterior tibiae and tarsi clear yellow; discal cilia of forewing moderately coarse and dense. First six antennal joints yellow, the club black; scape long and slender, as long as the next five joints combined; pedicel twice as long as its greatest width; funicle joints a little narrower than the pedicel; 1 somewhat shorter than the pedicel, twice as long as its greatest width; 2 hardly shorter than 1; 3 and 4 abruptly shorter, quadrate; club compact, six-jointed, joint 2 the largest, 1 and 2 slightly wider than long, 3-5 each twice as wide as long.

Habitat.—North Queensland: Cairns district, one male, two females, in May-August, A. P. Dodd.

Holotype in the South Australian Museum, I.2005.

The sexes were originally described as distinct species.

XENOMERUS LATICEPS Dodd.

Trans. Roy. Soc. S. Aust., 40, 1916, 28.

♀. Length, 1.20 mm. Black, the abdomen reddish at extreme base, the tip of the metanotal spine whitish; legs golden-yellow; antennae wholly black.

Head very transverse, distinctly wider than the thorax, the vertex very thin and descending abruptly to the posterior margin; frons smooth and shining, with a strong median carina; lower frons with longitudinal striae; behind the line of the vertex the surface bears fine scaly reticulation; cheeks smooth. Antennal scape long and slender; pedicel two and a half times as long as its greatest width; funicle joints narrower than the pedicel; 1 two-thirds as long as the pedicel; 2 two-thirds as long as 1, one-half longer than wide; 3 and 4 a little wider than long; club six-jointed, as in *varipes*. Thorax stout, as wide as long, from lateral aspect somewhat higher than long; parapsidal furrows and sculpture of scutum and scutellum as in *varipes*; metanotal tooth rather long and acute; propodeum short, declivous, densely punctate, without noticeable pubescence. Forewings normal; hyaline; discal cilia moderately dense and coarse; venation as in *varipes*. Abdomen one-third longer than its greatest width; segment 1 a little shorter than its basal width, much wider posteriorly than basally; 2 slightly longer than 1; 3 twice as long as 2; 1 and 2 strongly striate; 3 striate medially for about two-thirds its length, smooth laterally and posteriorly; 4 and 5 finely reticulate at base.

♂. Unknown.

Habitat.—New South Wales. Hawkesbury River, the type female in October, A. A. Girault.

Holotype in the South Australian Museum, I.5428.

Differs from *varipes* in the wider head, dark antennae, shorter second funicle joint, and the longer metanotal tooth.

XENOMERUS FLAVICORNIS Dodd.

Trans. Roy. Soc. S. Aust., 38, 1914, 84.

♀. Length, 1.20 mm. Head black; thorax dusky-brown; abdomen black, the basal segment yellow; legs golden-yellow, the coxae fuscous; first six antennal joints yellow, the scape and pedicel somewhat dusky, the club black.

Head smooth, or nearly so, the lower frons with striae converging to the mouth. Antennae as in *varipes*, except that the funicle joints are more distinctly narrower and shorter than the pedicel. Scutum and scutellum, according to the original description, smooth with a few scattered pin-punctures. Forewings hyaline, the discal cilia moderately coarse and dense. Abdomen stout, one-fourth longer than its greatest width; segment 1 distinctly shorter than its basal width; striation of segments as in *varipes*.

♂. Unknown.

Habitat.—North Queensland: Cairns district, the holotype female in September, A. P. Dodd.

Holotype in the South Australian Museum, I.2007.

The holotype is mounted on a slide; hence the sculpture of the thorax could not be re-examined. The species is very close to *varipes*, but differs apparently in the smooth scutum and the colour of the thorax and the base of the abdomen.

NOTES ON AUSTRALIAN DIPTERA. XXIII.

By J. R. MALLOCH.

(Communicated by I. M. Mackerras.)

(Thirty Text-figures.)

[Read 26th March, 1930.]

Family TACHINIDAE.

The matter presented in this paper is to be considered as supplementary to that in my preceding paper in this series in which I gave a partial revision of the Tachinidae of Australia, with generic key, the material upon which it is based having been received from Dr. I. M. Mackerras some months after the completion of that paper.

Despite the fact that this additional material greatly increases the number of genera and species now known to me, the recorded total in the two papers must fall far short of the number actually occurring in Australia and discoverable through intensive collecting.

No dipterous fauna, with the possible exception of that of New Zealand, has had as much interest for me as that of Australia, and I regret very much that I am unable to devote to it the time necessary for its thorough elucidation, and to carry my investigation of it into the field, without which latter course it is not possible to form a definite opinion of many of the inter-relationships, and also an impossibility to present a proper consideration of the systematics of the family now dealt with.

I do not present in this paper an extended generic synopsis, as it will be found necessary to do that later when a larger percentage of the genera are known, but in all cases where I record genera either new or previously described from other faunal regions and not included in my published key, I add sufficient data to permit of their being relegated to their proper place in that key, and in the case of those genera with uncarinate face and haired propleura I give a synopsis.

A striking feature of the Australian members of this family is the frequent occurrence of hairs on the centre of the propleura, these being found in genera in several of the tribes which are evidently quite unrelated to each other, if one is to judge relationships by the characters usually employed for this purpose in other faunal regions.

I have just received, in answer to a request of mine, type material of most of the species described by Mr. C. H. Curran from Australia, through the generosity of Dr. Walther Horn of the Deutsches Entomologisches Museum, Berlin-Dahlem, and offer a few notes on them herein.

Tribe PHASINI.

Genus STRONGYGASTER Macquart.

This genus in its emended form was utilized for the reception of two Australian species by Curran, as listed in my catalogue. I have before me paratype females of the species.

The genus *Strongygaster* was erected by Macquart in 1833, and in it he placed but one species, *globulus* Meigen, but in his next reference to the genus, some two years later, he included two other species, all three European. It is thus clear that the only originally included species must be accepted as the genotype. In view of this fact, it is of interest to note that *globulus* Meigen is included in the genus *Tamiclea* Macquart in the Catalogue of Palaearctic Diptera, Part 3, page 568. We are, however, not particularly concerned with the peregrinations of the European species and are rather compelled to discover if possible whether the genus name *Strongygaster* (emend. *Strongylogaster* Blanch., nec Dahlbohm, Hymen.) can be used for the Australian species referred to it.

Macquart laid particular stress upon the wing venation, using as the distinguishing character in his key "Première cellule postérieure à petiole très-court", and in his figure he shows the petiole much as I figured it for *Gymnosoma rotundata* Meigen in a recent paper in this series, and not at all like that of *H. lepidofera* Malloch. The two species described by Curran have the first posterior cell with a long petiole as in *lepidofera*. I should also hesitate to describe the abdomen of either of these species as "ventre rond", Macquart's stated meaning of his generic name.

In view of these facts I propose to reject the use of *Strongygaster* for the Australian species and retain *Hyalomyia*.

I have now a number of additional species of the genus from Australia.

Genus HYALOMYIA Robineau-Desvoidy.

The genitalia of the females of this genus present in some cases good structural characters for specific distinction, but it is not always an easy matter to relate the sexes of the species. I figure the genital segments of some of the species to show the peculiar structures referred to, which, incidentally, are quite similar in general nature to those of some North American species placed in *Alophora*.

I have attempted to work up all of the material now in my hands and to include in the key below the two species placed in *Strongylogaster* by Curran, as well as his Australian species placed in *Alophora*. I expect that there will be many more species of the genus found in Australia.

Key to the Species.

1. Apical pair of scutellar bristles well developed and situated at tip 2
 Apical pair of scutellar bristles generally short and fine, much shorter than the lateral sub-basal pair, situated well before tip 6
2. Petiole of the first posterior cell of wing at least as long as outer cross-vein, and not less than four times as long as the inner cross-vein; bend of fourth vein rounded, but the whole presenting the appearance of a hockey stick, the longitudinal portion much longer than the forwardly directed portion; species not more than 5 mm. in length; lower plate of female genitalia as in Figure 1 *normalis* Curran
 Petiole of first posterior cell of wing not more than two-thirds as long as outer cross-vein, and not twice as long as inner cross-vein; bend of fourth vein broadly and rather evenly rounded, the apical section forming an almost regular rounded arc; species not less than 6 mm. in length 3
3. Large species, about 10 mm. in length; epistome not at all projecting in profile *nigrisquama* Malloch
 Smaller species, not more than 8 mm. in length; epistome quite distinctly projecting in profile 4
4. Dorsum of abdomen in male uniformly golden or brassy dusted, without dark marks, the incurved ventral portions of the tergites densely pale-grey dusted; wings

- greyish hyaline, darkened along basal half of costa, most conspicuously so in the subcostal cell; thorax with four broad black dorsal vittae, the submedian pair extending to about midway between suture and hind margin, and twice as wide behind as before the suture, the vittae presuturally separated by conspicuous whitish-dusted intervening areas, the postsutural region golden-yellow dusted *chrysis*, n. sp.
- Dorsum of abdomen not uniformly dusted, variously marked with black; thorax not marked as above, the postsutural area broadly black centrally 5
5. Scutellum entirely black, slightly shining; area between the submedian vittae presuturally black-brown, wing with a fuscous cloud on basal half of the costa extending to apex of first vein, and a faint yellowish cloud on region surrounding the inner cross-vein *costalis* Malloch.
- Scutellum black, slightly shining, with quite distinct yellowish-grey dusting on apical margin; area between the submedian vittae presuturally not much darker than those between these and the sublateral vittae; wing with a fuscous cloud on costa as in *costalis*, but with a brown cloud along centre of disc, extending broadly on both sides of fourth vein up to outer cross-vein, and a yellowish suffusion on apical section of fourth vein *discalis*, n. sp.
6. Petiole of first posterior cell of wing not nearly as long as outer cross-vein and not twice as long as inner cross-vein 7
- Petiole of first posterior cell of wing about as long as, or longer than, outer cross-vein, and at least three times as long as inner cross-vein 8
7. Abdomen with the dorsum entirely and densely golden or brassy yellow dusted; wings with a fuscous cloud on costa from base to apex of first vein, otherwise greyish hyaline (male) *chrysis*, n. sp.
- Abdomen of male, densely golden dusted dorsally, with a faint dorsocentral vitta, and sometimes more or less blackened on the apical two segments; female with the abdomen black, second and third tergites with broad interrupted yellow-dusted basal fascia, fourth tergite wholly yellow dusted; wings of male blackish, with pale streaks in the costal cell, along the third and fifth veins, and in the apical cell; female with wings hyaline *aureiventris** Curran.
8. Males 9
- Females 13
9. All the hairs on the mesopleura slender, none of them lanceolate or scale-like, and all of them black, but some of those on the lower portion of the humerus yellow or fulvous and distinctly widened, scale-like 10
- The humeral hairs either all normal, or, if some of them are scale-like, then some of those on the mesopleura are similar in form 11
10. Wings quite conspicuously blackened on basal half costally, the dark colour extending from base to beyond inner cross-vein, and from costa to fifth vein; dust on dorsal exposure of third and fourth visible tergites of abdomen brassy, and rather checkered *basalis*, n. sp.
- Wings entirely whitish hyaline; dust on third and fourth visible tergites when seen from behind pale grey, and quite regular in distribution *hyalis*, n. sp.
11. Abdomen about as broad as long, almost circular in outline, the fourth visible tergite very little longer than third, and about three times as broad at base as long in centre; hind tarsi entirely black; wings pale brown; mesonotum with four black vittae anteriorly; pleura with normally formed dark hairs *lativentris* Malloch.
- Abdomen distinctly longer than broad; fourth visible tergite much longer than the third; wings not evenly pale brown; mesonotum not vittate anteriorly 12
12. Both the lower portion of the humeri and the upper portion of mesopleura with many yellow scale-like hairs *lepidofera* Malloch.
- Humeri normally haired, some of the hairs on anterior portion of upper section of mesopleura rather flattened and a little paler than the others *nigrihirta* Malloch.

* I have arbitrarily placed this species in the key, basing my action on Curran's description. I have also placed *chrysis* in both sections because of some possible variability in the scutellar bristling.

13. Ventral plate of genitalia straight, not curved downward at tip *sensua* Curran.
 Ventral plate of genitalia quite conspicuously curved downward at tip 14
14. Hind tarsi entirely black *nigrihirta* Malloch.
 Hind tarsi with the basal segment largely yellowish *lepidofera* Malloch.

HYALOMYIA NORMALIS (Curran).

This species, of which I have seen only one female paratype, will not find a place in my previous key, being only 4-4.5 mm. in length, and having the apical pair of scutellar bristles quite strong, and situated on the margin. The wing venation is similar to that of *lepidofera*, but the discal cell is narrower and longer. The facets are but slightly enlarged on the upper half of eye in the female. Curran describes the male as having the wings entirely hyaline, which character, coupled with the silvery-grey dust on the apical portion of the second and all of third and fourth visible tergites of abdomen, readily distinguishes it from the other species in this segregate.

Locality, Palmerston, Qld.

I figure the female genitalia of this species (Fig. 1).

HYALOMYIA NIGRISQUAMA Malloch.

I have seen only the type male of this species.

HYALOMYIA CHRYSIS, n. sp.

♂. Head black, frons deep black, orbits in front and the parafacials silvery-white dusted, face, cheeks, and occiput, densely white dusted; antennae black, palpi testaceous yellow, darker at bases; frontal hairs black, lower occipital and genal hairs white. Thorax black, with whitish-grey dusting, mesonotum with four deep black vittae, the outer one on each side entire, the submedian pair discontinued a little behind the suture and twice as broad behind it as before it, the central portion of the postsutural area densely golden-yellow dusted; scutellum black, grey dusted. Abdomen black, entire dorsal exposure densely golden or brassy-yellow dusted, the incurved lateral portions of tergites densely grey dusted, all hairs black. Legs black. Wings subfuscous, darker along costa to apex of first vein. Calyptrae fuscous, whitish at junction.

Frons linear above; epistome slightly produced; cheeks as high as length of antenna. Thorax much as in *costalis* Malloch, but the scutellum is shorter and has the apical bristles practically undifferentiated, which fact has caused me to place the species in two segregates in my key. Abdomen broadly ovate, the tergites subequal to fourth visible one, the fifth very short but distinct. Legs as in *costalis*. Wing with the apical section of fourth vein forming an almost regular fourth of a circle.

Length, 7 mm.

Type, Narrogin, W.A., 30.8.1926 (E. W. Ferguson). One specimen.

HYALOMYIA COSTALIS Malloch.

I have seen only the type specimen of this species.

HYALOMYIA DISCALIS, n. sp.

♂. Very similar to the preceding species in general appearance, but readily distinguished by the characters cited in the key. It has the scutellum more elongate and with the apical pair of bristles quite strong and outstanding, the

apical section of fourth vein not so regularly rounded, and, though the type specimen has the abdomen largely greasy, it shows traces of having the fourth visible tergite grey dusted, the others brown anteriorly, quite broadly on first and second tergites, and the posterior margins narrowly grey dusted.

Length, 8 mm.

Type, Geraldton, W.A., 5.9.1926 (E. W. Ferguson). One specimen.

It might be worth mention that the sixth wing vein in this group is not so very abruptly discontinued as in the *lepidofera* group, its apex being usually tapered off, while in the other group it is quite blunt-tipped.

HYALOMYIA AUREIVENTRIS (Curran).

I have not seen this species, but have no doubt that it belongs here.

HYALOMYIA BASALIS, n. sp.

♂. This species belongs to the same group as *lepidofera*, but it has the wings quite conspicuously blackened along costal half to the apex of first vein, which is quite unique in this section of the genus as far as I am aware. The head is the same colour as in *lepidofera*. Mesonotum seen from in front evenly white dusted to beyond the suture, the sides posteriorly not so distinctly dusted and the central portion behind suture noticeably yellowish, though by no means as strikingly yellow as in *lepidofera*, no trace of vittae present; pleural hairs black, only some of the lanceolate hairs on anterior lower portion of humeri yellow or fulvous. Abdomen very noticeably purple on the hind margins, and to less extent on the sides at curves, of the tergites, disc of tergites yellowish dusted, rather checkered, and with traces of a central dark vitta; fifth and sixth tergites, and first visible one at the curve, greyish dusted. Legs black, basal segment of all tarsi slightly yellowish, bases of femora ventrally pale-haired, elsewhere black-haired. Wings as described above. Calyptrae white, slightly darkened and shining behind. Halteres brownish-yellow.

Interfrontalia obliterated on a space about as long as third antennal segment; facets not greatly enlarged on upper half of eye; epistome produced as in *lepidofera*. Some of the pleural hairs on anterior lower portion of humerus lanceolate and yellowish, those on the mesopleura all black, and normal; notopleural region rather densely black-haired; scutellum with the apical bristles fine and short, rather far from margin. Abdomen narrowly ovate, fourth visible tergite about one and a half times as long as third. Legs normal. Longitudinal portion of apical section of fourth vein not much longer than the forwardly directed section; discal cell at inner cross-vein about as wide as first posterior cell at its widest point; petiole of first posterior cell longer than outer cross-vein and more than four-fifths as long as penultimate section of fourth vein.

Length, 5.75 mm.

Type, Wahroonga, Sydney, N.S.W., 16.11.1926 (E. W. Ferguson). One specimen.

HYALOMYIA HYALIS, n. sp.

♂. Very similar to the preceding species, and possibly only a variety of it. In addition to the characters listed in the key the wings are narrower, which makes the discal cell appear longer, and the outer cross-vein is not much more than one-half of the length of the penultimate section of fourth vein, while in *basalis* it is about four-fifths as long as it. Possibly the genitalia will furnish other

characters for the separation of the forms if they are distinct, but I do not desire to destroy the unique examples now in my possession in so far as their outward appearance is concerned in dissecting them.

Length, 5 mm.

Type, Como, N.S.W., December, 1923, on flowers (H. Peterson). One specimen.

HYALOMYIA LATIVENTRIS Malloch.

I have seen only the type male of this species.

HYALOMYIA LEPIDOFERA Malloch.

Apparently a common species, as I have a good series from the type locality and a number more recently received from Wahroonga, Sydney, N.S.W.

I figure the genitalia of the female (Fig. 2).

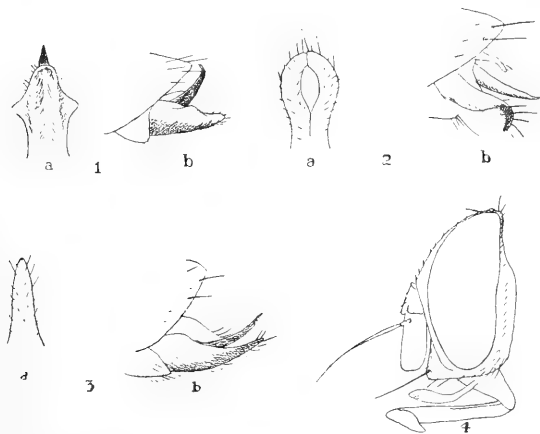


Fig. 1.—*Hyalomyia normalis*. Female genitalia; a, from below; b, from the side.

Fig. 2.—*Hyalomyia lepidofera*. Female genitalia; a, from below; b, from the side.

Fig. 3.—*Hyalomyia sensua*. Female genitalia; a, from below; b, from the side.

Fig. 4.—*Tayloria testacea*. Head of male, from the side.

HYALOMYIA NIGRIHIRTA Malloch.

Through a peculiar error the wing of this species appears as Figure 7 in my paper xix of this series (These PROCEEDINGS, 54, 1929, 111). In sending my manuscript I evidently wrongly labelled this figure as this species instead of *Gymnosoma rotundata* Meigen, and Dr. Mackerras wrote me that the figure of the wing of the latter was missing, upon which I sent a second figure, which appears properly labelled on the succeeding page. There are thus two figures of the wing of *Gymnosoma* and none of *nigrihirta* in that paper. The wing of the latter is very similar to that of *lepidofera*.

I present now characters for the separation of *nigrihirta* female from the others, but the genitalia are as in Figure 2.

HYALOMYIA SENSUA (Curran).

Only the female is known of this species, the genitalia (Fig. 3) being figured from a paratype sent to me by Dr. Walther Horn.

The legs are entirely black, the facets on the upper half of eyes are almost as large as the anterior ocellus, and the interfrontalia is obliterated on a space more than twice as long as third antennal segment.

Locality, Palmerston, Qld.

Genus TAYLORIA, n. gen.

This genus is distinguished from *Hyalomyia* Robineau-Desvoidy, at least in the male, by the following characters: Femora of all legs with two series of short spines on the apical half or more of the anteroventral and posteroventral surfaces; antennae extending almost to the mouth margin, the latter not projecting, and but slightly below vibrissae (Fig. 4); abdomen not flattened above; postscutellum not projecting beyond the level of scutellum, evenly rounded. The wing venation is similar to that of *Hyalomyia lepidofera* Malloch, the first posterior cell being long petiolate, and the petiole ending in the apex of wing. Other characters may be gleaned from the description of the genotype given below.

The genus will run down to Caption 13 in my published key to the genera, and to the first section therein, but, lacking information as to the structure of the female, I can only apply the first character in that section of the synopsis to it with absolute certainty. To prevent confusion it is necessary therefore to omit tentatively all after the first semicolon in using the key; we will then have three genera in which there are no strong dorsal bristles on the abdomen. The new one will readily separate from *Hyalomyia* on the character of the femoral bristling and the convex dorsum of abdomen, the latter in at least the males of *Hyalomyia* being more or less conspicuously flattened; from *Gymnosoma* Meigen it can be readily distinguished by the shorter second antennal segment, the very distinct and functional segmentation of the abdominal dorsum, the more extensive femoral armature, and the different wing venation.

The genus is more closely related to *Gymnosoma* than to *Hyalomyia*.

Genotype, the following species.

TAYLORIA TESTACEA, n. sp.

♂. Fulvous testaceous, slightly shining. Frons, upper occiput, third antennal segment except base, and bases of arista, fuscous; frontal orbits, face, cheeks, and occiput except upper third, silvery-white dusted; cheeks dark centrally. Mesonotum with yellow dust, most dense on a narrow presutural band, and to a lesser extent on hind margin. Abdomen sometimes with a faint trace of a dark linear dorsocentral vitta, evenly and lightly yellowish-dusted apically; all hairs black. Legs concolorous with body, tarsi fuscous, fore and mid pairs paler at bases. Calyptrae concolorous with body. Wings brownish hyaline, yellow at bases. Halteres fulvous.

Eyes bare, facets enlarged on central front portion; frons at vertex about one-sixth of the head width, orbits on entire length narrower than interfrontalia, with fine short incurved bristles along inner margins in front of ocelli; ocellar bristles short and fine, proclinate and divergent; inner verticals minute, shorter than the short postverticals; profile as in Figure 4; palpi club-shaped, bent, bare except for a few microscopic black hairs at apices; arista subnude. Thoracic hairs

very short; the following bristles present: one humeral, one pair of prescutellar dorsocentrals and acrostichals, two notopleurals, one supra-alar, two postalars, four marginal scutellars, two (1:1) sternopleurals, about four mesopleurals, one or two propleurals, one stigmatal, one pteropleural, and about eight hypopleurals, the presutural bristle minute, almost lacking; prosternum, centre of propleura, postalar declivity and the infrasquamal region bare. Abdomen elongate-ovate, slightly convex on dorsum, first visible tergite without a concavity in front, fourth slightly longer than any of the others, all without apical bristles, and with many short stiff black hairs; fifth sternite with a very large broad central excavation, reduced to a mere strip on each side which is produced into a short obtuse process at apex. Legs rather strong, hind femora stouter than the others, all femora with two series of short strong black bristles from before middle to apices; fore and mid tibiae without median bristles; hind tibia with one anterodorsal and one posterodorsal bristle near middle, both short; claws and pulvilli long. Wings rather narrow; inner cross-vein a little more than one-third from apex of discal cell and below apex of first vein; outer cross-vein straight, a little nearer inner cross-vein than to outer end of bend of fourth; petiole of first posterior cell more than half as long as outer cross-vein. Lower calypter large, transverse at apex, straight on outer side.

Length, 7.5-9 mm.

Type and one paratype, Mt. Molloy, Qld. (F. H. Taylor).

The genus is dedicated to the collector.

Tribe MICROTROPEZINI.

Genus MICROTROPEZA Macquart.

I have now before me several additional species of this genus and as the most precise manner of presenting information upon their distinguishing characters I am now publishing a new specific synopsis.

Key to the Species.

1. Second visible abdominal tergite without any outstanding bristles in centre of apical margin 2
 Second visible abdominal tergite with some strong black bristles in centre of apical margin 4
2. Abdomen testaceous yellow, with a bluish-black dorsocentral vitta which ceases about middle of fourth visible tergite and occupies less than one-third of the dorsal exposure; no strong bristles at the lateral curve of first and second visible tergites of abdomen; wings greyish hyaline, yellowish at bases; fore tarsi of female slender; mesopleura dark haired in centre *flaviventris*, n. sp.
 Abdomen black, with dense whitish-grey dusted markings; one or more strong bristles on lateral curves of first and second visible tergites of abdomen; wings more or less distinctly infuscated, bright orange coloured at bases; fore tarsi of female more or less widened 3
3. Mesopleura with some strong black hairs on centre; presutural area of thoracic dorsum inconspicuously vittate, the black vittae linear, and the pale dust greyish and not very distinct; fore tarsi of female but slightly widened .. *sinuata* Don.
 Mesopleura entirely yellow haired; presutural area of dorsum of thorax conspicuously vittate, the black vittae rather broad and the intervening spaces densely white dusted; fore tarsi of female much widened *latimana* Malloch
4. Abdomen glossy blue-black, with dense whitish-grey dusted markings as in *sinuata*; pleural hairs, except those on centre of propleura, black; wings with the veins bright orange basally *intermedia*, n. sp.
 Abdomen largely yellow, darkened only on a variable proportion of centre of dorsal exposure; pleural hairs mostly yellow; wing veins not orange coloured at bases 5

5. Abdomen with visible tergites 3 and 4 ochreous, when seen from behind with dense uniform ochreous dust *ochriventris* Malloch
 All visible abdominal tergites, when seen from behind, with dense grey or yellowish dusting and a pair of large glossy ochreous or reddish-brown spots on dorsum *flavitaris* Malloch

MICROTROPEZA SINUATA Donovan.

It would appear to be worth noting that Macquart's figure of this species does not represent the one so named by Brauer and Bergenstamm, and so accepted by me in my previous paper. The distinctly marked presutural area of thoracic dorsum and the quite evidently dilated fore tarsi indicate that he figured *latimana*. I assume that the two species were mixed in his collection and possibly in most of the others then extant.

Before me there is one additional female specimen from Geraldton, W.A. (J. Clark).

MICROTROPEZA LATIMANA Malloch.

The new material of this species available is in better condition than that from which I described the species, and the specimens all show a very much more marked division of colour between the orange-yellow bases of the wings and their fuscous apices. The five examples from Eastern Australia are distinctly larger than the four from Western Australia, but I can detect no specific distinctions between the two groups.

Localities: Lindfield, 31.10.1925 (Jones); Eccleston, Allyn R., 28.2.1921; Orange, N.S.W., 21.4.1923 (Health Dept.); Gisborne, Vict., 5.2.1922, and 16.12.1923 (G. Lyell), Swan R., W.A. (J. Clark).

MICROTROPEZA OCHRIVENTRIS Malloch.

One specimen, Gordon, 23.11.1924 (Harrison).

MICROTROPEZA FLAVITARSIS Malloch.

Five specimens, Geraldton, W.A., 5.9.1926 (E. W. Ferguson), and Kojarena, W.A., 6.9.1926 (E. W. Ferguson).

MICROTROPEZA INTERMEDIA, n. sp.

♂. Similar in general habitus and coloration to *latimana*, differing as follows: Parafacials and anterior portion of cheeks with dark hairs, third antennal segment fuscous except at base; thoracic dorsum with conspicuous white-dusted presutural marks, but the acrostichal area has a broad white central mark, not two on the lines of the bristles, and the one on each series of dorsocentral bristles is interrupted in middle; pleural hairs all black, with the exception of those on centre of propleura; mesonotum and scutellum entirely dark-haired; abdomen marked as in *sinuata* and *latimana*, but the dark portions are blue-black, and the second visible tergite, instead of having two whitish-dusted spots near anterior margin in centre, has a similar mark to the third and fourth tergites which is faint and greenish in front and grey-dusted only on the narrow posterior central portion; wings yellow at bases, but not infuscated apically; tarsi fuscous except at base of first segment.

Structurally quite similar to *latimana*, but the third antennal segment is shorter and broader, and the second visible abdominal tergite has a pair of central apical bristles. I have not compared the hypopygia of the two species.

Length, 15 mm.

Type, Eidsvold, Qld., 20.4.1924 (Bancroft). One specimen.

MICROTROPEZA FLAVIVENTRIS, n. sp.

♀. Superficially this species resembles a rather large *Chaetophthalmus*. Head orange-yellow, frontal, parafacial, and anterior genal hairs, dark, other hairs yellow, postocular cilia black; antennae and palpi orange-yellow. Thorax orange-yellow, with whitish dusting, mesonotum bluish-black except on margins, the dust so disposed as to leave four rather faint linear dark vittae; pleural hairs largely yellow, mesopleura with strong black hairs centrally; scutellum yellow, with black hairs above and pale hairs on sides below. Abdomen coloured as thorax, bases of second and third visible tergites whitish dusted, that of fourth yellowish dusted, a blue-black dorsocentral vitta occupying about one-third of the dorsal exposure extends over the basal three visible tergites, becoming narrow on apex of third, and linear or obsolete on fourth. Legs entirely yellow. Wings greyish hyaline, veins yellow basally. Calyptae and halteres orange-yellow.

Frons at vertex a little less than one-third of the head width; ocellars not developed; third antennal segment as long as second. Second visible abdominal tergite without apical central bristles, third with a complete apical series, fourth with a preapical and apical series, the apex not depressed. Fore tarsi not widened. In other respects similar to *sinuata*.

Length, 12 mm.

Type, Narromine, N.S.W., no other data. One specimen.

Tribe AMENIINI.

Genus AMENIA Robineau-Desvoidy.

I append some additional records of the occurrence of species of this genus.

AMENIA LEONINA Fabricius.

Twenty-five specimens from the following localities in Queensland and New South Wales: Eidsvold, Cairns, Broken Bay, Milson Is., Woy Woy, National Park, Barrington Tops, Como, Woodford, Manly, and Loowanna.

AMENIA IMPERIALIS Robineau-Desvoidy.

Twenty-nine specimens from the following localities in Queensland and New South Wales: Magnetic Island, Eidsvold, Meringa, Broken Bay, Glen Innes, Gordon, Chester Hill, National Park, Heathcote, Como, Woy Woy, and Mosman.

AMENIA DUBITALIS Malloch.

A specimen which agrees well with the type of this species, except in having short but distinct ocellar bristles is from Eidsvold, Qld., 4.4.1924 (Bancroft).

AMENIA CHRYSAME Walker.

Amenia parva Schiner will have to fall as a synonym of this species.

Ten specimens from the following localities: Eidsvold, Qld., December, 1922, and 20.4.1924 (Bancroft); Barrington Tops, N.S.W., February, 1925, Allyn Range,

on *Leptospermum* (S.U. Zool. Exped.); Mill, Allyn Range, 18.12.1922, brush (Nicholson); Woy Woy, N.S.W., 22.9.1923 (Mackerras) and 4.10.1925 (Nicholson); Ararat, Vict. (H. W. Davey).

In addition to the characters mentioned in my key for the distinction of this species from its congeners, it may be worth mention that the second antennal segment is fuscous, while in *leonina* it is yellow. This character is specifically mentioned by Walker in his description of *chrysame*.

AMENIA NIGROMACULATA Malloch.

♀. This sex agrees in markings and general structure with the male, but the frons is about one-fourth of the head width at vertex, gradually widened to anterior margin, and each orbit has two or three quite strong forwardly-directed outer supraorbital bristles.

Locality, W. Australia; no other data.

This specimen should be considered as the allotype.

Genus STILBOMYIA Macquart.

In my catalogue of Tachinidae of Australia I listed two species of this genus, *costalis* Walker, and *opulenta* Walker, the latter with a doubt. I have now before me two species and endeavour to elucidate them below.

Key to the Species.

- A. Apex of lower calypter fuscous; fourth visible abdominal tergite without a silvery-white dusted spot on each side; central stripe of frons (interfrontalia), antennae, and palpi, fuscous; antennal foveae darkened; only the mesopleura with a white dusted spot *costalis* Walker.
- AA. Calyptres entirely white, lower one with narrow dark rim; fourth visible tergite of abdomen with a large silvery-white dusted spot on each side; frons, antennae, palpi, and face, orange-yellow; mesopleura and sternopleura each with a white dusted spot *minor*, n. sp.

STILBOMYIA COSTALIS Walker.

This identification is based upon the example named *opulenta* Walker in the United States National Museum, and accepted as such by me in my previous paper on the genus. I am unable to say who identified the specimen. It agrees well with Engel's redescription of *costalis*, but in his paper he states that only the sternopleura has a white spot, whereas it is the mesopleura which is so marked, and he says that the base of the lower calypter is brown, whereas it is the apex that is dark.

The frons at vertex is hardly more than one-fourth of the head width, each orbit at centre is about as wide as the interfrontalia, the postocular orbits are entirely golden-yellow dusted, the thoracic dorsum is brilliant metallic blue-green and devoid of white dusting even on the humeri, and the abdomen is concolorous with it, the sutures a little darker.

Length, 8 mm.

Locality, Kuranda, Qld. (F. P. Dodd). One specimen.

STILBOMYIA MINOR, n. sp.

♀. Similar to the preceding species in general colour, being metallic blue-green, with orange-yellow head, black legs, and the wings conspicuously infuscated on costa to beyond middle, most broadly so at bases. It differs as stated in the key

and in having the upper half or more of the postocular orbits silvery-white dusted, the mesonotum slightly white dusted anteriorly and quite densely so behind the humeri and on two spots on the supra-alar margins, and the wings paler, with the costal dark mark more sharply defined. Halteres black.

Frons at vertex more than one-third of the head width, widened in front, each orbit at middle not more than one-third as wide as the interfrontalia; preapical central bristles of scutellum stronger than the preapical sublateral pair (weaker in *costalis*); wing not so narrow at apex as in *costalis*, the fourth vein more curved beyond the preapical angle than in that species.

Length, 7 mm.

Type, Eidsvold, Qld., 1923 (Bancroft). One specimen.

STILBOMYIA OPULENTA Walker.

This species should be omitted from the Australian list. It is apparently distinct from *costalis*, having the calyptrae entirely white. I have not seen it.

Genus NEOAMENIA, n. gen.

This genus is almost intermediate between *Amenia* and *Stilbomyia*, running down to the section in my key to the genera of Australian Tachinidae which contains these genera, but it is separable on characters not utilized therein. The frons of the male is about one-fifth of the head width, and the forwardly directed fronto-orbital bristles are very weak, the third wing vein is setulose only at base and not to the inner cross-vein, and the facial carina is broadly, longitudinally, sulcate. This last character distinguishes the genus from both of the others, the less extensively bristled basal section of the third wing vein distinguishes it from *Stilbomyia*, as does the narrower and less strongly bristled frons, and the presence of forwardly directed outer orbital bristles and the much longer third antennal segment distinguish it from *Amenia*.

Genotype, the following species.

NEOAMENIA LONGICORNIS, n. sp.

♂. Head bright orange-yellow, with yellow dust, occiput with a large black mark on each side of upper half; antennae reddish-yellow; arista and their hairs black; palpi orange; frontal and occipital hairs black, genal hairs yellow, marginal genal bristles black. Thorax shining black, with very distinct purple or violet reflections, especially around the white marks and on disc of mesonotum and scutellum, the hairs all black; mesonotum with the following conspicuous white dusted marks: two submedian vittae anterior to suture, a streak over inner half of each humerus extending to the transverse suture, and two marginal postsutural spots; a white spot on the mesopleura and another on the sternopleura. Abdomen metallic violet-blue, with a conspicuous white dusted spot on each lateral curve of visible tergites 2 to 4 inclusive, largest on 4. Legs black. Wings greyish, blackened from bases to the apices of basal cells. Upper calypter white, lower one black except at base. Halteres black.

Eyes bare; frons at vertex about one-fifth of the head width, inner verticals long and strong, outer pair short and fine; ocellars well differentiated, orbits linear above, with a series of black bristles along inner margins which are fine behind and become longer and stronger in front, one or two very fine forwardly-directed setulae on upper half, and in front of these numerous fine hairs laterad

of the bristles; carina of face gradually widened from between antennae to middle, quite conspicuously sulcate; third antennal segment more than one and a half times as long as height of cheek, the latter not half as high as eye; parafacials bare; arista quite densely haired to apex, longest hairs not as long as width of third antennal segment; a number of bristles and setulae above the vibrissae. Thorax with two or three plus four dorsocentrals, one plus two or three acrostichals, sternopleurals two plus one, and eight marginal scutellars. Abdomen with two or four bristles on centre or apex of second visible tergite, and a complete series on apices of third and fourth. Mid tibia with a submedian ventral bristle; hind tibia with two anteroventral and six or more irregular anterodorsal and posterodorsal bristles. Venation of wing as in *Amenia leonina* Fabricius, the setulae on base of third vein not extending midway to inner cross-vein.

Length, 9 mm.

Type, Western Australia; no other data (Newman). One specimen.

Tribe RUTLIINI.

I had not intended to revert to this tribe again because of press of other work, but there are so many interesting species amongst the new material to hand that I have determined to add a few notes to those I have already published.

Genus FORMOSIA Guérin.

I have found two species amongst Dr. Mackerras's material which were previously unknown to me and, finding no published descriptions with which they agree, I am describing them as new. I also give some additional distribution records for some of the other species of the genus. The two new species belong to the subgenus *Pseudoformosia*.

FORMOSIA QUADRIPUNCTATA, n. sp.

♂, ♀. Brilliant metallic blue-green; thoracic dorsum marked with white dust as in *frontosa* Malloch, two submedian presutural vittae, a streak from middle of each humerus to transverse suture, and one postsutural spot on each lateral margin; pleura with two white-dusted spots. Abdomen with twelve white-dusted spots as follows: one above and one below lateral curve on each side of second visible tergite, one on each side at lateral curve and one on each side of median line on third and fourth tergites. Legs black. Wings with bases infuscated. Calyptrae entirely fuscous.

Structurally similar to *frontosa*, but smaller. Parafacials bare. Arista pubescent.

Length, 12-14 mm.

Type, male, allotype, and one male and one female paratype, Eidsvold, Qld., December, 1922 (Mackerras).

This species may be distinguished from *frontosa*, to which it will run in my key to the species of this genus, by the following characters:

- A. Postocular orbits yellow dusted below, silvery-white dusted on upper half; second visible abdominal tergite without white-dusted submedian spots, four-spotted *quadripunctata*, n. sp.
- AA. Postocular orbits entirely and densely golden yellow dusted; second visible abdominal tergite with a pair of submedian white-dusted spots, six-spotted *frontosa* Malloch.

FORMOSIA CINGULATA, n. sp.

♂. Black, with blue or purple reflections around the lateral spots on mesonotum, and the submedian spots on tergites 3 and 4 of abdomen, and a bluish or greenish tinge showing through the white dust on second tergite, especially behind. Head bright orange-yellow dusted, upper half or more of postocular orbits silvery-white dusted, posterior extremities of frontal orbits, ocellar triangle, and a large mark on each side of upper half of occiput, blackish; antennae and palpi orange; arista fuscous; hairs on frontal orbits and anterior portion of cheeks, and the postocular ciliae, black, other cephalic hairs yellow. Mesonotum and pleura with white-dusted markings as in the preceding species. Abdomen with a band of greyish-white dust covering almost all of second visible tergite, slightly notched in middle anteriorly, and not continued to extreme lateral edge below, third and fourth tergites each with four white-dusted spots, the submedian pair small, the sublateral one on each side below lateral curve and not visible from above. Legs black. Wings fuscous at bases. Calyptres fuscous.

A more robust species than the preceding one, with the frons a little narrower, the facial carina broader, and with a quite noticeable vertical sulcus below. Second visible abdominal tergite without apical central bristles.

Length, 15 mm.

Type, Wentworth Falls, 14.12.1923 (Harrison).

This species will run down to the second segregate of Caption 4 in my key to the species of this genus already published, and may be separated from *speciosa* Erichson as follows:

- A. Abdomen predominantly black, second visible tergite nearly all white dusted above, without a black apical central spot and similarly placed bristles; legs black; mesonotum without a white-dusted mark between the presutural submedian vittae, and lacking submedian white spots near posterior margin *cingulata*, n. sp.
- AA. Abdomen predominantly white dusted, second visible tergite with a central apical transverse black spot upon which there are several strong bristles; mesonotum with a white mark between the presutural submedian vittae, and a pair of white submedian spots near hind margin *speciosa* Erichson.

FORMOSIA SPECIOSA Erichson.

Fourteen specimens from the following localities: Barrington Tops, N.S.W., February, 1925, on *Leptospermum* (S.U. Zool. Exped.); "Allowrie", Killara, Eccleston, and Fish River, N.S.W., and Bright, Vict. (H. W. Davey).

FORMOSIA SMARAGDINA Malloch.

Nine specimens from the following localities: Meringa, Qld., November, 1926 (Goldfinch), Kuranda (F. P. Dodd).

FORMOSIA ATRIBASIS Walker.

Four specimens with the same data as the preceding species.

Genus CHRYSOPASTA Brauer and Bergenstamm.

CHRYSOPASTA ELEGANS Macquart.

Rutiña elegans Macquart, *Dipt. Exot.*, Suppl. 1, 1845, 309.

I have before me a specimen labelled as this species and marked "Compared with type by Major E. E. Austen". I had previously looked over Macquart's

description, but had failed to associate it with this species. It will now be necessary to reduce *zabrina* Walker to a synonym of *elegans*. The latter was accidentally omitted from my catalogue of Australian Tachinidae.

The series of specimens before me includes the following localities: Western Australia, no other data; Swan River, W.A. (J. Clark); Wyalkatchem, W.A., 1.9.1926 (E. W. Ferguson); Mundaring, W.A. Ten specimens.

The species appears to be exclusively Western Australian, although Macquart's original locality is "De L'île Sydney".

It would appear to be of importance to note that one of the Swan River specimens bears a large written label as follows: "*Rutitia* sp. in nest of Termites, *Eut. westaustraliensis*", and mounted with a second specimen of the same lot there is an empty puparium, this second one bearing also a red paper label with the word "Inquiline" printed on it. This is the first indication of the larval habits of the genus that I know.

The puparium is dark brown in colour, slightly shining, about 14 mm. in total length and 5 mm. wide at widest point, broadly rounded at each extremity, the surface with microscopic transverse striae or furrows, and each segment with the greater part of its extent covered with minute sharp-pointed protuberances. The dorsal portion of the cephalic cap with the anterior spiracles attached is missing in the specimen in hand, there are no dorsal respiratory horns, and the posterior spiracular organs are large, flat, glossy, and situated in a slight cavity above the central line of the posterior extremity. Their general outline is as Figure 5, the

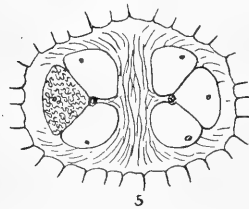


Fig. 5.—*Chrysopasta elegans*. Posterior spiracles of larva, only one lobe showing the serpentine markings.

"button" being encircled by the three greatly enlarged subtriangular spiracular lobes, each of the latter showing a small raised spot which may be the base of the fan-shaped processes generally found in most related larvae for the protection of the spiracular openings in liquid pabuli or surroundings, though no such processes are discernible, or they may represent the actual and much modified tracheal openings. The surface of each of the large subtriangular lobes is furnished with close-set serpentine markings which do not apparently penetrate the cuticle, though they roughen the surface somewhat. It would be necessary to obtain larvae to enable one to describe the structural characters more reliably. Enough is shown, however, to justify the belief that the species is really an inquiline and not a parasite.

In the puparia of certain genera of the calliphorid subfamily Rhiniinae that I have examined, the posterior spiracles are similar to those of *Chrysopasta*, except that the three lobes are not so distinctly separated, and they are not situated in a cavity or depression. The small raised spot on each lobe is present in them also.

Genus RUTILIA Robineau-Desvoidy.

I had not intended to return to this genus again, but in the material recently received there are several specimens which either belong to species previously unknown to me or throw a new light upon the distinguishing characters of some of those already dealt with in this series of papers. I present below data upon those species.

RUTILIA ARGENTIFERA Bigot.

When I dealt with this species, I had but one male before me; now I have a series of nine specimens, including both sexes. I find that, while the male has the submedian presutural pale vittae usually indistinct, the female has them normally well defined by the presence of white dust and, in addition, sometimes a pair of narrower and less distinct whitish-dusted vittae between these near the suture. The species belongs to my Group 1, both sexes having the sternopleurals 1 + 1, and the female lacking the forwardly-directed outer orbital bristles.

In my key (presented in These PROCEEDINGS, 1928, p. 331) this species will run out very readily to its proper place, except that the conspicuous presutural submedian thoracic vittae of the female may cause some slight doubt on the part of users. However, the other characters, and more especially the presence of but two white spots on each lateral margin of the mesonotum, and four round spots on second and third visible tergites of the abdomen, will readily distinguish the species.

Localities: "Allowrie", Killara, N.S.W., 29.1.1921 to 7.2.1921; National Park, Sydney, N.S.W., 21.2.1925; Penrith, 11.3.1923; Woolgoolga, N.S.W., 27.1.1923 (Health Dept.); Eidsvold, Qld., December, 1922.

RUTILIA LEUCOSTICTA Schiner.

The material now before me contains two rather distinct varieties, the typical one, in which the calyptrae and the bases of the wings are brownish-yellow, and a new one, in which the calyptrae and bases of wings are fuscous, almost black.

The general coloration of the typical form is more black on thorax and coppery on abdomen, the male having the abdomen coppery-brown, appearing semipellucid, with a broad black dorsocentral vitta.

Localities: Barrington Tops, Allyn Range, N.S.W., on *Leptospermum*, February, 1925 (S.U. Zool. Exped.); and Leura, 23.3.1924 (Harrison). Twenty specimens.

RUTILIA LEUCOSTICTA, var. FUSCISQUAMA, n. var.

This variety, of which only two females are known to me, is distinguished from the typical form by the thoracic dorsum being largely metallic dark blue-green, the white-dusted band on second visible tergite of abdomen being broadly interrupted on each lateral curve, and the calyptrae and bases of wings quite conspicuously blackened. There are also two vertical white-dusted streaks on the central portion of the upper half of occiput which are faint or lacking in the other form. Possibly a good species.

Length, 13-14 mm.

Type and one paratype, Barrington Tops, Allyn Range, on *Leptospermum*, February, 1925 (S.U. Zool. Exped.).

RUTILIA MICANS Malloch.

Two specimens agreeing with the type series.

Locality, Kosciusko, 21.2.1926 (Nicholson). This is the type locality.

RUTILIA ALBOCINCTA, n. sp.

♂, ♀. Head black, frontal orbits, face and cheeks grey dusted, postocular orbits greyish dusted, changeable according to the angle from which they are viewed, in some lights brassy; antennae and palpi fuscous; occipital hairs dull yellow. Thorax black, almost velvety, posterior portion of mesonotum slightly, disc of scutellum noticeably, shining, presutural region in both sexes whitish-grey dusted on entire width, the male with four narrow, the female with four broad, black vittae, female with, male without, an elongate whitish-grey dusted mark on each side behind suture; mesopleura and sternopleura both whitish dusted centrally. Abdomen black, more or less shining and coppery at apex, male with the second visible tergite almost entirely greyish-white dusted, third tergite with a pair of large submedian spots and the anterior half on each side below lateral curve similarly dusted, fourth tergite with two small submedian spots and a spot on each side below pale dusted; female with second tergite almost entirely greyish-white dusted above, a black central line evident, but below curve the dust is sparse and the ground colour is noticeably metallic bluish or greenish, the third tergite has a complete white-dusted band on anterior half above and below, and the fourth tergite has the anterior margin faintly white dusted below curve only. Legs black, tibiae brownish. Bases of wings, calyptrae, and halteres fuscous. Thoracic and abdominal hairs black.

Frons of male at vertex not more than twice as wide as third antennal segment, that of female more than one-fifth of the head width, both lacking forwardly-directed outer orbital bristles, and with the parafacials bare below level of apex of second antennal segment; third antennal segment in female about as long as distance from its apex to the mouth margin, much shorter in the male; arista subnude; palpi normal. Thorax as in the *formosa* group. Second visible tergite of abdomen in male with a pair of apical central bristles, in female with discal and apical bristles, third tergite in both sexes with apicals and discals. Male with a regular fringe of bristles on the anterodorsal surface amongst which one bristle is slightly longer than the others, female with two or more outstanding anterodorsal bristles on same tibia.

Length, 13-15 mm.

Type, female, allotype, and two female paratypes, Barrington Tops, Allyn Range, on *Leptospermum*, February, 1925 (S.U. Zool. Exped.).

There is considerable sexual dimorphism in the specimens before me and, though it is quite possible I may have two species confused, I believe that, despite the difference in length of third antennal segment, and other characters, I have male and female of the same species in my type series. If it should be discovered that there are in fact two species in my concept, the female shall be considered as entitled to the name given above.

This species belongs in Group I, as defined in my last paper on this genus, having forwardly-directed orbital bristles in neither sex, and the anterior sternopleural bristle present in the female only. It is readily distinguished from any of the other already known species by the general black and white coloration of the thorax and abdomen, and particularly by the black, whitish-grey dusted face,

and the broad white-dusted fascia on the second visible abdominal tergite. It has much the same appearance as *Formosia cingulata*, n. sp., but the presutural dorsal area of the thorax appears to be white dusted, with four black vittae, while in *cingulata* the same area appears as deep black, with four narrow silvery-white dusted vittae.

Subgenus *SENOSTOMA* Macquart.

RUTILIA (*SENOSTOMA*) *HIRTICEPS* Malloch.

One male, Sydney, N.S.W., 26.11.1922 (Health Dept.).

RUTILIA (*SENOSTOMA*) *FLAVIPES* Brauer and Bergenstamm.

Two females: Northbridge, December, 1927 (M. Fuller), and Bowral, February, 1923.

RUTILIA (*SENOSTOMA*) *NIGRICEPS* Malloch.

Five males: E. Dorrigo, N.S.W., 30.1.1923, and Barrington Tops, January, 1925, and February, 1925, the last one on *Leptospermum* (S.U. Zool. Exped.).

RUTILIA (*SENOSTOMA*) *RUFICORNIS* Macquart.

I consider it highly probable that I have two closely related species, both of which would run out to this one in my key recently published, but I am unable to devote the necessary time to their elucidation at present and must perforce lay the material aside pending an opportunity to go into the matter.

One series of specimens from Barrington Tops has a much more coppery, or even purplish, suffusion on thorax and abdomen in both sexes than is found in the specimens from other sections, and possibly they belong to an undescribed species.

There are at least two names involved in the matter, but whether they have been correctly synonymized remains to be decided.

Tribe DEXINI.

This tribe, as at present accepted, is rather heterogeneous, being a group distinguished mainly by the slender form of the species, the presence of distinct hairs on the arista, and a few rather intangible and variable characters of different nature. I hope to be able to deal with the grouping of the entire family at some future time, but have nothing concrete to offer at this time. The first genus dealt with below is quite different from *Prosema* and its allies, and was probably derived from entirely different progenitors.

Genus *THELAIRIA* Robineau-Desvoidy.

I did not include this genus in my key to the Australian Tachinidae, but I have before me now one species which I cannot distinguish from the genotype, and present below a generic diagnosis.

Longest hairs on arista not as long as width of third antennal segment, frons of male narrower than that of female, at vertex about one-fifth of the head width, widened anteriorly, orbits bristled, lacking forwardly-directed supraorbitals in the male, possessing them in the female, interfrontalia complete in both sexes, ocellars long, proclinate and divergent, inner verticals long in both sexes, outer pair undeveloped in male, microscopic in female, parafacials bare; face almost flat; head at vibrissae shorter than at base at antennae; proboscis and palpi normal.

Prosternum and centre of propleura bare, no hairs above or below lower calypter, the latter bare on disc above, subtransverse at apex, and not very noticeably widened behind. First wing vein setulose on at least the basal half above, third with a few setulae at base below and on a variable extent of its upper surface; first posterior cell open, ending before wing tip; outer cross-vein much nearer to bend of fourth vein than to inner cross-vein. Abdomen with strong bristles in centre of apices of all tergites, and at least one pair of discal bristles on each tergite from second to fourth inclusive.

THELAIRIA LEUCOZONA (Fallen).

This species is evidently listed from Australia as *T. australis* Walker. I have carefully compared Australian and North American specimens and can find no material differences in them. The male has the abdomen rufous, with a broad dorsal stripe and the apex black, while the female has it entirely glossy black; both sexes have the bases of the tergites broadly silvery-white dusted. The legs are black. Hypopygium of male as Figure 6.

Length, 9-12 mm.

Localities: Sydney, N.S.W., October, November, December, and April (Health Dept.); Barrington Tops, N.S.W., January, 1928 (Benham).

This genus will run down to Caption 32 in my key to the Australian genera, but it will not fit exactly in either segregate because of the hairing of the arista, the longest hairs of which are shorter than the width of the third antennal segment. It fits best in the first segregate, but is distinguished from *Mesembriomintho* Townsend (= *Sumpigaster* Macquart) and *Rhinomyiobia* Brauer and Bergenstamm by the setulose first vein of the wing, calling for the following change in the key:

- 32a. First wing vein setulose above on at least its basal half *Thelairia* R.-D.
 First wing vein bare above 32b.
N.B.—Change 32a to 32b in key.

Genus SUMPIGASTER Macquart.

Amongst the material now before me there are two males and two females of this genus, one of them identified as *fasciatus* Macquart by the late Dr. E. W. Ferguson. A comparison with the genotype of *Mesembriomintho compressa* Townsend proves that the latter is synonymous. We must therefore dispense with the latter name.

SUMPIGASTER FASCIATUS Macquart.

To rectify my generic key it will be necessary to supplant *Mesembriomintho* by using *Sumpigaster*.

Four specimens: North Bay, April 10, on window pane; Sydney, N.S.W., 19.10.1924; Gordon, 9.11.1924 (Harrison); Port Macquarie, 19.4.1924 (Nicholson).

I may present a fuller description of this species than is now available at some future time if there should be any closely similar species in collections sent me.

Genus ZOSTEROMYIA Brauer and Bergenstamm.

This genus falls in Caption 32 of my generic key because of the distinctly haired arista, the longest hairs on which, though not as long as the width of the third antennal segment, are about twice as long as its basal diameter. Possibly the best method of rectifying this section of the key to take care of this genus and

several others would be to amend the first sentence of Caption 32 as follows: "Arista distinctly haired, the longest hairs always at least twice as long as its basal diameter;" and to delete all after that point. This will permit the alteration given under the genus *Thelairia* herein, and the present genus, having the arista with its longest hairs distinctly shorter than the width of the third antennal segment, may be distinguished from *Sumpigaster* Macquart, and *Rhinomyiobia* Brauer and Bergenstamm, by that character, and from the latter it can be further distinguished by the presence of discal bristles on at least the second to fourth visible tergites of abdomen.

ZOSTEROMYIA CINGULATA (Macquart).

A very conspicuous deep velvety-black species with silvery-white dust on face, lower occiput, and postocular orbits, a complete annulus of same nature on thorax just in front of suture and a fascia on hind margin of mesonotum, and one on each visible abdominal tergite from second to fourth inclusive similarly coloured. Cheeks, antennae, palpi, and legs black. Wings greyish hyaline, darker costally. Calyptres white. Halteres yellow.

Eyes bare; frons of male about one-sixth, of female about one-fourth, of the head width, the female with, the male without, forwardly-directed outer orbital bristles. Thorax with two plus three dorsocentrals and three plus three acrostichals; apical scutellars lacking. Abdomen conical, not compressed. Mid tibia in neither sex with ventral bristle; hind tibia with a number of anterodorsal and posterodorsal bristles, two on each surface much longer than the others; fore tarsi slender in both sexes. Outer cross-vein about three-fifths from inner cross-vein to bend of fourth; first posterior cell ending a little before apex of wing, bend of fourth vein subangular, lower calypter not much widened behind, the apex rounded.

Length, 5-8 mm.

Localities, Kuranda, N. Qld. (F. P. Dodd); Meringa, Qld., Nov., 1926 (Goldfinch); Eccleston, Allyn River, 26.2.1921; Gundamaian, National Park, N.S.W., 1.1.1926 (Nicholson); Sydney, N.S.W., 25.1.1924; Port Macquarie, 19.4.1924 (Nicholson).

Larval habits unknown to me.

Genus PROSENA St. Fargeau and Serveille.

I included this genus in my generic key, the principal distinguishing characters cited being the long proboscis, the carinate face, and plumose arista. I figure the characteristic head of the genus (Fig. 7), and this may be compared with the head of a closely related genus included herein (Fig. 16). The palpi are comparatively short and somewhat club-shaped. Other characters may be gleaned from the generic key already referred to, and the matter appearing subsequently in this paper. The hypopygial characters are very similar to those of some of the related genera, indicating a possibility of a common, and recent origin, but my information on the matter of relationships is too scanty to draw any definite conclusions.

Curran has published a key for the identification of the species, a reference to which is given in my recent catalogue, but it is based exclusively upon colour characters, and I find it impossible to determine the Australian species definitely by its use. I have made tentative identifications in some cases, but I may be

wrong in my conclusions, which can be proven only by an examination of the hypopygia of the males of the species involved. It is for this reason that I now present a synoptic key and details of the hypopygial structures of the species before me, hoping that the same may prove useful to students of the family. I make use of the males only in the first key.

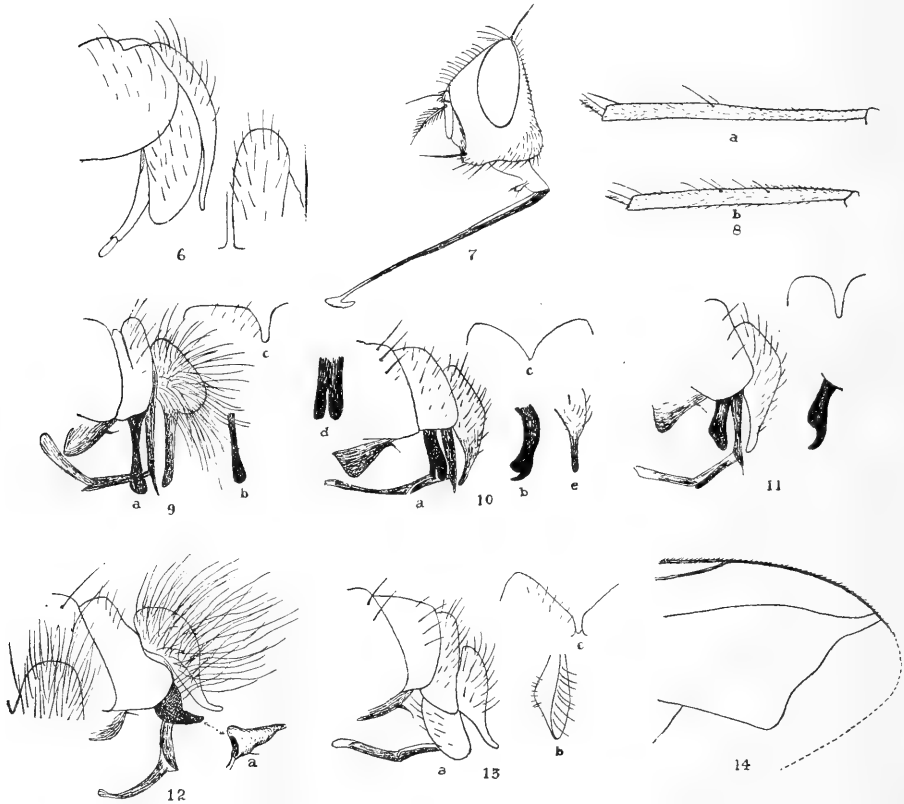


Fig. 6.—*Thelairia leucozona*. a, Male hypopygium from side; b, fifth sternite of same, one lobe.

Fig. 7.—*Prosenia sibirita*. Head of male from side.

Fig. 8.—*Prosenia* species. Hind tibiae; a, *argentata*; b, *sibirita*.

Fig. 9.—*Prosenia tenuis*. Male hypopygium; a, from the side; b, inferior forceps from behind; c, fifth sternite, one side.

Fig. 10.—*Prosenia* species. Male hypopygia; a, *sibirita*, Australian form from side; b, inferior forceps of same from in front; c, fifth sternite of same; d, inferior forceps of Asiatic form and *parva*; e, superior forceps of *parva* from the side.

Fig. 11.—*Prosenia sibirita*, var. *confusa*. Hypopygium of male; a, from the side; b, inferior forceps from in front; c, fifth sternite, one side.

Fig. 12.—*Prosenia argentata*. Male hypopygium from the side; a, inferior forceps from below.

Fig. 13.—*Prosenia indecisa*. Male hypopygium; a, from the side; b, inferior forceps from in front; c, fifth sternite, one side.

Fig. 14.—*Prosenia indecisa*. Apex of wing.

Key to the Species.

Males.

1. Interfrontalia practically obliterated for a shorter or longer distance above the middle of frons by the broad, densely white-dusted frontal orbits; mesonotum when viewed against the light and from above left humerus densely silvery-white dusted on anterior three-fourths, brownish-yellow dusted on posterior fourth, when seen from behind against the light the pale-dusted portion becomes dark grey or fuscous, broadly paler on central (acrostichal) area, and narrowly so on lines of dorsocentrals; hind tibia quite conspicuously attenuated on basal half (Fig. 8a), and with one quite well developed bristle on the posterodorsal surface well beyond middle; genital segments quite copiously furnished with soft pale hairs ventrally *argentata* Curran.
- Interfrontalia generally clearly visible on its entire extent, the frontal orbits never silvery-white dusted, and the dusting on the mesonotum always greyish or yellowish; other characters not as above *in toto* 2
2. Hind tibiae not noticeably attenuated on basal half (Fig. 8b); mid tibia with a quite well developed submedian ventral bristle; hind femur with only one bristle on posterodorsal surface, which is at about its own length from apex 3
- Hind tibiae quite noticeably attenuated on almost, or more than, the basal half (Fig. 8a); mid tibia without a distinct submedian ventral bristle; hind femur without any posterodorsal bristles or with two or more which are not close to apex 5
3. Bases of the superior hypopygial forceps quite abruptly differentiated from the apical slender portion and with longer and more abundant brown hairs than usual, appearing tufted from side view (Fig. 9) *tenuis*, n. sp.
- Bases of the superior hypopygial forceps tapered into the apical portion, and not at all tufted 4
4. Inferior forceps of hypopygium furcate (Fig. 10) *sibirita* Fabricius.
- Inferior forceps not furcate (Fig. 11) *sibirita* Fabricius, var. ?
5. Legs black, apices of femora narrowly reddish; fifth visible abdominal tergite with a pair of well developed apical bristles, in some cases very strong, in others much weaker; scutellum without differentiated discal bristles, the hairs much longer and denser apically than basally; cheeks almost bare behind the vibrissal angle *nigripes* Curran.
- Legs testaceous yellow, only the tarsi fuscous; fifth visible tergite of abdomen without well developed bristles, merely haired; discal hairs on scutellum of almost uniform length; cheeks quite distinctly pale haired behind vibrissae *indecisa*, n. sp.

Females.

1. Legs black, only the extreme apices of femora reddish *nigripes* Curran.
- Legs largely yellow or fulvous 2
2. One of the two bristles at apex of auxiliary vein on costa at least as long as the inner cross-vein *parva*, n. sp.
- Neither of the two bristles at apex of auxiliary vein on the costa nearly as long as the inner cross-vein 3
3. Frontal orbits greyish-yellow dusted, dark brown at upper extremities; fourth vein slightly but distinctly bisinuate beyond the preapical bend (Fig. 14) *indecisa*, n. sp.
- Frontal orbits grey or yellowish dusted, not distinctly darker at upper extremities; fourth vein not bisinuate beyond the preapical bend 4
4. Outer pair of mesonotal dark vittae much broader than the submedian pair in front of the suture; abdomen brownish testaceous, apices of tergites almost black, their bases broadly and densely grey dusted, the whole having the appearance of being alternately grey and black-brown fasciate; antennae and arista orange-yellow; third visible abdominal tergite with four strong apical bristles including those on the sides *bella* Curran.
- Outer pair of mesonotal dark vittae not much broader than the submedian pair; abdomen not conspicuously grey and dark-brown fasciate; third visible abdominal tergite with at least six strong apical bristles 5
5. Thorax and abdomen with whitish-grey dusting; fore femur with the posteroventral series of bristles very short basally, becoming longer near apex sp.

Thorax and abdomen with yellowish-grey or brownish-grey dusting; fore femur with the posteroventral series of bristles normal, longest at or near middle
 *sibirita et al.*

PROSENA ARGENTATA Curran.

This is the most striking species of the genus known to me, the silvery dust on the head and thoracic dorsum being very noticeable. Curran describes the mesonotum as having a broad black fascia behind the suture, but makes no mention of the similar one before it, which is equally conspicuous. In several other respects the original description is not in accordance with my material, but I can see no reason to doubt the identification. I figure the male hypopygium (Fig. 12). I have seen no specimens which might with certainty be considered as the females of this species, the only specimens which I hesitated to identify as this species or *sibirita* being radically different from the one described as *argentata* by Curran. I therefore do not record any of my specimens as the female of this species.

Localities: Eidsvold and Yeppoon, Queensland, and Glenreagh, N.S.W.

PROSENA TENUIS, n. sp.

♂. Head testaceous yellow, interfrontalia brownish-yellow behind, paler in front, antennae and palpi orange-yellow; arista brownish-yellow; frontal orbits, face, cheeks, and occiput white dusted. Thorax as in *sibirita*, fuscous, with pale-grey dust, the four mesonotal vittae inconspicuous, interrupted at suture, and not continued to hind margin; scutellum blackened on sides basally; mesopleura with the hairs nearly all yellow, some on upper margin and a few behind the hind marginal bristles black. Abdomen testaceous yellow, translucent, with slightly checkered white dusting, a black central apical mark and one on each lateral curve on first two visible tergites, the third and fourth tergites more broadly black on dorsal exposure. Legs yellow, apices of mid and hind femora and tibiae darkened, tarsi black. Wings greyish-hyaline. Calyptrae yellowish-white. Halteres yellow.

Frons at vertex about one-third as wide as either eye, orbits as wide as interfrontalia at any part, each with about seven inner marginal bristles; ocellars short but rather strong, outer verticals undeveloped, inner pair long. Thorax as in *sibirita*. First visible tergite of abdomen without apical central bristles, second with a pair; hypopygium as in Fig. 9. Legs as in *sibirita*, neither the apices of the femora nor the bases of the tibiae noticeably attenuated; mid tibia with the submedian ventral bristle rather short. Fourth wing vein beyond the preapical curve slightly and almost regularly curved.

Length, 12 mm.

Type, Gundamaian, National Park, N.S.W., 1.1.1926 (Nicholson). One specimen.

PROSENA SIBIRITA (Fabricius).

This species is one which has caused me some difficulty in arriving at a decision as to its status. Originally European, it has been recorded from a large number of countries and, if certain authorities are correct, it has been described under quite a number of different names. I have made a careful study of the hypopygia of many of the available specimens from Europe, Asia, and Australia, and am still undecided as to the specific limits in the material examined. The typical forms have the inferior hypopygial forceps broad, and deeply cleft at

apex (Fig. 10), which form is found also in *parva*, n. sp., but in the Australian specimens the same organ is found with the apex much narrower, and very much less deeply cleft (Fig. 10). Possibly the form figured as variety *confusa*, n. var., herein (Fig. 11) is merely a variety of *sibirita*, but more material is necessary to arrive at a definite conclusion as to this.

I am uncertain of the identity of the female in my Australian material.

Localities: Marwood and Eidsvold, Qld., and Manly, N.S.W.

PROSENA SIBIRITA, var. CONFUSA, n. var.

This variety, if such it is, may be distinguished from typical *sibirita* only by the structure of the inferior forceps (Fig. 11).

Type, Eidsvold, Qld., December, 1922. One specimen.

PROSENA PARVA, n. sp.

♂, ♀. Very similar in general coloration to *sibirita*, but the male has the thoracic dorsum lead-grey dusted in front between the vittae and brownish-grey dusted behind, the abdomen has the dorsal dusting yellowish-grey except on a small region in centre of fore part of each tergite, where it is lead-grey. This difference in coloration is not noticeable in the female, except to a small extent on the abdomen.

Structurally the species differs in being much smaller, and in having one of the bristles at apex of the auxiliary vein on costa about as long as, or longer than, the inner cross-vein. The male hypopygium is very similar to that of *sibirita*, but the inferior forceps are narrower at base, and the superior pair are straighter on the apical attenuated portion (Fig. 10).

Length, 5-7 mm.

Type, female, Sydney, 14.1.1923; allotype, same locality, 21.1.1923; paratypes, all females, Glenreagh, N.S.W., 1.2.1923, Manly, N.S.W., 16 and 19.11.1923, and Sydney, N.S.W., 1.1.1923.

PROSENA NIGRIPES Curran.

Dr. Aldrich (*Ent. Mitt.*, 17, No. 2, 1928, 130) has discussed this species in a paper dealing with *sibirita* and its allies. He assumes that *malayana* Townsend is a good species, but states that he is unaware whether *nigripes* Curran and *doddi* Curran are synonymous with it.

The male standing as *malayana* in the United States National Museum collection is, in my opinion, merely a dark-legged specimen of *sibirita*, but it is not the type, so that I am unable to state definitely the status of the species. However, *nigripes* is a good species, quite distinct from *sibirita*, the hypopygium of the male being very similar to that of *indecisa* figured herein, the only difference apparent to me being that the inferior forceps are somewhat broader at the apices. The peculiar broadened apices of the femora in the female of this species, coupled with the almost entirely black legs, readily distinguish that sex. The male has the legs much as in *indecisa*, but they are black.

Localities: "Allowrie", Killara, N.S.W.; Sydney, N.S.W.; Austinmer, N.S.W.; Marwood, near Mackay, Qld.; Cairns, Qld. Eleven specimens.

PROSENA BELLA Curran.

I have seen only the female of this species and cannot, of course, tell if the presence of but four strong apical bristles on the third visible abdominal tergite

is an invariable character. In the only specimen before me, the anterodorsal bristles on the fore tibia are more irregular and less numerous than in *sibirita*, and there is a pair of strong apical central bristles on the first visible tergite, which is quite unusual in the females of the genus. The colour markings would appear to be a good criterion for the identification of the species.

Locality: Marwood, near Mackay, Qld., January, 1924 (W. C. Harvey).

PROSENA INDECISA, n. sp.

♂, ♀. This species is very like *argentata* in general appearance, but lacks the silvery dust of the thoracic dorsum, and the presutural and postsutural black patches, the vittae being of the usual narrow form and well separated. The abdomen has the black dorsocentral vitta always distinct and usually more or less distinctly widened at apex of each tergite. Legs fulvous yellow, tarsi black. Wings slightly yellowish, the veins sometimes more or less clouded with yellow apically.

Structurally differing from *argentata* in the distinct interfrontalia, and the form of the male hypopygium (Fig. 13), as well as in the bisinuate apical section of fourth vein beyond the preapical angle (Fig. 14).

Length, 11-14 mm.

Type, allotype, one male and one female paratype, Barrington Tops, N.S.W., January, 1925 (S.U. Zool. Exped.). Paratypes, Woodford, 27.1.1923, Austinmer, 19.12.1921, Gisborne, V., 26.3.1922, Woy Woy, September and October, 1923-25, "Allowrie", Killara, 6.2.1921, 9.10.1924 and 4.11.1924, Blue Mts. 13.4.1922. Fourteen specimens in all.

I would have accepted this as *macropus* Thomson were it not for the presence of a pair of strong bristles at the apex of the first visible abdominal tergite.

PROSENA SP.

I have one female from Marwood which does not appear to belong to any of the species before me, but do not care to deal further with a single example.

PROSENA DORSALIS Macquart; PROSENA VITTATA Macquart.

I have nothing to add to my catalogue record, except that *vittata* closely resembles my description of *indecisa*.

Genus PROSENA, n. gen.

This genus has much the appearance of *Prosema*, but the first posterior cell is closed at a short distance from the margin of the wing, the preapical angle of fourth vein is sharp, and usually furnished with a short appendiculate vein, and the sternopleural bristles are three (2 + 1) in number instead of two (1 + 1).

Genotype, the following species.

PROSENA NICHOLSONI, n. sp.

♂, ♀. Black, shining, with grey dusting on head, thorax and abdomen. Interfrontalia brown, face and anterior portion of cheeks brownish or yellowish testaceous, frontal orbits, parafacials, face, posterior portion of cheeks, and the parafacials, densely grey dusted; antennae varying from brown to fuscous, the base of third segment reddish-yellow; palpi brown or yellowish. Thorax with

traces of four blackish vittae, and irregularly marked with brown, especially at bases of the larger bristles and near posterior margin of dorsum. Abdomen with minute setigerous black dots on dorsum, and some larger dark brown spots on posterior margins of all tergites except fourth, the latter at bases of the strong bristles. Legs black. Wings greyish hyaline, a portion of the subcostal cell, both cross-veins, and at least the preapical angle of fourth vein, clouded with fuscous. Calyptrae white. Knobs of halteres fuscous.

♂. Eyes bare; frons at vertex about half as wide as one eye, interfrontalia complete, narrower above than either orbit, the latter with quite long strong inner marginal bristles on entire length, which are incurved, ocellars well developed; parafacials bare from below level of second antennal segment, wider than third antennal segment and more than half as wide as height of cheek, the latter not one-third of the eye height; facial carina as in *Prosenia*, visible from the side; arista plumose; third antennal segment about three times as long as second; vibrissae a little above mouth margin; proboscis and palpi as in *Prosenia*. Thorax with two pairs of presutural acrostichals, three pairs of postsutural dorsocentrals, and two pairs of intraalars, the other characters, except the sternopleurals, as in *Prosenia*. Abdomen subcylindrical, the tergites all with apical central bristles which become progressively farther from apex to fourth where they are almost on centre of disc; hypopygium small, concealed. Legs shorter than in *Prosenia*, similarly bristled, the mid tibia with a quite long submedian ventral bristle, the hind tibia usually with two long and one short bristles on the anterodorsal and posterodorsal surfaces, and two on the anteroventral. Apical wing venation as in Figure 15.

♀. Differs from the male in having the frons about as wide as one eye, the orbits wider and with two proclinate outer bristles, the parafacials wider, almost as wide as height of cheek, the abdomen broadly ovate, and the femora widened at the extreme apices much as in *Prosenia nigripes* Curran, and mesonotum broadly dark on disc.

Length, 5-6.5 mm.

Type and two male paratypes, Gundamaian, National Park, N.S.W., 1.1.1926 (Nicholson); allotype, Eradu, W.A., 8.9.1926 (E. W. Ferguson); male paratypes, Woodford, N.S.W., 28.11.1925 (Nicholson), Sydney, N.S.W., 3.9.1922 (Health Dept.), female, Wyalkatchem, W.A., 1.9.1926 (E. W. Ferguson). Seven specimens.

To facilitate the recognition of this genus and others in which the face is prominently carinate and the arista plumose, that are not included in my key to the Australian genera, I append a key below. All of those genera, with the exception of one in which the centre of the propleura is haired, will run down to Caption 22 in the key. At that caption, two of the genera split off from the others on the length of the proboscis, *Prosenia* and *Prosenina* having it more than twice as long as the head, while the others have it not more than one and a half times as long as the head. All of the other genera have the palpi rather short, not more than twice as long as the basal diameter of the apical portion of the proboscis, and would cause one to hesitate as to which section under Caption 23 they ought to fall in. They fit in neither very well, and it will therefore be necessary to erect a new section on the basis of the plumose arista and prominently carinate face, no genus in either section of Caption 23 having both of those characters in common. All of the genera are closely related and the following key will be of service in their recognition.

Key to the Genera.

1. Apical portion of proboscis distinctly longer than head, usually not less than twice as long, heavily chitinized, swollen at base and from there attenuated to apex or near it (Fig. 7) 2
- Apical portion of proboscis not, or very slightly, longer than head, chitinized, and usually of almost uniform thickness on entire length, the labellae always enlarged (Fig. 16) 3
2. First posterior cell of wing open *Prosenina* St. Fargeau and Servelle
First posterior cell of wing closed and short petiolate *Prosenina*, n. gen.
3. Centre of propleura haired; lower calypter bare on upper surface; parafacials finely haired on almost their entire length *Rhyncodexia* Bigot
Centre of propleura bare 4
4. Lower calypter with fine erect hairs on a portion of upper surface along the outer margin 5
Lower calypter bare except for the marginal fringe *Austrodedxia*, n. gen.
5. Parafacials bare below level of lower frontal bristle *Lasiocalypter*, n. gen.
Parafacials haired on almost their entire extent *Lasiocalyptrina*, n. gen.

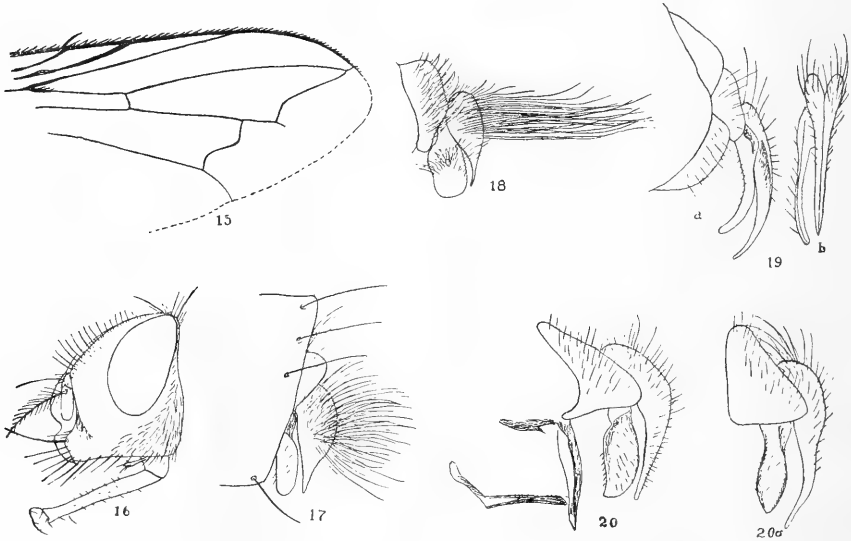


Fig. 15.—*Prosenina nicholsoni*. Apex of wing.

Fig. 16.—*Lasiocalypter nigrihirta*. Head of male from the side.

Fig. 17.—*Lasiocalypter nigrihirta*. Hypopygium of male from the side.

Fig. 18.—*Lasiocalypter hirticauda*. Hypopygium of male from the side.

Fig. 19.—*Lasiocalypter flavohirta*. Hypopygium of male; a, from the side; b, from behind; one side incomplete.

Fig. 20.—*Lasiocalypter atripes*. Hypopygium of male from the side.

Fig. 20a.—*Lasiocalyptrina modesta*. Hypopygium of male from the side.

Genus RHYNCODEXIA Bigot.

I have some doubts as to the identification of this genus and wrote to Mr. J. E. Collin some time ago asking him to examine the genotype for certain characters, but have had no reply from him. Provided it is possible for me to obtain the desired information later, I will publish the results and if correction is necessary will make same in a future paper.

RHYNCODEXIA LONGIPES (Macquart).

This is the largest species of this tribe known to me from Australia, and has the hind legs much elongated. Macquart's description will enable anyone to identify it.

Localities: Barrington Tops, January, 1925 (S.U. Zool. Exped.), and Gunda-
maian, National Park, N.S.W., 1.1.1926 (Nicholson). Thirty specimens.

Genus LASIOCALYPTER, n. gen.

This genus is distinguished from any in Dexiini known to me, in which the face is strongly carinate, by the presence of rather long erect hairs along the outer margin of the lower calypter. Such hairs occur in the tachinid genus *Nemoræa* Robineau-Desvoidy, and in certain Calliphoridae, but in these they occupy a larger proportion of the surface, or, when more restricted, they are near base and not along the outer margin. In *Anacamptomyia africana* Bischof, an African species, the lower calypter is similar to that of the present genus, but the face is not carinate, and the arista is merely pubescent, not plumose. In other respects the new genus is quite similar to the preceding genus. The wing lacks an outstanding bristle at the apex of the auxiliary vein on the costa.

Genotype, *Lasiocalypter flavohirta*, n. sp.

I present below a key for the separation of the species now known to me.

Key to the Species.

- | | |
|---|----------------------------|
| 1. Males | 2 |
| Females | 4 |
| 2. Fourth visible abdominal tergite with quite long and moderately strong apical bristles; claws and pulvilli of fore tarsi at least as long as fifth segment of that pair of tarsi; all of the hairs on the mesopleura, except those on lower anterior angle, and all, or a large portion, of those on margin of disc of the lower calypter, black | <i>nigrihirta</i> , n. sp. |
| Fourth visible abdominal tergite centrally without strong apical bristles; claws and pulvilli of fore tarsi not as long as the apical segment of same; most of the hairs on the mesopleura and all of those on margin of disc of lower calypter yellow | 3 |
| 3. Bases of the superior hypopygial forceps with numerous long brown hairs which project backwards and are slightly curled (Fig. 18); legs entirely black | <i>hirticauda</i> , n. sp. |
| Bases of superior forceps without long backwardly directed hairs | 3a |
| 3a. Apices of femora, fore and mid tibiae, and bases of hind tibiae fulvous yellow; hypopygium as Fig. 19 | <i>flavohirta</i> , n. sp. |
| Legs entirely black; hypopygium as Fig. 20 | <i>atripes</i> , n. sp. |
| 4. All of the discal hairs on the mesopleura yellow or pale | 5 |
| None of the discal hairs on the mesopleura pale | 6 |
| 5. Legs entirely black; all femora widened at apices where they are as thick as at any other point; hind tibiae not at all attenuated basally | <i>hirticauda</i> , n. sp. |
| Apices of femora and nearly all of tibiae yellowish-brown, remainder fuscous; femora not at all widened at extreme apices, apical third or more of mid and hind pairs distinctly attenuated, and thinner than the basal portions | <i>flavohirta</i> , n. sp. |
| 6. Legs black; first visible abdominal tergite with a pair of strong apical central bristles; second with one or more pairs of discal bristles | <i>nigrihirta</i> , n. sp. |
| Tibiae brownish-yellow; no apical central bristles on first visible abdominal tergite, and no discals on second tergite | <i>flavohirta</i> , n. sp. |

LASIOCALYPTER NIGRIHIRTA, n. sp.

♂, ♀. Occiput and frontal orbits fuscous, densely white dusted, interfrontalia dark brown in the male, fuscous in the female, lower portion of parafacials and

anterior portion of cheeks reddish, upper portions of parafacials whitish-grey dusted; face testaceous yellow, dull; antennae in female almost entirely black, only the apex of second segment rufous, paler in the male, second segment rufous, the third segment reddish at base, fuscous beyond; arista and their hairs fuscous; palpi brownish to fuscous, paler at apices; proboscis with the apical section glossy black; occipital hairs pale, those on margins and the frontal hairs dark. Thorax black, with quite dense whitish-grey dusting, the mesonotum with four black vittae, the submedian pair discontinued between suture and posterior margin, the sublateral pair interrupted at suture and continued almost to posterior margin, the surface slightly speckled with dark colour at bases of the hairs and bristles, the female with indications of brown intervening vittae behind suture, especially centrally in front of scutellum. Abdomen coloured as thorax, the dusting dense and changeably checkered, the male with a dark dorsocentral vitta which is widened at apex of each tergite, the female without such a distinct vitta. Pleural hairs mostly yellow, but those on disc of the mesopleura all black; abdominal hairs black above, largely yellow below to beyond middle. Legs black in female, apices of femora sometimes yellow in male, and generally the tibiae yellowish in the latter also. Calyptrae yellowish-white, margins yellow, the hairs partly yellow, partly black, in both sexes. Wings greyish hyaline, veins slightly browned in the female.

♂. Frons at vertex about as wide as third antennal segment, the interfrontalia obliterated just in front of ocelli, orbits with long bristly hairs along their inner margins; ocellar bristles long and fine, no hairs laterad of the marginal bristles; parafacials bare, about as wide as length of third antennal segment; profile as Figure 16; palpi short, not dilated at apices. Thorax with three plus three dorsocentrals, one pair of long presutural and prescutellar acrostichals, sternopleurals one plus one, prosternal plate and centre of propleura bare. Abdomen tapered to apex, cylindrical, first visible tergite depressed in centre to apex, bulging up on each side above, second tergite with a transverse depression at base above; all tergites with strong apical central bristles, second to fourth tergites with discal bristles; hypopygium as Figure 17. Legs slender, moderately elongated, hind tibiae attenuated on basal third or less; fore tibia with two or three anterodorsal and posterior bristles; mid tibia with one ventral, one anterodorsal, one posterodorsal, and two posterior bristles; hind tibia with one anteroventral and about three anterodorsal and posterodorsal bristles; claws and pulvilli of fore tarsi as long as fifth tarsal segment. Wings with some setulae at base of third vein above and below; bend of fourth vein angular; distance from apex of third vein to apex of wing about half as great as distance from it to apex of second vein; inner cross-vein distinctly proximad of level of apex of first vein and close to middle of discal cell.

♀. Frons at vertex nearly one-third of the head width; each orbit with two proclinate outer bristles, and some fine hairs laterad of the inner marginal bristles. Abdomen ovate, bristled as in the male. Legs not so long as in male, similarly bristled.

Length, 11-12 mm.

Type, male, allotype, one male and one female paratype, Barrington Tops, N.S.W., February, 1925 (S.U. Zool. Exped.).

LASIOCALYPTER HIRTICAUDA, n. sp.

♂, ♀. Differs from the preceding species in having the palpi yellow, the pleural hairs practically all yellow, the abdomen translucent fulvous yellow in the male,

less translucent in female, with a black dorsocentral vitta and brown apices to tergites in both sexes, the dorsum with greyish or yellow dusting which is rather checkered and most distinct on the anterior lateral portions of the dorsal exposure of the tergites, legs black, calyptres yellowish, more intensely yellow on margin of lower one, halteres yellow.

Structurally the species differ as stated in the key, the tufted apex of abdomen of the male (Fig. 18) and the almost uniformly thick hind femora of the female being very distinctive. The mesonotum has two pairs of intra-alars, the abdomen in the female lacks discal bristles on second and third tergites and apical bristles on first, the male has apical central bristles on first and second visible tergites, a pair of bristles near apex of third tergite centrally and no apical bristles on fourth on the dorsal section, though there are some on sides, the second and sometimes the third with weak discals. Mid and hind femora of male attenuated on apical third or more, the hind pair with some anteroventral bristles on basal half, mid and hind tibiae in same sex attenuated on more than their basal third, mid pair without a distinct submedian ventral bristle, hind pair with one anteroventral, one posterodorsal, and usually two anterodorsal bristles, all very short; fore tibia in both sexes with some short bristles on median portion of anterodorsal surface, and two posterior bristles; female with a distinct submedian ventral bristle.

Length, 8-10 mm.

Type, male, allotype, and one male and two female paratypes, Barrington Tops, N.S.W., January and February, 1925 (S.U. Zool. Exped.).

This species rather closely resembles some species of *Prosema* in superficial appearance, but the shorter proboscis and haired lower calypter readily separate it from any in that genus.

LASIOCALYPTER FLAVOHIRTA, n. sp.

♂, ♀. Similar in general appearance to *nigrihirta*, but with the dorsum paler owing to the dusting being whitish and the soft hairs largely pale, the pleura almost entirely pale-haired, and the apices of the femora broadly yellow, more conspicuously so ventrally.

Structurally the male is very similar to that of *hirticauda*, but the absence of long backwardly-directed hairs on the bases of the superior forceps, and differently-shaped forceps, will readily distinguish the two species. The female differs very markedly from that of *hirticauda* in the shape of the femora, which are attenuated apically, though not so much so as in the male. There is some slight difference in the colour of the hairs on the mesopleura in some of the specimens before me, and possibly they do not all belong to the same species (Figure 19).

Length, 10-12 mm.

Type, male, allotype, and two male and one female paratypes, Barrington Tops, N.S.W., Jan.-Feb., 1925 (S.U. Zool. Exped.); two females, same locality, 25.1.1922 (Nicholson).

LASIOCALYPTER ATRIPES, n. sp.

♂. Very similar to the preceding species, but with the four black vittae on the mesonotum rather broader and more distinct, and the legs entirely black.

Structurally similar, but readily distinguished by the structure of the hypopygium (Fig. 20), the broad, leaf-like inferior forceps apparently connecting

the species more nearly with the other species than with *flavohirta*. The legs are the same in structure as in the preceding species.

Length, 11 mm.

Type, Blue Mts., N.S.W., 26.1.1922 (Health Dept.). One specimen.

In figuring the hypopygia of the species of this genus, I have purposely left out the penis except in one figure, but the omission is unimportant as this organ is apparently similar in all the species, the only appreciable difference being found in the superior and inferior forceps.

Genus LASIOCALYPTRINA, n. gen.

Similar to the preceding genus, distinguished therefrom by the haired parafacials. The hind tibiae in the male are much attenuated on their basal halves as in some species of several of the foregoing genera, and the male has the first visible tergite humped up on each side dorsally and the second depressed across its anterior third.

Genotype, the following species.

LASIOCALYPTRINA MODESTA, n. sp.

♂, ♀. Similar to *Lasiocalypter flavohirta* in general coloration, even to the broadly pale apices of femora and the pale-haired pleura and lower calypter.

Structurally it differs from that species in having the parafacials with fine and rather long forwardly-directed pale hairs on the greater portion of their extent, and the hypopygium quite different, very similar to that of *L. atripes*, but with the inferior forceps more noticeably narrowed at bases (Fig. 20a), and the superior pair more slender and more evidently curved on apical halves.

It is noteworthy that the female which I associate with the male of this species has the hind tibiae almost as conspicuously attenuated on basal halves as does the male, while the female associated with the male of *flavohirta* has them hardly at all attenuated. In both species the female has strong apical bristles on the fourth visible tergite, while the male lacks them.

Length, 11-12 mm.

Type, male, and one male paratype, Gisborne, V., 19.3.1922, and 26.3.1922, respectively; allotype, Barrington Tops, January, 1925 (S.U. Zool. Exped.).

Provided it may be discovered subsequently that there are two species confused in my material, the male will be considered as entitled to bear the specific name.

It is also possible that the character used for separation of the genus from *Lasiocalypter* may not be found invariably dependable and the genus may fall as a synonym thereof.

Genus AUSTRODEXIA, n. gen.

Very similar to *Rhyncodexia*, but there are no hairs on the centre of propleura, or on the parafacials below the lower frontal bristle or at least from a short distance below it. The lack of erect hairs on disc along the outer lateral margin is a ready distinguishing mark from *Lasiocalypter*.

Genotype, *Austrodexia setigera*, n. sp.

Key to the Species.

Males.

1. Lower calypter with a large brown stain or cloud on disc, best seen when the calypter is viewed from behind 2

- Lower calypter satiny-white or uniformly yellowish-white, without a dark discal cloud when seen from any angle 3
2. First visible abdominal tergite with the anterior depression not continued beyond middle; lower calypter with most of the marginal hairs on outer side black, the long hairs carried farther towards apex than usual; intra-alars three, the anterior one close to suture; posteroventral bristles on fore femur uniseriate; tarsal claws and pulvilli fully as long as entire antenna; one of the pair of bristles on costa at apex of auxiliary vein as long as inner cross-vein *pictipennis* Macquart.
- Depression on anterior portion of first visible tergite continued to almost the extreme apex centrally; lower calypter with all of the marginal hairs yellowish-white; intra-alars two; posteroventral bristles on fore femur in more than one series; tarsal claws and pulvilli shorter than antenna; longer one of the two bristles at apex of auxiliary vein much shorter than inner cross-vein, hardly distinguishable *rubricarinata* Macquart.
3. Hind femur gradually and slightly tapered from beyond middle to apex, and with one outstanding posterodorsal bristle at not, or but little, more than its own length from apex; hind tibia not strikingly attenuated basally, or, if so, on less than its basal fourth, and with several anterodorsal and posterodorsal bristles, one beyond middle distinctly longer than diameter of tibia 4
- Hind femur much attenuated on apical third or more, widened at extreme apex, and with from one to five bristles on basal portion of apical half; if with only one bristle, it is at one-third from apex; hind tibia distinctly attenuated on about its basal half, usually with one anterodorsal and posterodorsal bristle beyond middle which are not longer than its diameter 5
4. Mid tibia with the submedian ventral bristle much longer than the tibial diameter; three or more bristles on the basal half of anteroventral surface of hind femur; intra-alars three *setigera*, n. sp.
- Mid tibia with the submedian ventral bristle very small, often lacking; when present, not nearly as long as tibial diameter; usually no strong bristles on the basal half of anteroventral surface of hind femur; intra-alars two *communis*, n. sp.
5. Fifth abdominal sternite with many long downwardly-directed bristles on basal half of each process, which are longer than the process and curve backward at apices giving the abdomen a tufted appearance (Fig. 23) *setiventris*, n. sp.
- Fifth abdominal sternite without long bristles as described above 6
6. Hind tibia with a submedian posterodorsal bristle; inner cross-vein distinctly clouded with fuscous *unipuncta*, n. sp.
- Hind tibia without a submedian posterodorsal bristle; inner cross-vein not at all clouded 7
7. Fore coxae entirely yellow-haired *pallidihirta*, n. sp.
- Fore coxae with some strong black bristles amongst the yellow hairs .. *mixta*, n. sp.

Females.

1. Lower calypter with a large brown mark or cloud on middle of disc 2
- Lower calypter white or yellowish, with a dark discal mark 3
2. Intra-alars three *pictipennis* Macquart.
- Intra-alars two *rubricarinata* Macquart.
3. Inner cross-vein of wings distinctly clouded with fuscous *unipuncta*, n. sp.
- Inner cross-vein of wings without a dark cloud 4
4. Scutellum quite noticeably paler than the mesonotum, yellowish testaceous *pallidihirta*, n. sp.
- Scutellum not noticeably paler than the mesonotum *setiventris*, n. sp.

AUSTRODEXIA PICTIPENNIS (Macquart).

♂, ♀. A black species, with grey dusting on head, thorax, and abdomen. Interfrontalia and face centrally brownish testaceous in male, interfrontalia in female fuscous; basal two antennal segments reddish, third fuscous; palpi fuscous. Thorax with four or five dark dorsal vittae. Abdomen with the whitish-grey dusting distinctly checkered, the male with darker spots at bases of the strong

bristles. Legs black. Wings greyish hyaline, with both cross-veins and usually the fourth vein on its apical section narrowly clouded with fuscous. Calyptrae white, lower one with a large dark brown discal mark. Halteres brown.

Frons of male at vertex hardly wider than third antennal segment, ocellars and inner marginal bristles on orbits long; frons of female fully one-third of the head width, orbits at level of lower reclinate outer bristle about as wide as interfrontalia, each orbit with three outer bristles on upper half, the upper one curving outward and slightly backward, the other two proclinate; palpi short; arista rather densely haired, the longest hairs about as long as width of third antennal segment. Thorax with three plus three dorsocentrals, one or two plus two acrostichals, one plus one sternopleurals, and six marginal scutellars. Abdomen subcylindrical and tapered in male, with apical central bristles on all tergites and discals on second to fourth, first visible tergite with the central anterior depression not very sharply defined and ceasing well before apex of dorsum, fifth sternite with several quite strong bristles on each process, hypopygium as in Figure 21; abdomen of female ovate, lacking apical central bristles on first visible tergite and discal bristles on the others. Legs normal in female, except that the femora are slightly spatulate at extreme apices, the hind tibiae of male very distinctly attenuated at bases; female with, male without, a submedian ventral bristle on mid tibia. Outer cross-vein of wing almost S-shaped; first posterior cell narrowly open; one of the bristles at apex of auxiliary vein on costa quite long.

Length, 7-11 mm.

Localities: Hawkesbury Sandstone bush, 9.9.1923, two males (Nicholson); National Park, Gundamaian, 12.4.1925 (Mackerras); Kuring-gai, 26.9.1925; and Mundaring, W.A., 26.8.1926 (E. W. Ferguson).

It must be noted that identification of this and other Macquart species will require confirmation by examination of type specimens, if such exist.

AUSTRODEXIA RUBRICARINATA (Macquart).

♂, ♀. This species is quite radically different from the preceding one, having the hind tibiae in the male without an attenuation at bases, the first visible abdominal tergite with a quite deep depression to apex in the male, no discal bristles usually present on third visible tergite in that sex, and the mesosternum with dense erect yellow hairs in front of the posterior marginal bristles which are not present in the male of *pictipennis*. The outer cross-vein is not noticeably clouded, though the inner one is, and the former is not so abruptly bent. The frons of the female is more narrowed above than in *pictipennis*, being less than one-third of the head width at vertex and, though this sex has a rather evident bristle at apex of the auxiliary vein on costa, the male has none.

Length, 10-12 mm.

Localities: National Park, 16.10.1927, and 1.1.1926 (Mackerras), Bayview, Sydney, N.S.W., 19.12.1925 (Health Dept.); "Allowrie", Killara, N.S.W., 7.11.1921; Woy Woy, 8.3.1924 (Nicholson); Mosman, N.S.W., 24.9.1922; Eidsvold, Qld. Thirteen specimens.

AUSTRODEXIA SETIGERA, n. sp.

♂, ♀. Very similar to the preceding species in coloration, but the face is more yellowish, and the lower calypter is satiny-white. Structurally it differs in having the mid tibia in both sexes with a strong submedian ventral bristle, the hind

tibia of male slightly but quite evidently attenuated at base, and the hind femur with three or four strong bristles on the basal half of the anteroventral surface. The inner cross-vein of the wing is slightly clouded, the outer one is without an evident cloud, and there is one rather long bristle on costa at apex of auxiliary vein; outer cross-vein less curved than in the two preceding species.

Length, 11-13 mm.

Type, male, allotype, and three male paratypes, Woy Woy, sand bush, 2.9.1925 (Nicholson); paratypes, same locality as type, 8.8.1925 (Nicholson), and Manly, Sydney, N.S.W., 17.9.1923 (Health Dept.).

The last mentioned male paratype has a pair of strong apical central bristles on the first visible abdominal tergite, which are lacking in the other males, but it agrees in every character other than that with the type, including the hypopygium (Fig. 25).

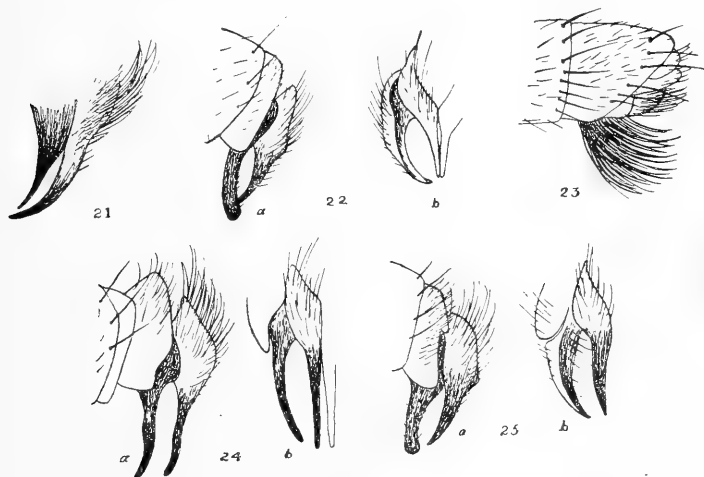


Fig. 21.—*Austroderia pictipennis*. Apex of hypopygium of male from the side.

Fig. 22.—*Austroderia communis*. Hypopygium of male; a, from the side; b, from behind; one side.

Fig. 23.—*Austroderia setiventris*. Apex of abdomen of male from the side.

Fig. 24.—*Austroderia pallidihirta*. Hypopygium of male; a, from the side; b, from behind; one side.

Fig. 25.—*Austroderia setigera*. Hypopygium of male; a, from side; b, from behind.

AUSTRODEXIA COMMUNIS, n. sp.

♂. Very similar to the preceding species, differing in the characters mentioned in the key to species, and in the genitalia of the male (Fig. 22), though the latter has the same general characteristics to a greater extent than in other species of the genus.

Length, 11-13 mm.

Type, Canberra, F.C.T., 27.1.1929 (M. Fuller); paratypes, National Park, 16.10.1927, Waterfall, 9.11.1927, National Park, Gundamaian, 12.4.1925 (Mackerras), Bunya Mt., Qld., 9.1.1926.

AUSTRODEXIA UNIPUNCTA, n. sp.

♂. A more slender species than the preceding one, with the hind legs more elongated, the hind tibiae attenuated on about their basal halves, the hind femora without well developed anteroventral bristles on the basal halves, and the mesopleura black, instead of white, haired.

Length, 11-13 mm.

Type, male, and one paratype, Barrington Tops, N.S.W., January, 1925 (S.U. Zool. Exped.); paratypes, National Park, 16.10.1927, and Gundamaian, National Park, 12.4.1925 (Nicholson).

AUSTRODEXIA PALLIDIHIRTA, n. sp.

♂, ♀. The largest and most robust species of the genus before me, readily distinguished from its congeners by the reddish or testaceous scutellum, and the conspicuous pale hairs on thorax and abdomen. The abdomen has the grey dusting on dorsum quite dense, and because of the distinct dark dorsocentral vitta and transverse dark marks on apices of the tergites, they appear almost as whitish spots on each side of each tergite. The face is paler than in the other species and so also are the central portions of the tibiae. The mid and hind tibiae are conspicuously attenuated on basal halves in the male, but they are not noticeably so in the female, though they are distinctly curved. Here, as in the other species, there is the sexual dimorphism of the abdominal armature, the male having discal bristles and the female lacking them. Hypopygium of male as Figure 24.

Length, 12-15 mm.

Type, male, allotype, and ten paratypes, Barrington Tops, N.S.W., January and February, 1925 (S.U. Zool. Exped.).

AUSTRODEXIA MIXTA, n. sp.

♂. Very similar to the preceding species, but smaller, and differing as noted in the key to species.

Length, 12 mm.

Type, male, Barrington Tops, N.S.W., January, 1925 (S.U. Zool. Exped.).

AUSTRODEXIA SETIVENTRIS, n. sp.

♂. Like a slender specimen of *pallidihirta*, but with the scutellum not paler than the mesonotum, the legs even longer and more slender, and the body not so robust. Structurally the species is distinguished at once from all its congeners by the presence of many long bristly hairs on the basal portion of the fifth abdominal sternite, which curve backwards and give the abdomen a slightly tufted appearance. I have not dissected the hypopygium, as the external characters appear to distinguish the species for present purposes (Fig. 23).

Length, 13 mm.

Type, male, allotype, and three male paratypes, Glenreagh, N.S.W., 29.1.1923, 2.2.1923, and 25.1.1923 (Health Dept.).

When the family is ultimately worked up intensively, the hypopygia of all the species ought to be figured and more extensive descriptions published, but in the meantime the above details will suffice, with the type specimens, for comparison.

Genus ANATROPOMYIA, n. gen.

Propleura haired in centre; prosternum bare; face without a distinct keel; arista short-haired; palpi well developed; proboscis normal; third vein of wing

setulose at base, other veins bare; first posterior cell open, ending near apex of wing; lower calypter widened behind.

Genotype, the following species.

ANATROPOMYIA FLAVICORNIS, n. sp.

♂. Frons fuscous, orbits grey-dusted, face testaceous, parafacials and anterior portion of cheeks brown, the former yellowish-grey dusted, posterior portions of cheeks fuscous, with grey dust; antennae orange-yellow, basal two segments dark; palpi orange-yellow; proboscis black. Thorax black, with rather dense pale-grey dust, dorsum with four black vittae, the submedian pair abbreviated behind. Abdomen black, more distinctly shining than thorax, with grey dust which is somewhat checkered, and a rather indistinct dark dorsocentral vitta. Legs black. Wings greyish hyaline. Calyptrae yellowish-white, with a dark spot in centre of upper one. Halteres brown.

Eyes bare; frons at vertex about one-third as wide as one eye, interfrontalia entire, orbits linear above, with quite long inner marginal bristles, inner verticals developed, ocellars proclinate, profile as Figure 26. Thorax with three plus three dorsocentrals and acrostichals, three intra-alars, the posterior sublateral lacking, sternopleurals two plus one and no hairs below lower calypter. Abdomen sub-cylindrical, tapered to apex, with apical bristles on tergites 2 to 4 and discals on 3 and 4. Legs normal in length, tibial bristles quite long, mid pair with a submedian ventral bristle. Wings normal, preapical bend of fourth vein angular, without a spur, outer cross-vein much closer to bend than to inner cross-vein.

Length, 11 mm.

Type, Ilford, N.S.W., 30.12.1923. One specimen.

This species is like a tachinine, being of stouter build than is usual in the Dexiini, but because of the haired arista, low situation of the antennal insertions, and one or two other characters, I place it in this tribe. Possibly it should be placed in *Trichostylum* Macquart, but the species is distinct from the type of that genus.

Genus HOBARTIA, n. gen.

Readily distinguished from its allies by the peculiar shaped head with the low placed antennal insertions, subplumose arista, and haired centre of propleura. Other characters may be gleaned from the description of the genotype given below.

Genotype, the following species.

HOBARTIA PECULIARIS, n. sp.

♂, ♀. Black, densely yellowish-grey dusted, basal two antennal segments, palpi, trochanters, and in the male the apical lateral portions of first visible and the entire sides of second visible tergite, testaceous yellow or reddish-yellow; tibiae more or less yellowish, sometimes entirely so. Wings greyish hyaline. Thorax with four incomplete dark dorsal vittae. Abdomen almost uniformly densely yellowish-grey dusted in male, shining black in female and with dense grey dust at bases of the tergites which tapers off apically. Calyptrae yellowish-white. Halteres brown.

Eyes subnude; profile as in Figure 27, frons depressed at vertex, inner verticals strong in both sexes, ocellars short and fine, orbits with an inner marginal series of incurved bristles and one recurved upper bristle; the male with rather strong

hairs laterad of the bristles, the female with two or more proclinate outer orbitals; arista with the longest hairs not as long as width of third antennal segment; palpi well developed. Thorax with three plus three dorsocentrals and acrostichals, the posterior sublateral bristle lacking, sternopleurals one plus one, marginal scutellars six. Abdomen tapered apically in male, the tergites subequal, first with shallow depression to apex, second and third with discal and apical

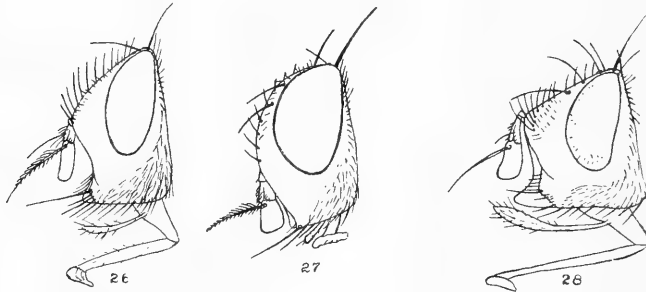


Fig. 26.—*Anatropomyia flavicornis*. Head of male from the side.

Fig. 27.—*Hobartia peculiaris*. Head of female from the side.

Fig. 28.—*Ezechopalpus rufofemorata*. Head of female from the side.

bristles, fourth with long strong bristles on sides and apex, female with the abdomen ovate, less strongly bristled. Legs normal, mid tibia in both sexes with ventral bristle, fore tarsi of female slender. First posterior cell open, ending slightly before wing tip, first vein bare, third setulose at base, outer cross-vein about one third from bend of fourth. Lower calypter broadened and rounded apically, lying close to side of scutellum.

Length, 6-8 mm.

Type, male, and allotype, Hobart, Tasmania, male labelled "Bred from Wood".

This is the only perfect species of the family I have seen from Tasmania.

Tribe LESKIINI.

This group is a rather difficult one to define, there being no outstanding characters for its recognition, although the general shape of the head is quite uniform in all the genera, there being a similarity in the long lower border which always exceeds the length of head at bases of antennae. The proboscis is always rather slender, in some cases with the apical portion very slender and exceeding the length of the head. In other respects the head differs both in the absence or presence of hairs on the arista and the parafacials, and though the palpi are always well developed there is a slight variation in both the length and the dilation of these in different genera. I have seen no Australian genus in which there are hairs on either the prosternum or the centre of the propleura, and the dorsocentrals are invariably three-paired behind the suture.

In my new key to the genera which I hope to publish shortly I have not attempted to bring the genera of the tribes together in the same section, believing that a key at this stage of our knowledge of this family here should primarily be intended to enable students to identify the species, and not to show relationships which unfortunately are too frequently based upon opinion and not upon

demonstrable facts either of biology or anatomy. Subsequent work, or some other worker, may discover reliable means for the grouping of the members of this and other tribes, but at present there is none such available which may be used with ease by even the advanced student of the family, and certainly none which is not susceptible to misconstruction, and therefore apt to mislead.

I have examined the genotypes of many of the genera which belong to this tribe, and base my deductions as to generic concepts upon these examinations. Coquillett has sunk *Pyrrhosia* Rondani, and *Myiobia* Robineau-Desvoidy and several other genera as synonyms of *Leskia*, but his generic concepts were quite broad and it is not advisable to accept his conclusions without careful comparisons of the genotypes, unless the genera are isogenotypic.

Genus DEMOTICUS Macquart.

Curran has referred one Australian species to this genus, but it does not belong here, so the genus should be deleted from the list, at least until confirmed.

Genus RHINOMYIOBIA Brauer and Bergenstamm.

This genus was founded for the reception of one species, *australis*, which, I consider, is represented amongst my present material. In his recent paper on the Diptera of the Fiji Islands, Bezzi described two species which he placed herein, but it is possible there are two genera represented in the recorded species, as the generic limits are not very clearly established. As accepted by me, on the basis of the characters of the genotype, the distinguishing features of the genus are: Parafacials bare below the lower frontal bristle, the latter not below apex of second antennal segment; proboscis with the apical section about as long as head and not very slender; palpi of average length; arista with distinct hairs, always distinctly longer than its basal diameter; abdomen without discal bristles. Bezzi describes one of his species as possessed of proclinate fronto-orbital bristles in both sexes, and the other without such bristles in the male. The one with the reclinate bristles in the male has the arista with its longest hairs as long as width of third antennal segment, while the other one has the arista much shorter. I have two species before me which exhibit the same difference in the aristal hairing, but in the one with long hairs there are no proclinate orbital bristles in the male.

Below I present a diagnosis of the two species in my hands.

- A. Arista with its longest hairs about twice as long as its basal diameter; frontal bristles biserial in front near bases of antennae; second visible abdominal tergite with a pair of long strong bristles; tibiae reddish-yellow; mesonotum when seen from behind with four narrow dark vittae which are not fused behind the suture *australis* Brauer and Bergenstamm.
- AA. Arista with its longest hairs about four or five times as long as its basal diameter, and about equal in length to width of third antennal segment; second visible abdominal tergite without well developed apical central bristles; tibiae largely infuscated; mesonotum when seen from behind with a pair of narrow dark grey submedian vittae in front of suture and on each side of these a broader spot-like black mark, the postsutural region with a broad black anterior marginal transverse mark which consists of the four fused vittae *transversalis*, n. sp.

RHINOMYIOBIA AUSTRALIS Brauer and Bergenstamm.

The male has the abdomen with a rather broad black dorsocentral vitta which is slightly widened at apex of second visible tergite and forms an apical fascia on third, while it almost entirely covers the apex of abdomen; the female has the

dorsocentral black vitta less defined and the apices of the tergites either entirely black or with three black marks. Both sexes have the frontal bristles at least biseriate anteriorly, most noticeably so in the male. There is a slight difference in the structure of the fore tarsi in the two females before me, one having the apical three segments more noticeably widened than the other. However, I consider they are the same species.

Localities: Sydney, N.S.W., 23.12.1923 (Health Dept.); National Park, Gunda-
maian, 12.4.1925 (Mackerras), and "Allowrie", Killara, N.S.W., 16.1.1921.

RHINOMYIOBIA TRANSVERSALIS, n. sp.

♀. Head testaceous, with grey dust, interfrontalia black-brown, antennae fulvous yellow, third segment black except at base; palpi orange-yellow. Thorax black, with brownish-grey dusting, scutellum not noticeably yellow as in *australis*, the mesonotum marked as stated in key. Abdomen reddish-yellow, with a partial blackish dorsocentral vitta, the bases of the tergites narrowly white dusted. Legs fulvous yellow, tibiae largely infuscated, tarsi black. Wings brownish hyaline, darkest along costa.

Frons at vertex hardly more than one-third of the head width, ocellar bristles minute, frontal bristles descending almost to apex of second antennal segment, in one series. Thorax with three plus three dorsocentrals, two pairs of presutural acrostichals, and two plus one sternopleurals. Legs normal, fore tarsi not widened, mid tibia with a ventral bristle. Wing venation as in *australis*, first posterior cell ending a little before wing tip.

Length, 8 mm.

Type, Cairns district, Qld. (Dodd), no other data.

I have a male which may belong to this species, but it lacks the arista and has the mesonotum marked as in *australis*, so there is some doubt as to its identity and I therefore leave it aside meantime. It is from Marwood, Queensland.

Genus EXECHOPALPUS Macquart.

This genus was unknown to me when I arranged my key to the genera, but I now have several species which are referable here. All except one of these have the palpi much longer than usual in the group, and rather distinctly club-shaped. Like all of the tribe, the prosternum and propleura are bare, and the head is longer at lower margin than at bases of antennae. In this genus the aristae are bare, the proboscis has the apical portion rather slender and varying from slightly shorter than, to a little longer than, the length of head at lower margin. The parafacials are either bare on their lower halves or almost so, the frontal orbits in male lack proclinate outer bristles, and they have at least one such in the female, the two upper outer bristles on each orbit in that sex being directed almost straight outward over the eyes, a character which distinguishes the genus from *Demoticus*, in which the upper bristle is directed, or curved, backward. The ocellars are distinct, quite strong in the female, and the profile of head is usually as in Figure 28. For other characters see the subjoined key and descriptions of species.

I am not certain that I have the genotype, *rufipalpis* Macquart, in hand and am therefore leaving it out of consideration in my treatment of the genus. An examination of the type specimen will be required to determine its identity and relationship to the species dealt with herein.

Key to the Species.

- 1. Males 2
- Females 3
- 2. Abdomen with well developed discal bristles on second and third visible tergites; first posterior cell of wing open; femora rufous yellow, fore pair fuscous on posterior side; abdomen rather densely whitish-grey dusted, first visible tergite with its dorsal exposure, second and third with their apices, rather broadly shining brownish-black *ruffemur*, n. sp.
- Abdomen without well developed discal bristles on second and third visible tergites; first posterior cell of wing closed and with a short petiole; femora black, rufous yellow on about the apical halves on ventral surface; abdomen quite densely whitish-grey dusted, the dust checkered when seen from different angles and not arranged as in preceding species *dubitalis*, n. sp.
- 3. Abdomen with well developed discal bristles on second and third visible tergites; legs tawny yellow, posterior side of fore femur and apical two or three segments of each tarsus fuscous *ruffemur*, n. sp.
- Abdomen lacking well developed discal bristles on at least the second visible tergite; legs not coloured as above 4
- 4. Legs black, slightly reddish at apices of femora, most noticeable ventrally *atripes*, n. sp.
- Legs tawny yellow, fore femur on posterior side and apices of tibiae slightly darkened, tarsi entirely black *fulvipes*, n. sp.

EXECHOPALPUS RUFIFEMUR, n. sp.

♂, ♀. Fuscous, with rather dense pale-grey dusting. Interfrontalia reddish to fuscous, orbits whitish dusted; basal two segments of antennae rufous, third fuscous; palpi rufous yellow, usually darker at apices. Thorax with four dark dorsal vittae, in female sometimes the mesonotum and disc of scutellum brown marked. Abdomen rather checkered on dorsum in female, the male, and to a lesser extent the female also, with dark apices to tergites 2 and 3. Legs tawny yellow, fore femora largely dark in male on posterior side, less so in female, tarsi infuscated at apices. Wings slightly fumose, more noticeably so basally. Calyptrae greyish-white. Halteres brown.

Eyes with sparse microscopic hairs; frons of male about one-fourth of the head width at vertex, orbits narrowed above, with incurved bristles along the inner margins and numerous lateral hairs, the female with the frons nearly one-third of the head width at vertex, orbits more strongly bristled along inner margins and with three long outer bristles on upper half, the uppermost two curved outwardly, the anterior one proclinate; arista bare, second segment short; profile as Figure 28. Thorax with three plus three dorsocentrals, two plus two acrostichals, the anterior postsutural pair nearer suture than usual, three pairs of intra-alars, three bristles on presutural lateral area, and three sternopleurals, prosternum and regions above and below lower calypter bare; scutellum with four long marginal and two shorter preapical bristles, the apicals undeveloped. Abdomen ovate, broader in the female, with apical central bristles of first and discal and apical bristles on other tergites. Fore tarsi of female not dilated, mid tibia in both sexes with anterodorsal and ventral bristles; hind tibia with two or three long and a number of short bristles on anterodorsal surface. First vein bare, third with setulae at base above and below; first posterior cell open, ending well before tip of wing, outer cross-vein not half as far from bend of fourth vein as from inner cross-vein, a quite conspicuous costal bristle at apex of auxiliary vein.

Length, 9-11 mm.

Type, male, allotype, and eight female paratypes, Eradu, W.A., 8.9.1926, and one female paratype, Wyalkatchem, W.A., 1.9.1926 (E. W. Ferguson).

EXECHOPALPUS DUBITALIS, n. sp.

This species differs from the preceding one in being smaller, and in having darker legs, and the first posterior cell of wing closed. It is possible that there are sometimes discal bristles on the third visible abdominal tergite, but it is hardly likely that such are ever present on the second. Structurally the male differs from that of the preceding species in having the frons less protuberant, and the third antennal segment narrower. Besides the closed first posterior cell of the wing, the bend of the fourth vein is more rounded than in the preceding species and may be used as a distinguishing character.

Length, 6.5 mm.

Type and one male paratype, Tammin, W.A., 31.8.1926 (E. W. Ferguson).

This species in some particulars agrees very well with Macquart's description of the genotype, but it does not do so closely enough to justify me in deciding that it is that species. The tibiae are but slightly paler at bases than at apices and not markedly yellowish as would be expected from the description of *rufipalpis*.

EXECHOPALPUS NIGRIPES, n. sp.

♀. Agrees very well with the colour description of *rufifemur* in so far as the head, thorax, and abdomen are concerned, except that the latter has no dark apices to the tergites and is checkered on dorsum. The legs are black, with very slight indications of red colour at extreme apices, most noticeable below.

Structurally the species differs from *dubitalis* in having the first posterior cell of the wing narrowly open, and in having the frons less protuberant. The fourth visible abdominal tergite has the discal transverse series of bristles quite strong and conspicuous.

Length, 7 mm.

Type, Sydney, N.S.W., 25.10.1925 (Health Dept.). One specimen.

This can hardly be *rufipalpis*, as in the females of this and related genera the legs are always paler than in the males.

EXECHOPALPUS FULVIPES, n. sp.

♀. Similar in coloration to *dubitalis*. but the humeri and apex of scutellum are slightly yellowish, the fore femora are narrowly striped with fuscous along the posterior side, and the tarsi are black. Sides of abdomen yellowish at base.

The palpi are not as long as in the other species, being shorter than the length of the head, and are less pronouncedly club-shaped, with much shorter bristles than usual, appearing almost bare except under a high power lens. The head is much as in the other species. with the parafacials above wider than the third antennal segment. The thorax is similar to that of *rufifemur*, except that there is a pair of apical bristles on scutellum, which are rather short and curve upward. Apical bristles on abdominal tergites strong, present on all tergites, discals lacking even on the fourth visible tergite. First posterior cell of wing open, bend of fourth vein angulate. Fore tarsus slender, mid tibia with two or three anteroventral bristles, the lower one longest, and a strong submedian ventral bristle.

Length, 8 mm.

Type, Eradu, W.A., 8.9.1926 (E. W. Ferguson). One specimen.

This species is slightly aberrant in having the palpi shorter and less strongly club-shaped and bristled than in the other species, but the frontal bristling is the

same as in the others, and in most characters it agrees so closely with them that I can see no reason for removing it from the genus.

There are several other Australian genera of this tribe.

Tribe PALPOSTOMINI.

I have already presented a key for the identification of the three genera of this tribe known to me, in Part xii of this series of papers, but in some manner I erred in omitting *Eustacomylia* Malloch from the segregate in my recent key to the Australian Tachinidae in which the propleura is haired, and included it in the one with the propleura bare. I present below some data on the tribe and rectify this error.

Genus EUSTACOMYIA Malloch.

This genus has the propleura haired centrally and falls in the group contained between Captions 2 and 13 in my recent generic key. It is at once distinguished from all the genera in the segregate by the unlobed lower calypter, which is not produced on its inner side, but equally wide from base to beyond middle, lies well separate from the scutellum, and is evenly rounded at apex.

If one attempts to place it in the published key, provided the propleural hairs are not overlooked, it will not run out to any genus because of the lack of a facial keel. There are several genera dealt with in the present paper that fail to find a place in the key because of this same feature, and I present herein an addendum to the key to include these.

I have now in hand two species of the genus and present below a comparative synopsis to enable students to identify them.

- A. Arista hardly longer than the third antennal segment; abdomen brownish testaceous, with a blackish dorsocentral vitta, and dark dots at bases of most of the hairs and bristles, especially noticeable apically, the bases of the tergites grey dusted; outer cross-vein of the wing almost exactly mid-way between the inner cross-vein and bend of fourth vein; mid tibia with a ventral bristle beyond middle *breviseta* Malloch.
- AA. Arista longer than the entire antenna; abdomen dull black, mottled with grey dusting, which is seen only from certain angles, most evident on bases of tergites, and on a pair of small discal spots on second tergite; outer cross-vein of wing at about three-fifths of the distance from inner cross-vein to bend of fourth vein; mid tibia without a ventral bristle beyond middle .. *hirta*, n. sp.

EUSTACOMYIA BREVISETA Malloch.

I have still the type specimen of this species in my hands which enables me to give the above comparative data and other facts contained in the description of the new species. The locality of the type is Sydney, N.S.W.

EUSTACOMYIA HIRTA, n. sp.

♂. A larger, more robust, and much darker species than the genotype, with the surface hairs much longer. Head testaceous yellow, occiput fuscous, with grey dust, parafacials yellow dusted; interfrontalia dark brown; antennae and palpi testaceous yellow, third segment of former browned apically; aristae fuscous; all cephalic hairs dark. Thorax black, slightly shining, mesonotum with whitish-grey dust, which leaves five black vittae, the central one lacking in front of suture, the submedian pair not continued much behind suture; pleura grey dusted.

Abdomen dull black, with whitish dust, which appears speckled and is changeably visible as the surface is viewed from different angles. Legs pitchy, coxae and femora yellowish, the anterior surface of the fore pair noticeably pale, tibiae yellowish. Wings greyish hyaline. Calyptrae fuscous. Halteres brown.

Eyes bare; frons in front of ocelli not as wide as third antennal segment, verticals undifferentiated, ocellars the same, each orbit with some fine bristles along the inner margin on anterior two-thirds or more, haired laterally, the hairs continued on parafacials to lower level of eye, parafacials wider than third antennal segment, and about half as wide as height of cheek; arista microscopically pubescent; palpi quite long, slightly thickened. Thoracic dorsum with long, strong, erect hairs, the postsutural dorsocentrals four pairs; one long pair of acrostichals in front of suture; the discal hairs on scutellum much longer and finer than in *breviseta*; sternopleurals two plus one; postscutellum with the chitin more obviously rounded over above than in *breviseta*. Abdomen narrowly ovate, with quite long erect hairs, and long apical bristles on tergites 2 to 4. Legs normal, no anterodorsal bristles on fore tibia. Wing with setulae at base of third vein above and below.

Length, 9 mm.

Type, "Allowrie", Killara, N.S.W., 9.10.1921, no collector's name given. One specimen.

Genus APALPOSTOMA, n. gen.

This genus will take the place of *Eustacomylia* Malloch in my generic key as it will run down to Caption 19, second section, therein. It has the first posterior cell of the wing open, and the bend of fourth vein with a short spur vein which is never present, as far as I have seen, in *Palpostoma* Robineau-Desvoidy. There is one species of *Palpostoma* which has the first posterior cell of the wing very narrowly open or just closed at apex, *apicalis* Malloch, but in it the bend of the fourth vein is evenly rounded, and the frons is much narrower than in the present genus, while the third antennal segment is also longer. It might be well to change the two sections of Caption 19 in the key referred to as below.

19. First posterior cell of wing usually closed and with a more or less distinct petiole, the bend of fourth vein never with a spur vein; third antennal segment at least as long as height of cheek at highest point *Palpostoma* Robineau-Desvoidy.

First posterior cell of wing open; bend of fourth vein angular, and with a short spur vein; third antennal segment much shorter than height of the cheek at its highest point *Apalpostoma*, n. gen.

Genotype, the following species.

APALPOSTOMA CINEREA, n. sp.

♀. Head yellowish-white, interfrontalia yellow, ocellar spot and aristae black, third antennal segment brown except at base, basal two segments and palpi yellow, frontal orbits slightly darkened, grey dusted, parafacials white dusted, some of the lower occipital hairs white, other cephalic hairs dark. Thorax black, densely pale-grey dusted, entirely dull, with four linear dark vittae which do not extend to posterior margin of mesonotum; scutellum yellowish at apex. Abdomen coloured as thorax, with traces of a dark brown dorsocentral vitta, and similarly coloured apices to tergites, broadest on third, and broken on fourth. Legs testaceous yellow, fore femora on posterior sides and hind femora apically stained with grey or fuscous. Wings greyish hyaline. Calyptrae white. Halteres dull yellow.

Frons at vertex about one-third of the head width, much widened to anterior margin, each orbit at anterior extremity as wide as the parallel-sided interfrontalia, with a series of inner marginal bristles, three or four proclinate outer bristles on upper half, and many lateral hairs; verticals and ocellars short, about as long as the orbitals; parafacial about as wide as third antennal segment above; profile of head as Figure 29; proboscis without palpiform apical processes. Thorax with the dorsal bristles short; postsutural dorsocentrals four pairs, the hind pair long, presuturals two pairs, acrostichals in front of suture hardly differentiated from the rather strong hairs; sternopleurals 2, hardly longer than the long discal hairs; scutellum with the usual four marginal bristles; postscutellum with the chitin carried a short distance over on dorsum. Abdomen ovate, second and third

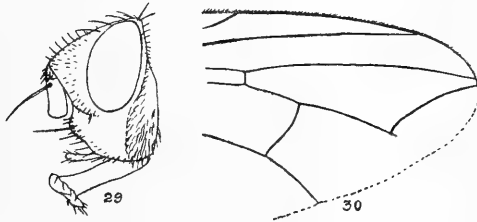


Fig. 29.—*Apalpostoma cinerea*. Head of female from the side.

Fig. 30.—*Apalpostoma cinerea*. Apex of wing.

visible tergites with the apical bristles short and weak. Legs normal; fore tibia without anterodorsal setulae; mid tibia with a distinct submedian ventral bristle; hind tibia with about three uneven anterodorsal and posterodorsal bristles. Outer portion of wing venation as Figure 30. Lower calypter normal for the tribe.

Length, 4 mm.

Type, Wyalkatchem, W.A., 1.9.1926 (E. W. Ferguson). One specimen.

The male is unknown to me.

Genus PALPOSTOMA Robineau-Desvoidy.

I have received some additional material in this genus lately, but am not as yet prepared to submit a revision for publication. As I have already pointed out in one of my published papers, the genus is a very difficult one and really would entail some careful field work and the possession of much material by some student to enable its thorough elucidation.

[To be continued.]

NOTES ON THE GENUS *APISTOMYIA* [DIPTERA] AND DESCRIPTION
OF A NEW SPECIES.

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(Communicated by I. M. Mackerras.)

(Fourteen Text-figures.)

[Read 30th April, 1930.]

The genus *Apistomyia* is one of the best characterized among the Paltostominae, especially on account of the peculiar shape of the simple radial sector which is curved upwards in its distal part in such a way as to reach the costa very near the tip of R_1 , on account of its glassy wings with a dark apical spot in the females of most species, and the typical coloration of the abdomen with silvery-grey transverse bands either complete or interrupted.

Five species, including the one hereafter described, are now known to belong to this genus, the distribution of which is a fairly wide one from the Mediterranean region, through the north of India to Malaya and to the east coast of Australia.

The first species to be described, *A. elegans* Bigot, was discovered in Corsica, and in spite of Bezzi's prediction that it would be found also in Sardinia and on the Italian peninsula, Cyprus is so far the only other locality from which it has been recorded.

Why this species has not been able to maintain itself on the mainland of Europe is a puzzle; the more so that it seems to be able to hold its own in Corsica where other species of Blepharoceridae exist in the same mountain streams, apparently living in association with it. The larva of *A. elegans* remained unknown for nearly sixty years and it is only quite recently that Edwards (1928) made it known; he mentions capturing it in the river Porto at its junction with the Aitone, at which spot he also found larvae of *Liponeura decipiens* and *L. bischoffi*, although he does not specially mention finding these three species in association. It must be noted also that species of *Apistomyia* are found in India and in New South Wales in association with other species of Blepharoceridae. The fact that *A. elegans* is absent from the mountain ranges of Europe cannot therefore be explained by the competition between species.

Apistomyia larvae seem to prefer spots where a large amount of water is falling directly on to them, such as the foot of a fall, as was observed for *A. elegans* by Edwards, by myself for *A. tonnoiri* and by Dr. Mackerras for the species hereafter described. Similar habitats abound in the mountain ranges of Europe, therefore this larval preference does not explain the absence of *A. elegans* from the European mainland.

The second species to be made known, *A. indica* Brunn. from Kashmir, is one of the many species which apparently exist in the Himalayan region. In a fine collection of Blepharocerid larvae from India, kindly submitted to me for study by Dr. S. L. Hora, and on which a report is being published elsewhere, I found five larval forms which I consider may belong to as many species, unless they be races of the same species, but even in that case the abundance of these larvae and their universal distribution throughout the Himalayan ranges indicate that the centre of origin of this genus may well have been in Northern India.

In his splendid study of the Blepharoceridae Bezzi (1912) described a third species, *A. collini*, from Queensland; but in spite of a detailed description, this species is not well known, as only one female specimen has ever been found.

Dr. Tillyard (1922) discovered and described the fourth species, *A. tonnoiri*, from the Blue Mountains in New South Wales, and the larva and pupa, which were found at the same time, were described by me (1923) a little later, this being the first time that the early stages of this genus were made known; all those of other species found since then are as strikingly characteristic of the genus as are the imagines.

In view of the presence of *Apistomyia* in India and in Australia, the recent discovery of that genus in Java does not come as a surprise. This species, on account of the complete anal vein, shows closer affinity with the northern species *A. elegans* and *A. indica* than with the Australian *A. collini* and *A. tonnoiri*.

The facts, that these last two species are somewhat more specialized and that this genus is absent from Tasmania, tend to show that *Apistomyia* is a comparatively recent immigrant from the north into Australia. In spite of extensive search for Blepharoceridae in New Zealand, this genus has never been found there yet and it is not likely to occur; its absence from that country is rather surprising, as the three endemic genera occurring there, *Neocurupira**, *Paracurupira* and *Peritheates*, are all closely related to *Apistomyia*, but are more generalized. They are not found in Australia, yet the Blepharocerid fauna of New Zealand must have come from the north as no primitive genus related to *Edwardsina*, which is evidently of southern origin and so well represented in Tasmania, is to be found in that country.

All the known species of *Apistomyia* can be differentiated in the adult stage by means of the following table:

- | | |
|---|-------------------------------|
| 1. Anal vein complete, reaching the wing margin; female with a distinct dark spot at apex of wing | 2 |
| Anal vein incomplete; no definite dark markings on the wings in either sex | 4 |
| 2. Thorax with two distinct narrow whitish vittae on the disc of the mesonotum or else with three wide black vittae on greyish-white background, or else coloration mostly orange in the female; larger species | 3 |
| Thorax without submedian narrow pale vittae; coloration blackish in female; smaller species | <i>A. mackerrasi</i> , n. sp. |
| 3. Second antennal segment flat and dilated in female | <i>A. trilineata</i> Brunn. |
| Second antennal segment normal; coloration of female often mostly orange | <i>A. elegans</i> Big. |

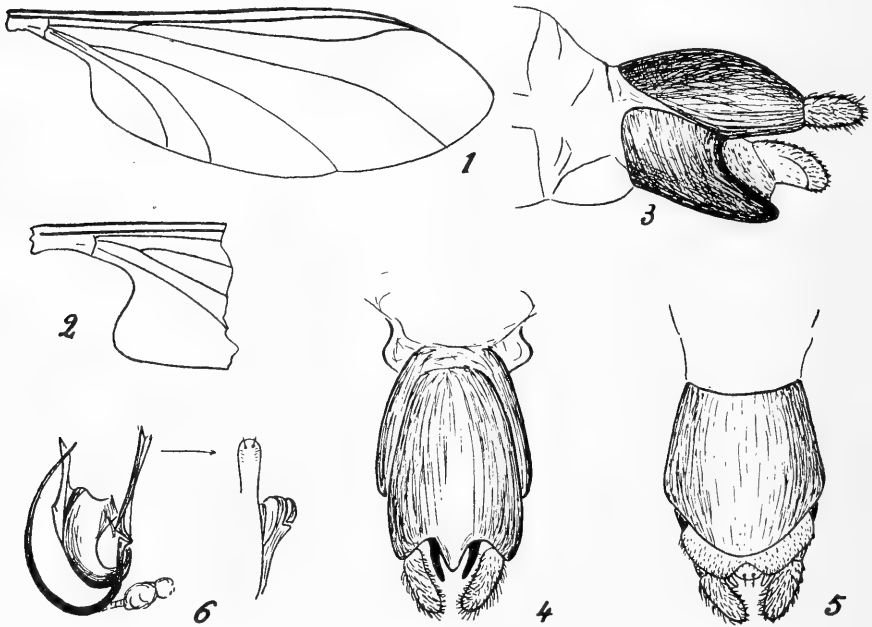
* It is not at all certain that the Australian species *N. nicholsoni* which Tillyard refers to *Neocurupira* is congeneric with the genotype *N. hudsoni* Lamb from New Zealand.

4. Wing clear; transverse basal whitish bands of abdominal tergites interrupted *A. tonnoiri* Till.
 Wing infuscated; abdominal pale bands complete *A. collini* Bezzi

As can be seen from this key, there are not many morphological features which can be used for differentiating the species.

The eye structure, as already noted by Bischoff (1928), differs in the sexes, in that the region of large facets is more developed than the one of small facets in the male, whereas it is the reverse in the female; this proportion may vary to some extent for each species, and so does the length of the proboscis as compared with the height of the head capsule.

The relative length of the antennal segments is also peculiar to each species, especially in the three or four basal segments. Usually there is no dimorphism in the structure of the antennae, but in the Indian species the pedicel of the female



Text-figures 1-6.

1.—Wing venation of male of *Apistomyia mackerrasi*. 2.—Anal lobe of female of *A. mackerrasi*? 3.—Hypopygium of *A. mackerrasi* from the side. 4.—The same from above. 5.—The same from below. 6.—Aedeagus removed from hypopygium and seen from the side.

is flat and dilated, whereas it is subnormal in the male; this observation has been made on imagines dissected out of some pupae of the Hora collection; the male of *A. indica* is so far unknown, so that no observation could be made on that point in this species.

The wing shape is very constant within the genus and there is apparently no sexual dimorphism of that organ, except perhaps in *A. mackerrasi*, as the female

which I refer to that species has a distinctly produced anal lobe (Text-fig. 2) which is not found in the male or in any other species. Such a produced anal lobe is a feature of some species of *Edwardsina*, *Phitorus* and *Hapalothrix*, but this character is not sexually dimorphic in these genera.

The base of Rs is not always absent, as shown in the figures given by different authors, including Bischoff, for *A. elegans*. According to Bezzi, it is present in *A. collini* and I have ascertained its presence in *A. tonnoiri* and *A. mackerrasi*, whereas in *A. indica* there is a close contact between R_1 and the curve formed by r-m and Rs. This basal segment of Rs is rather difficult to detect on account of its smallness, so that it may easily have been overlooked in *A. elegans*.

The male genitalia of the various species of *Apistomyia* differ but little, as is often the case in the family. I have made a detailed study of the hypopygium of *A. mackerrasi* and its various aspects are depicted in Text-figures 3 to 6; the same organ of *A. tonnoiri* has also been dissected and found to be very little different from the one here figured even in the intimate structure of the aedeagus. To my knowledge the hypopygium of *A. elegans* has been figured only by Bischoff (1928, p. 261), so that the genitalia of the three species whose males are known show that the best, although rather precarious, character of differentiation, is to be found in the relative length of the forceps (styles) as compared with that of the fused coxites. In *A. tonnoiri* the styles are as long as the coxites, in *A. mackerrasi* one-third and in *A. elegans* two-thirds (according to Bischoff's drawing) as long.

In the first two species the parameres are much longer and stronger than the three filaments of the penis which can be easily overlooked on account of their small size.

APISTOMYIA MACKERRASI, n. sp.

♂. Head and its appendages blackish, face greyish; upper portion of large facets more brightly red than the lower. Thorax silvery-grey, except on the disc of the mesonotum and the whole of the scutellum which are velvety-black. Abdomen velvety-black, with the first tergite completely grey and an anterior silvery-grey triangle on the sides of the following tergites; on the basal segments these markings are more extensive and not so distinctly triangular. Hypopygium velvety-black above, brownish below. Halteres with orange stem and brownish-black knob. Legs brown, the base of the anterior femora paler. Wing completely hyaline.

Head: Eyes hairy, region of large facets distinctly larger than the one of small facets, especially when seen from the side; ocellar triangle little produced. Antennae short, ten-segmented, the first shorter than the second which is a little longer than broad, the third longer than broad, but the following one shorter than broad, the last ovoid and somewhat longer than broad. Proboscis one and a half times as long as the head, the labella shorter than the basal part of the proboscis.

Tibial spur formula, 0.0.2; fore and mid femora subequal, fore tibiae and tarsi distinctly longer than the mid pair; hind legs very much elongate, their femora, tibiae and tarsi subequal to each other.

The relative lengths of the different segments of the legs are as follows:

Legs.	I.	II.	III.
Femora	15	17	49
Tibiae	22	19	49
Tarsi: 1	17	10	20
2	5	5	12
3	4	2	10
4	3	2	7
5	3	3	5

All the claws finely denticulated (4-5 teeth).

Wing venation as depicted in Text-figure 1, quite normal for an *Apistomyia*; base of Rs distinct.

Hypopygium as depicted in Text-figures 3-6.

Length of body, 3.5 mm.; wing, 4 mm.; hind legs, 11 mm.

Type from Mt. Malabar, near radio station, Java, 4,400 feet, 26th May, 1929, I. M. Mackerras. Collected on leaves of small bush along a path, 20 yards from the stream in which some larvae were subsequently discovered. Paratype: One male with crumpled wings and swollen abdomen, evidently immature, but apparently identical with type; it was collected in the same situation as the type but two hundred yards at least further up the valley. Allotype: The female here described is doubtfully referred to the same species on account of the different wing shape; the only specimen of that sex was captured in the same locality as the males, but at a good distance from them.

Coloration similar to that of the male, that is, velvety-black with silvery-grey markings, but these are more extensive in this sex. Frons with orbital grey margin; face grey; antennae more greyish than in the male. Coloration of thorax as in the male, the pale humeral markings more extensive. Abdomen velvety-black, first tergite completely silvery-grey, the following ones with a narrow transverse basal greyish band, sometimes very narrowly interrupted in the middle. Terminal lamellae brown. Wing with a small apical infuscation; the anal lobe also somewhat infuscated on the margin.

Head: Frons very wide, but as the eyes are crumpled the proportion cannot be made out; the region of large facets about one-fourth the height of the head, the facets not much larger than those of the lower region. Antennae as in male, the second segment proportionately a little larger. Proboscis three times as long as the height of the head; palpi as usual, very small and apparently one-segmented. The proportion of the different segments of the legs as follows:

Legs.	I.	II.	III.
Femora	20	20	55
Tibiae	25	22	55
Tarsi: 1	12	10	27
2	5	5	14
3	4	4	10
4	3	3	8
5	4	4	7

All the claws finely denticulated.

Wings as in male, but the anal lobe much more produced as depicted in Text-figure 2.

Length of body, 5.5 mm.; wing, 5.5; hind legs, 12 mm.

Larvae and Pupae.

The material collected by Dr. Mackerras in the stream along which the three imagines described above were captured, consists of about fifty larvae and thirty pupae which evidently do not all belong to the same species and perhaps not to the same genus.

This material is composed as follows:

A. Typical *Apistomyia* larvae, the majority in the fourth instar, a few in the third.

B. Numerous *Apistomyia* pupae with internal lamellae of the breathing organ pointed.

C. A few similar pupae but with the internal lamellae of the breathing organ blunt or truncate.

D. A number of larvae in the fourth and third instars with some characters of *Apistomyia*, yet with the end of the body shaped more as in *Liponeura* or *Blepharocera*.

Larva A. Text-figure 7.

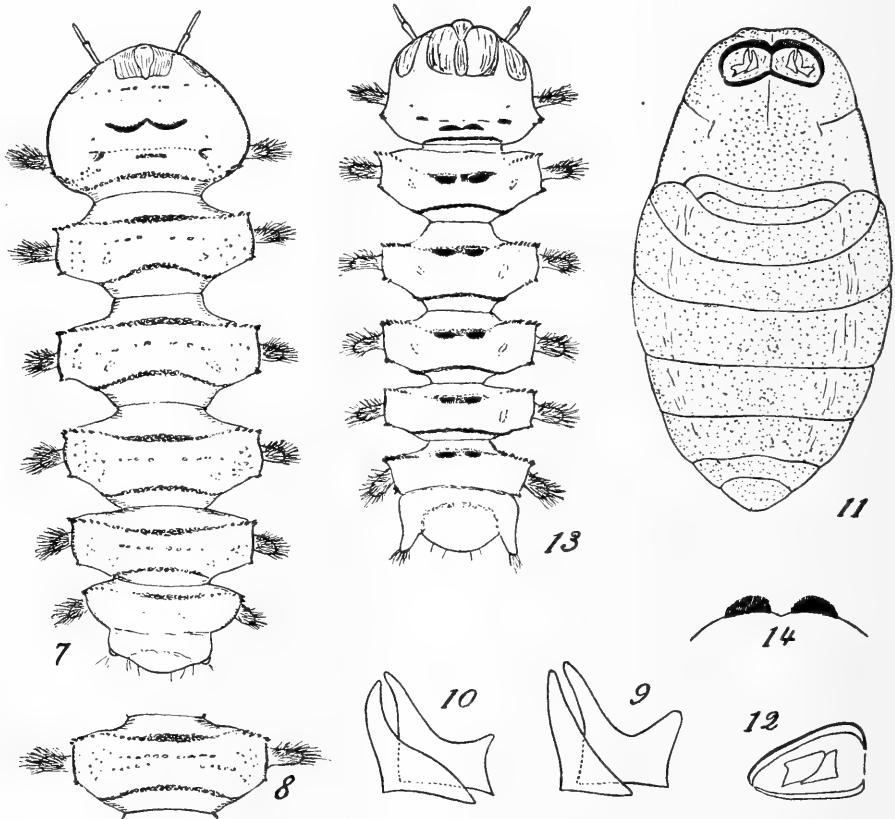
Length of fully grown specimen, 5 to 5.5 mm.

No definite colour pattern, but general coloration rather dark brown, darker on the ridges, and dorsum sprinkled with darker granulations. Antennae completely dark, the two segments subequal. Each body division is provided with the characteristic anterior and posterior ridges of *Apistomyia* larvae, as it has been found in *A. tonnoiri*, *A. elegans* and the many Indian larvae whose imaginal forms are not yet known. The median portion of the anterior ridge is formed by coarse granulations or protuberances which gradually change into spinules on the sides of the body; the larger spinules being placed on the anterior corners of the divisions; the posterior corners also carry one or two spinules, but these are not connected with the posterior ridge which starts a little more backwards and is only composed of granulations. In between the two ridges there are a certain number of small granulations arranged in a transverse row placed nearer the anterior ridge; this line is composed of six to eight granulations and is sometimes interrupted in the middle, on the sides of the divisions the granulations are smaller and scattered without any apparent order. Some specimens exhibit a second row of these small granulations behind the one just mentioned (Text-fig. 8). This row is more widely interrupted in the middle and somewhat oblique and curved. I thought at first that these specimens might belong to a different species because the pupal breathing organ dissected out of two of them seemed to differ slightly from those of the first type in the shape of the internal lamellae (compare Text-figs. 9 and 10), but this difference is not very great and, besides, there are intermediate types having from one to eight or more granulations placed behind the first row.

The lateral appendages carry long hairs dorsally and apically as well as smaller spinulous bristles which are not always very distinct. The last body

division is provided with two pairs of appendages; those placed on the sides of the penultimate segment are very small as is the rule in *Apistomyia* and are not readily visible from above.

The gill tufts are composed of five filaments, one turned backwards and the others forwards; the most internal one of the latter is in appearance two-segmented, but it is not doubled as in the Indian species of this genus.



Text-figures 7-14.

7.—Larva A. 8.—A median division of a specimen of larva A with two rows of granulations. 9 and 10.—Two types of pupal internal lamellae extracted from larva A. 11.—Pupa B. 12.—Breathing organ of pupa C. 13.—Larva D. 14.—Dorsal brushes of larva D seen in profile.

In the few larvae in the third instar, the gill tufts are composed, as usual, of only three filaments, two turned forwards and one backwards; for the rest these larvae are similar, also in the antennal structure, to the fully grown ones with the exception of the very small lateral appendages of the penultimate segment which are completely visible from above; there are no small granulations between the two main ridges of the divisions.

Length, about 3 mm.

Several fully-grown specimens of this type of larva are in the prepupal stage and the shape of the lamellae of the breathing organ of the pupa could be ascertained by dissection as shown in Text-figure 9; this shape corresponds well to that of the majority of the pupae contained in the material.

Pupa B.

This pupa, depicted in Text-figure 11, which should replace a detailed description, does not differ from any of those known in the genus *Apistomyia* except for the shape of the internal lamellae of the breathing organs. The coarse grain of the integument is present on the whole dorsum except on the base of the wing sheaths. A male fly dissected out of one of these pupae corresponds well in the structure of the hypopygium to *A. mackerrasi*, as far as could be ascertained in spite of its immaturity; there is therefore little doubt that larva A and pupa B belong to that species.

Pupa C.

Among the pupae above described are four others which differ from them in the shape of the internal lamellae of the breathing organ, which are both broader, the upper one being besides devoid of emargination (Text-fig. 12). The sheath of the mouth parts is also different from that of pupa B in which some of the parts are more elongate; this cannot be a sexual character, since two of the imagines extracted from similar pupae belonged to opposite sexes, as could be seen by the eye structure. Except for the venation which is clearly that of an *Apistomyia*, the imagines were not sufficiently developed to be certain that they differ in any way from *A. mackerrasi*, although it is most probable that they belong to another species.

Larva D. Text-figure 13.

Length of fully grown specimen, 5 mm.

No definite colour pattern, but general coloration rather dark, the transverse ridges darker. Antennae completely black, two-segmented, the segments subequal. The body divisions are shaped as in *Apistomyia* larvae, that is, with an anterior collar, a median part between the two ridges and a small tapering part behind the posterior ridge. The anterior ridge is not straight from one anterior corner to the other, but in its middle it bends backwards to the spot where it carries the two very peculiar tufts of bristles. These tufts or brushes are placed on a dilatation of the anterior ridge which is there darker than elsewhere; they are separated by a little gap where the dark coloration of that part of the ridge can best be seen. These brushes are formed by a row of cylindrical or tubular bristles slightly curved at the tip (Text-fig. 14). The spinules on the sides of the body are also rather cylindrical, not tapering to a point as in most *Apistomyia* larvae. The couple of brushes are present on the cephalic division, but there they are smaller and are touching each other.

The shape of the last body division is very characteristic and not at all like any known larva of *Apistomyia*, but much more similar to a *Blepharocera* larva on account of the lateral processes of the penultimate segment, which are completely visible from above, pointing backwards and being rather elongate; there is a distinct suture between the last two segments.

The gill filaments are as in *Apistomyia*; they number five; three are pointing forwards and two backwards.

Of the fourteen larvae of this type contained in the material, twelve are in the last instar, but none of these is in the prepupal stage; the two others are in the third instar; these are similar to the fully-grown larva, but the gill tufts are as usual composed of three filaments only, two pointing forwards and one backwards. The dorsal brushes are present in one of these specimens but not in the other which, however, does not seem to differ otherwise in the slightest; its anterior ridge is shaped as if the brushes were present, but even when looking at the specimen in profile there is no trace whatsoever of the brushes to be found. It seems that these dorsal processes could be either present or absent in this species, as is the case for the dorsal spines of the Indian genus *Horaia*.

As no larva showed the breathing organ of the pupa below the skin, it is impossible to say if pupa C, which differs from the others only in the shape of the internal lamellae, belongs to these larvae; it is not quite impossible, but not at all likely, because this pupa is typically that of an *Apistomyia*, whereas larva D, chiefly on account of the conformation of the end of the body, does not seem to belong to that genus.

The relationship of this larva with *Apistomyia* is evidently very marked; and much more so than in the three New Zealand genera *Neocurupira*, *Peritheates* and *Paracurupira*, the larvae of which are devoid of anterior and posterior ridges found in all *Apistomyia* larvae and in this larva D.

The presence of the dorsal brushes cannot be considered as a generic character, as similar ornamentation may be present or absent in species of a given genus, as in *Liponeura* or *Curupira*, for instance.

In conclusion, I wish to thank Dr. Mackerras for the opportunity he has given me of studying this interesting material; I hope that this paper will stimulate collectors in Malaya in searching more assiduously for Blepharoceridae and thus help to solve the questions of the generic status of larva D and of the correct attribution of the female here described as that of *A. mackerrasi*.

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THE GEOLOGY OF THE SOUTH COAST OF NEW SOUTH WALES.

Part ii. DEVONIAN AND OLDER PALAEOZOIC ROCKS.

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(Palaeontological Notes by W. S. DUN, Palaeontologist to the Geological Survey of N.S.W., and Lecturer in Palaeontology, The University of Sydney.)

(Plates i-ii; two Text-figures.)

[Read 30th April, 1930.]

INTRODUCTION.

Little detailed geological work has been published on the series of altered sedimentary or metamorphic rocks which outcrop over the south coastal portion of New South Wales, east of the Main Divide between the head of the Clyde River to the north and the Brogo River to the south. Over the greater part of this area are exposed outcrops of highly folded sediments, of which no stratigraphical subdivisions have been recognized up to the present time. The series is intruded by plutonic igneous rocks of various ages and characters, and is partly covered by Cainozoic sediments and volcanic rocks.

The lack of knowledge concerning these old sedimentary formations is due essentially to the inherent nature of the rocks themselves: petrologically they are not so interesting as the associated igneous series; palaeontologically, so far as is known, they have revealed little by which their geological age may be determined; and in addition the denudation of the series has produced wild, mountainous country, much of which is almost inaccessible.

The country is drained by three coastal streams, the Clyde, Deua and Tuross Rivers, which have cut gorges about 2,000 feet in depth in the upper portions of their courses, although their mouths are tidal on account of recent submergence of the coast.

As a result of the dissection by river action, road communication is confined chiefly to the coastal portion of the area, where the main road or Prince's Highway closely follows the coast as far south as Eden; between Nowra and Bega, a distance of about 200 miles, only two roads lead from the coast up on to the Main Divide, namely, the road from Bateman through Nelligen to Braidwood, and that from Moruya through Araluen to Braidwood. Some shorter roads connect inland farms and mines with the coast road, but do not lead westward to the tableland.

Furthermore, the soils derived from the sedimentary series are usually poor and offer little inducement for agriculture or farming, so that, apart from mining localities, human settlement is almost confined to the outcrops of intrusive igneous rocks, which yield soils particularly suitable for dairy farming.

The object of the present paper is to place on record some recently discovered occurrences of fossiliferous Palaeozoic sediments, and to collect together the avail-

able information concerning the stratigraphical problems of the far south coast of New South Wales, as a basis for future geological work in the area.

PREVIOUS RECORDS.

The earliest record of the existence of pre-Permo-Carboniferous strata on the south coast is contained in a paper by Alexander Berry (1822), in which is given a brief description of rocks outcropping in the vicinity of Bateman Bay and the (newly-discovered) Clyde River.

About the year 1851, the Rev. W. B. Clarke examined a large area of the Southern District in order to report to the Government on discoveries of gold at Araluen and elsewhere. Many of his geological observations are recorded in his "Southern Goldfields" (1860) and "Sedimentary Formations of N. S. Wales" (4th Edition, 1878, pp. 133, 17). He found Silurian fossils in the limestones near Bungonia, Shoalhaven River, and stated (1860, p. 42): "In the country along Yalwal and the Clyde, Silurian slates . . . undoubtedly occur". He apparently considered that the slates of the Deua River below Araluen were also of Silurian age, an opinion which up to the present has been generally accepted in the absence of evidence to the contrary.

Southwards, in the vicinity of Eden, the "reddish and purple deposits" (p. 196) he regarded as Devonian formations, apparently for lithological reasons alone, without the aid of palaeontological evidence, which since has fully justified his opinion.

Further observations on these sedimentary formations in several isolated localities have been made by members of the New South Wales Geological Survey.

Limestone caves discovered by Benjamin George at Bendithera, near the head of the Deua River, about thirty miles west of Moruya, were visited in 1890 by W. S. Leigh, who published a report (1890) and a map (1897) of the caves. In 1891, W. Anderson discovered in these limestones a coral which was determined by R. Etheridge, Junior, to be *Favosites*, and probably of Upper Silurian age. Further reference to these limestones has been made by Carne and Jones (1919).

In 1901, E. C. Andrews established the occurrence at Yalwal, of Devonian rocks, which had been considered by W. B. Clarke to be partly Silurian and partly Carboniferous. Marine forms from Yalwal Creek and Grassy Gully, Shoalhaven River, are recorded by C. F. Laseron (1910) and *Lepidodendroid* remains from Yalwal described in detail by A. B. Walkom (1928a).

H. I. Jensen (1908a, 1908b), C. F. Laseron (1908, 1910) and W. S. Dun (1911) have also described the Devonian marine fauna from Ettrema and Yalwal Creeks, tributaries of the Lower Shoalhaven. Although H. I. Jensen (1908a) noted the occurrence of similar beds and fossils between Nelligen and Braidwood, and W. N. Benson (1922) mentioned the existence of *Rhynchonella pleurodon* at the head of the Clyde River (Yardboro), no description of the form has been previously published.

In 1892 *Lepidodendron australe*, in association with marine fossils, was discovered by P. T. Hammond on a hill overlooking Back Creek, three miles from Major's Creek township.

The association of marine forms and plant remains in these localities is comparable with that in the Mount Lambie district, described by C. S. Wilkinson (1893, David and Pittman).

There appear to be no records of fossiliferous sediments between the Yalwal and Braidwood beds in the north and the Devonian series of the Eden-Wolumla district in the south, which extend to the south-west, across the New South Wales border into Victoria.

The stratigraphical relationships of the Devonian and older Palaeozoic rocks of Gippsland, Victoria, which have become known by the works of A. W. Howitt (1874, 1876, 1877), R. A. F. Murray (1878), E. J. Dunn (1890), O. A. L. Whitelaw (1899), H. Herman (1898) and others, and more recently by E. W. Skeats (1929), are intimately related to those of the pre-Carboniferous rocks of the south-eastern portion of this State. This was recognized at the end of last century when a joint geological survey by members of the Victorian and New South Wales survey departments was carried out along the border between Cape Howe and the head of the Murray River, the result of which was published by J. E. Carne (1897).

Reports on the goldfields of Pambula, Eden and Wolumla (Carne, 1896-7) contain valuable information concerning the stratigraphy of the area, while the palaeontology has been discussed in these papers and others by W. S. Dun (1897*a*, 1897*b*, 1898).

FIELD OCCURRENCE.

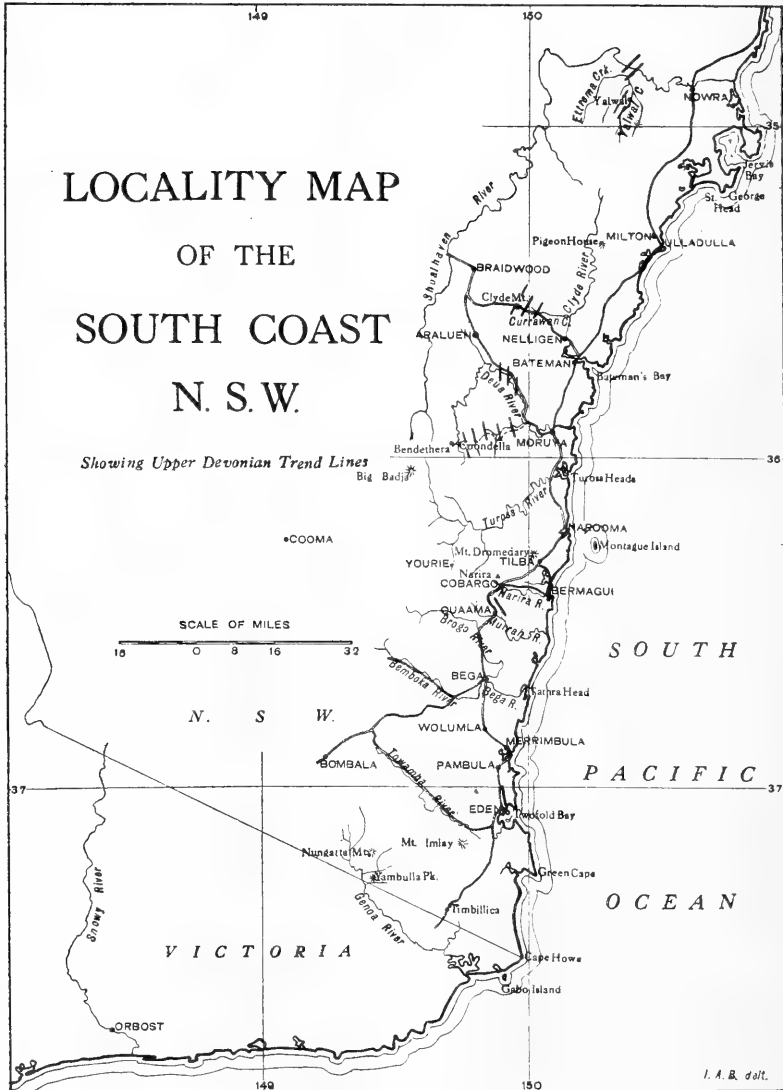
(i). *Section from Moruya to Bendithera.*

With the object of examining the section from Moruya westwards to Bendithera, the writer arranged a short reconnaissance trip in April, 1928, with a small party under the guidance of Mr. Randolph George, the present owner of Bendithera, and son of the discoverer of the limestone caves. Insufficient time prevented detailed examination of this area of wild, mountainous country, which as yet has not been surveyed in any detail, but the following notes may be of interest. Aneroid barometric readings taken at a number of points along the track, and corrected for barometric variation at Moruya, give the heights mentioned below.

The bridle track used at the present time is not indicated on the published county and parish maps; branching from the main road to Araluen about six miles from Moruya the track crosses the Deua River below its junction with the Burra Creek, and continues westward on the south side of Burra Creek, across Donald's Creek, then following a ridge running approximately in a south-westerly direction as far as a marked tree ("^C" Peppermint) at an elevation of about 1,275 feet. The track then ascends to Coondella Trigonometrical Station (2,243 feet) and a mile beyond turns westwards and descends abruptly to Diamond Creek (1,010 feet). Coondella Creek (570 feet), a couple of miles to the north-west, is a suitable camping-ground 20 miles from Moruya. Following upstream, the way leads up a steep spur between two arms of Coondella Creek, and along a ridge covered with open forest. The highest point on the track (2,800 feet) is reached near Bendithera Trigonometrical Station (3,265 feet), and from hereabouts an excellent view may be obtained of the tableland to the west, the general level of which is about 3,000 feet above sea-level; Big Badja (4,466 feet), Dampier (4,059 feet) and Snowball (3,426 feet) rise as monadnocks above the general level of the Plateau.

The Upper Deua River flows northwards, to the east of the Plateau, in a gorge only 900 feet above sea-level at Bendithera Homestead, situated on the left side of the Deua River above its junction with Con Creek.

Folded slates, quartzites and quartz-schists occupy the greater portion of the area between Moruya and Bendithera. The rocks outcropping within half a dozen miles of Moruya have already been described by the writer (1928). The wide belt of intrusive quartz-porphry, shown on the map accompanying that paper to out-



Text-fig. 1.

crop on the eastern side of the Deua River for several miles below Larry's Crossing, continues to the south across Burra Creek. Friable quartz-schists, quartzites and purple slates alternately outcrop between Donald's Creek and

Diamond Creek, on the south side of Burra Creek; the outcrops are about fifty yards in width, and trend in a north-north-westerly direction; no reliable measurement of the dip of the beds, or of their total thickness, could be obtained in this portion of the section. Conglomerate occurs on the ridge three miles south-west of the junction of Burra Creek and Deua River, at a height of about 680 feet above sea-level, between sandy slates and fine purple slates, and again on the eastern side of Diamond Creek between 1,220 feet and 1,435 feet above sea-level.

Light-grey, almost flinty quartz-porphry occurs in the bed of Diamond Creek, while a similar rock outcrops again on the eastern bank of the Deua River at Bendithera Station, forming also a bar across the bed of the river. This rock bears a strong resemblance to the late Devonian porphyry outcropping along the coast near Twofold Bay, with which it may be tentatively correlated.

West of Diamond Creek and extending across Coondella Creek is a belt of coarsely grained acid granite, between two and three miles in width, which is intruded by dykes of an andesitic nature. No perfectly fresh specimens are available, but the rock is probably similar to that outcropping near Currowan Creek, west of Nelligen.

Between Coondella Creek and the Deua River at Bendithera Homestead, interbedded slates and quartzites strike between N. 20° W. and N. 25° W. Again no reliable measurement of the amount of dip could be obtained, as there are neither natural nor artificial sections along the ridge, and well-developed cleavage obscures the bedding planes of the slates in the small sections examined in the bed of Coondella Creek. Narrow andesitic and basaltic dykes intrude this series.

Immediately east of the Deua River the strike of the beds swings round to N. 5° W., possibly due to the existence of a meridional fault, which appears to have determined the general course of the river here.

West of the Upper Deua River occurs a series of interbedded slates, quartzites and limestones, which are probably older than the series to the east. There is a distinct change in the trend of these outcrops compared with the rocks to the east, measurements of their directions of strike varying from N. 40° W. to N. 50° W.

There is evidence of faulting in three directions: (i), slightly west of north, along the course of the Deua River, and again to the west, a vertical fault on the north side of Con Creek, about one mile above its junction with the Deua, throws limestone on the west against slates and quartzites on the east; (ii), about W. 35° N. along the bed of Con Creek, resulting in the movement of the rocks on the south-west towards the north-west, relatively; (iii), approximately in an E. and W. direction, up a northern tributary of Con Creek, where limestone is thrown against grits and conglomerates.

So far as could be ascertained the strike of the limestone* is N. 50° W. in the main mass at Bendithera Cave; the dip of a narrow fossiliferous band within the Cave was determined to be N. 40° E. at 53°. The strike of the limestone is therefore conformable with that of the associated slates and quartzites, while its thickness must be at least several hundreds of feet. An underground stream issues from the limestone 300 feet below the level of Bendithera Cave entrance.

The limestone outcrops are easily recognized, even from a distance of several miles, on account of the very characteristic vegetation which they support (Plate i, fig. 1). A variety of *Acacia* (? *Chalkeri* or *decora*) having a bluish-grey foliage grows exclusively on the limestone, forming a very marked contrast with the

more sombre dark-green foliage of the eucalypts growing on the adjacent slates and quartzites. *Brachychiton populneus* (Kurrajong) and a variety of *Ficus* also grow on the limestone.

Some intrusive dykes of porphyry and andesite are responsible for small deposits of silver ore, which were reported by W. Anderson (1891). According to Anderson, Devonian conglomerates cap the tableland to the west; certainly large boulders of conglomerate and granite occur in the valleys below.

Geological ages of the Sediments between Moruya and Bendithera.

(a) *Silurian*.—The question of the geological age of the limestones at Bendithera is one which cannot yet be definitely answered.

W. Anderson (1892) discovered in the limestone near Bendithera Cave "a thin band which is very rich in individual specimens of one genus of coral", determined by R. Etheridge, Junr., to "belong to the genus *Favosites*", and to be "probably Upper Silurian".

The writer has collected several varieties of *Favosites*, Crinoid stems and (?) *Tryplasma* from different outcrops of limestone at Bendithera, but the rock is so marmorized that exact identification of the enclosed organisms is almost impossible. The limestones are interbedded with slates, and appear to strike in a north-westerly direction, in contrast with the north-north-westerly trend of the Devonian beds on the eastern side of the Deua River here.

To the north of Bendithera is a series of caves in limestones described by Carne and Jones (1919), which are probably of Silurian age, and with these the Bendithera beds may be provisionally correlated.

(b). *Devonian*.—At a position about three-quarters of a mile south-south-west of Coondella Trigonometrical Station (see map, Text-fig. 2), and sixteen miles along the Bendithera Track from Moruya, there occurs a bed of quartzite, crowded with casts of *Spirifer disjuncta*, described by Mr. W. S. Dun (p. 158, Plate ii, figs. 1-5). It outcrops in a slight saddle in the ridge running south-south-westerly from the Trigonometrical Station, at an elevation of about 1,860 feet above sea-level, and appears as a belt some twenty yards in width, consisting of boulders of quartzite, which extend down the slopes on both sides of the saddle (Plate i, fig. 2). No section of the solid rock is known to be exposed here, but the general trend of the outcrop in a horizontal direction is N. 20° W., the bed probably dipping to the south of west.

Along the track about a mile north-east of Coondella Trigonometrical Station and 2,000 feet above sea-level, a band of similar quartzite occurs interbedded with slates; only obscure traces of brachiopod casts were noticed here.

Due consideration of the topographical situation of the outcrop leaves little doubt that the formation is not a relatively horizontal capping over the associated slates and quartzites, but is actually a conformable member of the slate series.

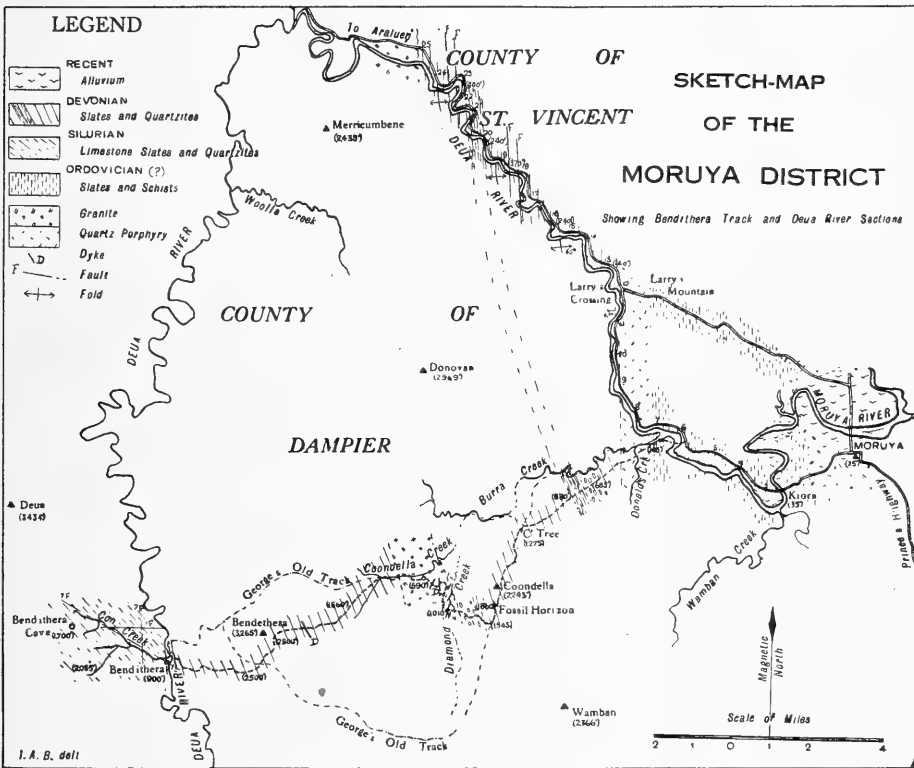
Thus an Upper Devonian age may be assigned to the sedimentary series between the porphyry of the Lower Deua River and the granite of Coondella Creek, and possibly also to the series as far west as the Deua River at Bendithera.

(ii). *Section from Moruya to Araluen.*

On lithological evidence the series described above may be correlated directly with that of the quartzites and reddish-purple slates outcropping along the Deua River—Araluen Road between Larry's Crossing and Merricumbene (see map, Text-fig. 2).

The road from Moruya to Araluen winds round the steep left bank of the Deua River, whose meanders are entrenched to a depth of several hundreds of feet. Normally the river does not occupy the whole width of its bed, but in flood-time it rises rapidly and the tremendous volume of water which comes down this narrow valley does considerable damage to the numerous road embankments and cuttings. Good geological sections are exposed in these artificial cuttings as well as in those formed by river action.

The sedimentary beds west of the belt of quartz-porphry at Larry's Crossing are thrown into a series of folds, in which the maximum dip of the beds is about



Text-fig. 2.

45°. An anticline is visible from the Halfway House, 19 miles from Moruya, in the southern bank of the river, and the dips indicate other anticlines between 15 and 16 miles from Moruya, and again near the 24-mile peg, with intermediate synclines. The axes of folding are nearly meridional.

Two conspicuous fault-zones occur, one between 18 and 19 miles from Moruya, and another between 22 and 23 miles along the road. In both cases hardened sandstones and quartzites are repeatedly faulted against purple slates, which show considerable crushing and contortion as a result. The faults have usually a steep dip to the east, and in some cases, narrow veins of quartz-porphry occur along

the fault-planes; the intrusive rock is lithologically similar to the belt below Larry's Crossing, and somewhat resembles the porphyry intrusive into Upper Devonian sediments near Eden.

The general sequence along the Araluen road is similar to that along the Bendithera Track (see Text-fig. 2), the series consisting essentially of interbedded slates and quartzites. Reddish colours prevail as a rule, with some white and bluish-grey quartzites and greenish-grey slates. Between 20 and 23 miles from Moruya there is a prominent outcrop of red and purple slates, very similar to those occurring on the south side of Burra Creek. In these slates there are obscure traces of organic remains, but all detailed structure has been obliterated by the severe crushing to which the rocks have been subjected by the faulting previously mentioned.

West of the purple slates, quartzites predominate, and at Merricumbene the river valley opens out into broad flats, on account of the outcrop of more homogeneous granite. Beyond Merricumbene, slates outcrop for a few miles along the road, and then give place to the granites of Araluen.

The shallow-water origin of the sediments is indicated by the occurrence of well-preserved ripple-marks in the sandstones, immediately west of the porphyry belt, about eleven miles from Moruya, but no determinable fossils have been found along this section. On account of their lithological similarity to the series along the Bendithera Track they may be provisionally classified as of Upper Devonian age.

(iii). *Section from Bateman's Bay to the Clyde Mountain.*

Recently the writer examined the section along the Bateman-Braidwood Road, approximately fourteen miles north of the Moruya-Araluen Road section. From the coast to three miles west of Nelligen highly-cleaved greenish-grey slates and phyllitic rocks outcrop, which have a meridional trend and apparently almost vertical dip, similar to the altered sediments along the coast to the south.

On the Braidwood Road between Nelligen Creek and Currowan Creek these give place to an outcrop of grey granite, lithologically similar to that at Coondella Creek, and probably of late Devonian age.

The granite is bounded on the west by a sedimentary series of an entirely different character from the slates on the east. A gently folded series of sandstones, quartzites and slates extends from below the junction of Currowan and Sugarloaf Creeks to the west of the Clyde Mountain. In Currowan Creek the beds dip N. 60° W. at 23° (Plate i, fig. 3). The general direction of strike remains fairly constant to the top of the mountain, although on account of folding the dip may be either to the south-east or to the north-west.

Certain bands in these beds contain abundant casts of *Rhynchonella pleurodon*, described and figured by Mr. Dun (page 159; Plate ii, figs. 6-7). H. I. Jensen (1908b, p. 304) implies that *Spirifer disjuncta* also occurs here, but no specimens are yet available for determination. The best preserved specimens of *Rhynchonella* occur near the top of the mountain, 15 miles from Braidwood, in hard, greenish-grey quartzites. In a cutting near the side of the road 21 miles from Bateman, a band only one inch in thickness, thickly crowded with a small, poorly-preserved variety of *Rhynchonella*, dips S. 30° E. at 25°.

An examination of the river gravels at Currowan Creek indicates that volcanic and hypabyssal igneous rocks are also present in the series, but these have not yet been identified *in situ*, as at Yalwal by E. C. Andrews (1901).

(iv). *Other fossiliferous Areas on the South Coast.*

(a). *Quaama-Cobargo District*.—About three miles east of Quaama, in the neighbourhood of Pipeclay Creek, a tributary of the Murrah River, near the old road from Quaama to Bermagui, a gently-folded series of interbedded slates and quartzites was determined by the writer to strike N. 30° W. and S. 30° E. with average dips of about 25°. In these beds Dr. A. A. Pain first discovered, in hard purple quartzites, Devonian fossils which were identified by Mr. W. S. Dun as *Spirifer disjuncta*, *Rhynchonella pleurodon*, *Pterinea*, and *Pteronites*.

To the east of the Devonian beds near Quaama, the older series of slates, cherts and more schistose rocks outcrop along the coast south of Bermagui, but the relations between the two series are not yet known.

The Pipeclay Creek beds are bounded on the south-west by a granitic mass, extending from the north of Cobargo, through Quaama, to the Brogo District. The relationship of the granite to the sediments is apparently an intrusive one, although probably faulting also occurs.

North of Cobargo the extension of the same granitic mass is in contact on its western margin with quartzites and black slates which, three-quarters of a mile north-west of Narira Trigonometrical Station, carry graptolites identified by C. F. Laseron as *Diplograptus foliaceus* (Murchison), *Climacograptus* sp., and *Dicellograptus* sp., thus fixing the age of the rocks as Ordovician (Browne, W. R., 1914, p. 194).

The lithological characters of these rocks strongly resemble those of the Ordovician slates and quartzites at Ballanya Trigonometrical Station near Tallong, described by W. G. Woolnough (1909).

(b). *Eden-Wolumla District*.—In the Eden district fossils are known to occur in only two localities, both close to the main road between Eden and Wolumla: (i), at Bellbird Creek, three miles north of Eden, and (ii), at Merrimbula Creek, one to three miles south-east of Wolumla, on the road to Pambula (see map, Text-fig. 1), where they have been collected by members of the Geological Survey of New South Wales and others.

Specimens obtained by J. E. Carne (1897, p. 163) from Bellbird Creek, were identified by Mr. W. S. Dun as *Rhynchonella pleurodon* (Phillips), *Rhynchonella* (?) *cuboides*, *Atrypa* sp. (?) *reticularis* (Linn.) and small branching polyzoa.

In addition, W. N. Benson (1922, p. 177) records *Rhynchonella primipilaris* (University Collection, Wolumla) and the Sydney University collection includes also some Lepidodendroid remains, considered by Dr. A. B. Walkom (1928b) to resemble the *Protolpidodendron* he has described (1928a) from Yalwal. These specimens were collected by Dr. W. G. Woolnough, the results of whose work in the Eden district are not yet published.

Recently, the writer has collected at Bellbird Creek, in addition to *Rhynchonella*, some pelecypod casts, described below by Mr. Dun (p. 159, Pl. ii, fig. 8) as probably *Phthonia*, and a fragment of (?) *Aviculopecten*. Fossils are not abundant in this locality, but occur in narrow bands in very hard greenish-grey quartzites, similar to some of the fossiliferous Upper Devonian quartzites at the Clyde Mountain, near Braidwood. The palaeontological evidence thus establishes the age of these beds as Upper Devonian.

In the lower portion of Bellbird Creek the red and purple quartzites are almost level-bedded; current-bedding is not noticeable, but ripple marks are well-

developed in layers only a few inches or less vertically above one another; the direction of the crests of the ripple-marks varies, but is most generally about east and west. Abundant remains of annelid tracks provide further evidence of the littoral origin of the beds.

GENERAL STRATIGRAPHY AND TECTONIC FEATURES.

The series of slates, quartzites, grits, quartz-schists, phyllites, cherts, and related rock-types outcropping on the far South Coast of New South Wales, and provisionally classified as Silurian, contain members of at least two formations, the newer being Upper Devonian (Lambian) in age, and the older Ordovician; rocks of proved Silurian age occur only west of the main series, in the Bendithera-Wyanbene belt.

Upper Devonian Beds.

The Upper Devonian beds described in this paper form a link between the previously known Upper Devonian beds of the Eden district described by W. B. Clarke (1860) and J. E. Carne (1896-7), and those revealed by the erosion of tributaries of the Shoalhaven River in the Ettrema and Yalwal gorges, described by H. I. Jensen (1908), C. F. Laseron (1908, 1910), and E. C. Andrews (1901).

Whereas at Eden these beds are practically horizontal or only gently folded, being probably extensions of the estuarine beds of Genoa Creek (Carne, 1897, p. 151; Dun, 1897) and the Upper Devonian of Gippsland (Howitt, 1874-7; Skeats, 1929) the intensity of the folding, in general, has increased in a northerly direction. Thus at Eden the dips do not exceed 20°, near Quaama the average dip of the beds unaffected by faulting or igneous intrusion is about 25°, along the Deua River the maximum dip is 45°, while at Yalwal some of the Devonian beds have almost vertical dip. This increase in the intensity of folding towards the north may be an early indication of the crustal down-warping which produced the great geosyncline of eastern New South Wales, in which Permo-Carboniferous and Mesozoic sediments were afterwards deposited.

The general direction of the fold-axes shows a progressive change (see Text-fig. 1) from N. 30° W. at Quaama, to north-north-west about Coondella, more nearly meridional along the course of the middle Deua River, N. 30° E. at Currowan Creek, generally north-north-east at the Yalwal goldfield, to north-east at the junction of Yalwal and Ettrema Creeks, near the lower Shoalhaven River.

Although there are minor local variations in dip, due to faulting and intrusion of igneous rocks, and the outcrops of Upper Devonian rocks are isolated on account of faulting and erosion, the general arcuate arrangement of the directions of strike of the Upper Devonian beds suggests that they have been compressed against a massif of older rocks lying to the east.

Middle Devonian Beds.

It has been shown by A. W. Howitt (1874-7) and others (Skeats, 1929) that there is a marked unconformity between Middle and Upper Devonian sediments in north-east Gippsland, Victoria, but hitherto no evidence of Middle Devonian deposition has been recorded from the adjacent area of south-eastern New South Wales. It therefore seems probable that the Upper Devonian sea extended much farther to the north-east into New South Wales than formerly, causing a consider-

able overlap on to much older sediments. At many places near the township of Eden the Upper Devonian beds may be seen resting on the upturned and denuded edges of old slates and schistose rocks.

Near Pambula and Merrimbula (north of Eden, see map) the writer has noticed a series of relatively gently-folded red beds underlying the Upper Devonian sandstones with a definite unconformity; no detailed examination of these beds has yet been made, but there seems a possibility that they may be Middle Devonian sediments, as they appear much less folded and altered than the series of slates and schistose rocks outcropping along the coast to the north, and underlying the Upper Devonian sandstones around Twofold Bay.

Older Palaeozoic Beds.

The older complex series, occupying the greater part of the coastal area between the head of the Clyde River and the Brogo River, contains a great variety of types, including sedimentary, igneous and metamorphic rocks.

There is no consensus of opinion regarding the age of the series; the only fossils yet recorded from the whole of the series are the graptolites in slates north of Cobargo, indicating an Ordovician age for these beds. The occurrence of turquoise at Whittaker's Creek, near Bodalla, recorded by Curran (1896, p. 252), and the general lithological and structural resemblances to portions of the Brisbane "Schist" series, have led to the provisional classification of the beds as Ordovician by Sir Edgeworth David.

It is hoped to give a more detailed account of the petrography and possible stratigraphical subdivisions of this series on a future occasion.

The series is characterized by rather intense folding, some faulting and well-marked cleavage, all of which are in a meridional direction, as a general rule; some local variations in the trend lines may be due to pitching folds, while intrusive igneous masses, particularly that at Mt. Dromedary, are responsible for marked local variations in the trend of the beds.

PALAEONTOLOGICAL NOTES, by W. S. DUN.

Spirifer disjuncta.

The *Spirifers* from Coondella occur as internal casts and impressions and are in agreement with Gosselet's figure (*Mém. Soc. Géol. du Nord*, iv, 1894, Pl. 1, fig. 1), being of his *elongati* group; some approach his high area forms, such as those shown on his Plate 4, figures 21, 22, and 23. They are also closely comparable to Davidson's figures on his Plate v (Devonian Brachiopoda. *Brit. Foss. Brach.*, iii, 1864). The species has also been described by R. Etheridge, Jr., from Mt. Lambie (*Journ. Roy. Soc. N.S.W.*, xiv, 1880, 255). Hall and Clarke refer to Upper Devonian *Spirifers* "with well developed fold and sinus, elongate hinge and elevated cardinal areas" as of the "*disjunctus* type" (*Pal. N. York*, viii, part 2, 1894; for figures see Vol. iv, Pl. 41, figs. 10-16).

Spirifer disjuncta occurs at numerous localities in New South Wales. The Mining Museum has specimens from Mt. Lambie, where it is most abundant; Sunny Corner; 6 miles north of Mudgee; Wilbertree; Palmer's Oak; Limekilns, Bathurst; Winburndale; Ph. Bell, Co. Ashburnham, Molong; The Peaks, Tonalli Creek, Burragorang; Back Creek, Ph. Bendoura; Marulan; Clear Creek; Grassy Gully, Windellama; Kowmung; Por. 60, Ph. Goollooinboin; Hartley; and Crown

Station, Capertee. In the Australian Museum are specimens from Gap Creek, Ph. Barton, near Molong; Marangaroo, and head of Bull's Creek, 3 miles NNE. of Jenolan Caves.

See also W. N. Benson (*Rec. Geol. Survey N.S.W.*, x, part 2, 1922, 181), Etheridge, R., Jr. (*Cat. Austr. Fossils*, 1878, 55-6), De Koninck (*Foss. Pal. N. Galles Sud*, 1876, 100; English Translation: *Mem. Geol. Surv. N.S.W.*, Pal. No. 6, 1898, 79-81).

Rhynchonella pleurodon.

The specimen of *Rhynchonella (Pugnax) pleurodon* figured is from the fine-grained, olive-coloured sandstone of the Clyde Mountain. This specimen of the protean species is closely comparable to the inflated quadrate-ovate type figured by Davidson (*Brit. Foss. Brach.*, ii, 1858 (1859), Plate 23, figs. 12 a and b). The ridges are subacute and accentuated towards the margins of the valves, undeveloped on the median and upper portions; there are from four to six ridges on the sinus, which has a well-marked marginal inflection.

See also De Koninck (*op. cit.*, 1898, pp. 75-76, 170, Pl. ii, f. 4; Pl. 40, f. 1); W. N. Benson (*op. cit.*, p. 176); R. Etheridge, Jr. (*op. cit.*).

Rhynchonella pleurodon occurs abundantly in the Upper Devonian of the Mount Lambie District, and at many localities in the Central Western Area of New South Wales; in the Southern District the form is found near Eden, Quaama, the Clyde Mountain, the Lower Shoalhaven at Grassy Gully, and the Ettrema Gorge.

Phthonia sp.

Specimens of a pelecypod, probably *Phthonia (Solemya)* of Hall, a genus which occurs in the Hamilton and Chemung of New York State, are from Bellbird Creek, three miles north of Eden. They represent a form very similar to Hall's *P. cylindrica* (*Pal. N. York*, v, Pt. i, Vol. ii, p. 473, Pl. 78, figs. 1-4).

The preservation is not very satisfactory; concentric growth-lines are shown, but no traces of radial striae, which are clearly to be seen in other species of the genus.

Phthonia has not been recognized previously in Australia.

SUMMARY.

The paper gives an account of the occurrence of Upper Devonian littoral deposits west of Moruya; between Braidwood and the Coast; near Quaama; and in the Eden District. Typical Upper Devonian fossils occur in each of these localities.

There is a progressive increase in the intensity of the folding of these beds from north-east Gippsland, Victoria, through the Eden District northwards to Yalwal, near the Lower Shoalhaven River, while the arcuate arrangement of the trend-lines suggests compression against a massif of older rocks lying to the east.

Within the area considered, rocks of proved Silurian age are only known to occur in the Bendithera-Wyanbene belt, west of the Deua River.

Ordovician graptolite-bearing slates outcrop near Cobargo; the age of the slates, cherts and schistose rocks outcropping over the greater portion of the South Coast area is not definitely known.

The paper includes a review of the previous literature on the stratigraphy of the older Palaeozoic rocks of the south-eastern portion of this State, and the adjacent area of Victoria.

Mr. W. S. Dun contributes palaeontological notes on *Spirifer disjuncta*, *Rhynchonella pleurodon* and *Phthonia*.

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EXPLANATION OF PLATES I-II.

Plate i.

- 1.—Outcrop of limestone faulted against slates and quartzites, on the north side of Con Creek, Bendithera.
- 2.—Outcrop of quartzite containing *Spirifer disjuncta*, three-quarters of a mile south of Coondella Trigonometrical Station; Track from Moruya to Bendithera.
- 3.—Tilted Devonian quartzites; Junction of Currowan and Sugarloaf Creeks, between Nelligen and the Clyde Mountain.

Plate ii.

- 1.—*Spirifer disjuncta*. Internal cast of pedicle valve, showing portion of area, and infilling of delthyrium. $\times 1\frac{1}{4}$.
- 2.—*Spirifer disjuncta*. Internal cast of more alate form, showing area. $\times 1\frac{1}{2}$.
- 3.—*Spirifer disjuncta*. Internal cast of wide form, showing fine striate ornamentation. $\times 1\frac{1}{2}$.
- 4.—*Spirifer disjuncta*. Internal cast of pedicle valve, showing high area. $\times 2$.
- 5.—*Spirifer disjuncta*. Internal cast of brachial valve, showing septal ridge. $\times 1\frac{1}{2}$.
- 6.—*Rhynchonella (Pugnax) pleurodon* J. Sby. Internal cast of brachial valve, showing coarse plications and median septal ridge. $\times 1\frac{1}{2}$.
- 7.—*Rhynchonella (Pugnax) pleurodon* J. Sby. Internal cast showing inflation of brachial valve. $\times 1\frac{1}{2}$.
- 8.—*Phthonia (Solemya)*. Mould of left valve. $\times 1\frac{1}{2}$.

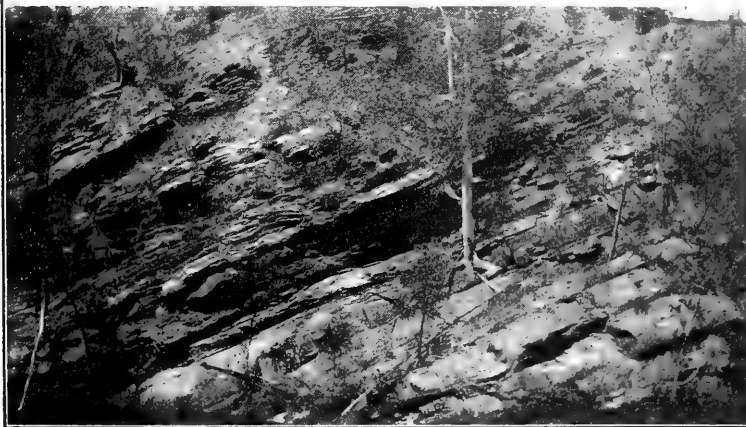
Figured specimens 1-5 from half a mile south of Coondella Trigonometrical Station, 10½ miles west-south-west of Moruya. Figured specimens 6-7 from the Clyde Mountain. Figured specimen 8 from Bellbird Creek, three miles north of Eden.



1



2



3

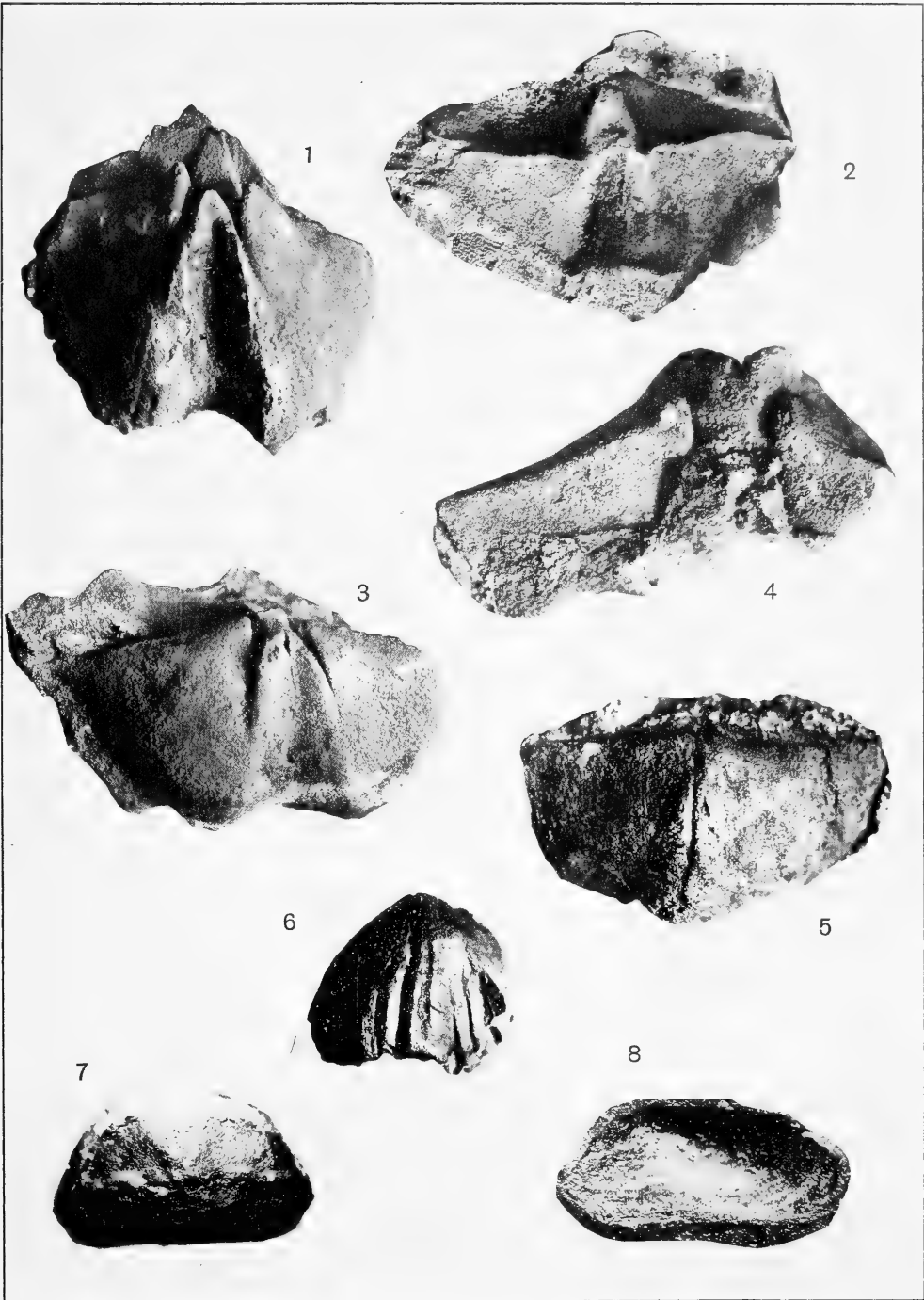


Photo., H. G. Gooch.

Upper Devonian Fossils from the South Coast, N.S.W.



AUSTRALIAN RUST STUDIES. II.

BIOMETRICAL STUDIES OF THE MORPHOLOGY OF SPORE FORMS.

By W. L. WATERHOUSE, D.Sc.Agr.
The University of Sydney.

(Plate iii.)

[Read 30th April, 1930.]

Introduction.

In the first paper of these studies (Waterhouse, 1929), the cereal rusts which occur in Australia were dealt with, and results of investigations into their specialization and occurrence recorded. These investigations followed the recognized methods of culturing the rusts on certain selected cereal varieties, and determining the physiologic forms from the rust reactions thus obtained. It has long been known that specialization of the rust fungi may be shown by this method.

More recently, morphological differences between physiologic forms have also been shown to exist in some cases. Levine (1923, 1928) made careful and extensive studies of the comparative morphology of various cereal stem rusts. By altering the cultural conditions, pronounced morphological differences were obtained in the uredospores of an individual form. But the differences in the size and shape of the uredospores of different forms, grown under identical conditions, were in many instances considerably greater than those induced by alteration of the cultural conditions. Definite parallelism between the differences in parasitism and in morphology was not found. It was concluded that, although there is a real morphologic distinction between physiologic forms of *P. graminis tritici* when developed under uniform conditions, the forms are best identified by their parasitic behaviour on standard differential hosts.

Homma (1929) has shown that there are significant morphological differences between physiologic forms of *Erysiphe graminis* D.C.

It would seem, then, that a biometrical study of the spores may serve as a useful tool in the rust identification work. In Australia, determinations of physiologic specialization have been made only in recent years. In the past, when severe epidemics occurred, no determinations were made of the forms concerned. But if biometrical studies can establish the identity of the forms, then from a study of herbarium material, it may be possible to determine the form or forms which caused the damage, and perhaps trace the changes in specialization which have occurred. These studies were, therefore, made as a first step to a more detailed and accurate series of measurements.

Methods and Material.

Efforts were made to ensure that the spores measured were truly representative, and that the collections were uniform.

In the case of the aecidiospores, the infected barberry shoots were lightly shaken over slides faintly smeared with albumen fixative. A 50% watery solution of lactic acid was used as a mounting medium. From the same shoots, further lots of spores were taken and used to inoculate susceptible cereal hosts. The specialization of the rust concerned was then determined by culturing on the standard differentials.

Uredospores were taken from fully susceptible hosts. A set of differentials, together with a pot of "Federation" wheat or of "Algerian" oats, was inoculated in the early summer. The pots of Federation wheat and Algerian oats were kept in similar locations on a well-lighted bench of the plant house, and given the most favourable conditions possible for rust development. After taking notes on the sets of differentials and making certain that the form used for measurement was what it purported to be, uredospores were obtained from the Federation and Algerian plants by lightly shaking the infected leaves over smeared slides, and mounted in 50% lactic acid.

The teleutospores were scraped from straw which had been collected whilst some uredospores were present. The latter were used to determine the specialization of the rust concerned. The straw in each case was later exposed in wire frames throughout the winter to weather conditions at Hawkesbury Agricultural College. The spores were taken in the following summer for measurement. Lactic acid was again used as the mounting medium.

No one of the cultures used was of monosporous origin. To date more than 250 single uredospores of *P. graminis tritici* have been isolated and used to inoculate susceptible Federation wheat plants. In no case has an infection been obtained, and therefore no monosporous culture is at present available. Levine's studies indicate that there is no significant difference between the results of measuring random samples of uredospores of monosporous as compared with composite cultures of the same physiologic form.

The measurements were all made with the same Zeiss microscope, standardized and calibrated in the ordinary way. An eyepiece micrometer was used, of which each division under the existing conditions measured 1.86 μ . The same light intensity derived from an artificial source was used throughout. The spores in each case were mounted in a 50% solution of lactic acid in water. Every effort was used to avoid bias in regard to the particular spores measured: each spore encountered as the slide was mechanically moved from one side of the stage to the other was taken. The greatest length and greatest width were taken in the case of aecidiospores and uredospores. The length of the teleutospores was measured from the exterior of the apex to the point of attachment of the pedicel, and the width taken across the septum separating the two cells. The shape was determined by calculating the ratio of length to width of each individual spore measured; the figures thus obtained were used in the calculations of the constants.

It should be stressed that these conditions of working differ from those employed by Levine. Whilst strict comparisons of the American and these Australian results are, therefore, not justifiable, a general agreement may be looked for.

AECIDIOSPORES.

Puccinia graminis.

As indicated already, the aecidial stage is uncommon in Australia. Only three collections of aecidiospores have been used for measurement. Two were forms

TABLE I.
Variations and constants for length, width, and shape of aecidiospores of *Puccinia graminis*.
LENGTH.

Form.	Spore classes in microns.										Size Limits.	Constants.		
												Mean.	Standard Deviation.	Coefficient of Variability.
	11-16	13-02	14-88	16-74	18-60	20-46	22-32	24-18	26-04	27-90					29-76
<i>P. graminis tritici</i> 46 ..			3	6	24	10	6	1			14-88-24-18	19-08 ± 0-199	1-95 ± 0-131	10-45 ± 0-71
<i>P. graminis tritici</i> 11 ..			2	4	22	38	24	8	1	1	14-88-29-76	20-68 ± 0-153	2-26 ± 0-108	10-96 ± 0-53
<i>P. graminis tritici</i> 46 and 11 ..			5	10	46	48	30	9	1	1	14-88-29-76	19-15 ± 0-126	2-28 ± 0-089	11-95 ± 0-48
<i>P. graminis avenae</i> 1 ..			1	6	30	41	26	11	4	1	14-88-27-90	21-18 ± 0-155	2-29 ± 0-11	10-85 ± 0-52

WIDTH.

Form.	Spore classes in microns.										Size Limits.	Constants.		
												Mean.	Standard Deviation.	Coefficient of Variability.
	11-16	13-02	14-88	16-74	18-60	20-46								
<i>P. graminis tritici</i> 46 ..			18	19	11	2					14-88-20-46	16-63 ± 0-162	1-54 ± 0-104	9-49 ± 0-64
<i>P. graminis tritici</i> 11 ..			5	10	28	52	5				13-02-20-46	17-32 ± 0-115	1-73 ± 0-082	9-71 ± 0-465
<i>P. graminis tritici</i> 46 and 11 ..			5	28	47	63	7				13-02-20-46	17-15 ± 0-098	1-78 ± 0-069	10-40 ± 0-41
<i>P. graminis avenae</i> 1 ..			2	4	25	41	23	5			11-16-20-46	16-53 ± 0-129	1-91 ± 0-091	11-49 ± 0-53

SHAPE.

Form.	Ratio of length to width.										Size Limits.	Constants.			
												Mean.	Standard Deviation.	Coefficient of Variability.	
	1-0	1-1	1-2	1-3	1-4	1-5	1-6	1-7	1-8	1-9					2-0
<i>P. graminis tritici</i> 46 ..												1-0-1-5	1-146 ± 0-0155	0-148 ± 0-0099	14-15 ± 1-025
<i>P. graminis tritici</i> 11 ..			14	17	10	3	3	1	2	1		1-0-1-8	1-187 ± 0-0106	0-153 ± 0-0073	12-88 ± 0-625
<i>P. graminis tritici</i> 46 and 11 ..			13	40	22	10	10	1	2	1		1-0-1-8	1-17 ± 0-0085	0-154 ± 0-006	13-18 ± 0-53
<i>P. graminis avenae</i> 1 ..			2	27	57	32	13	13	6	1	1	1-0-2-0	1-274 ± 0-0107	0-158 ± 0-0073	12-73 ± 0-618

of *P. graminis tritici*, and the other a form of *P. graminis avenae*. Aecidiospores of *P. graminis tritici* 46 were obtained in 1921, when only 50 spores were measured (Waterhouse, 1921). *P. graminis tritici* 11 was obtained in 1928 under artificial conditions, as reported elsewhere (Waterhouse, 1929). In this case 100 spores were measured, under conditions as nearly as possible identical with those obtaining in 1921.

The result of adding together the measurements of these two forms of *P. graminis tritici* is given immediately following the individual results of each form. The aecidiospores of *P. graminis avenae* 1 were obtained as a result of infecting a barberry with teleutospore material sent by Miss K. Sampson from Ireland.

Table 1 shows the results of these measurements.

Comparisons of the results obtained are summarized in Table 2.

TABLE 2.

Summary of differences between the means of the dimensions of aecidiospores of *Puccinia graminis*,

Types compared.	Length.		Width.		Shape.	
	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.
<i>P. graminis tritici</i> 11 and <i>P. graminis tritici</i> 46 ..	1.60±0.25	6.4	0.89±0.20	4.4	0.041±0.019	2.2
The total of <i>P. graminis tritici</i> 11 and 46 and <i>P. graminis</i> <i>avenae</i> 1	2.03±0.20	10.1	0.54±0.162	3.3	0.104±0.016	6.3
The total of <i>P. graminis tritici</i> 11 and 46 and <i>P. graminis</i> <i>tritici</i> recorded by Levine..	0.67±0.226	2.96	1.46±0.14	10.4		
<i>P. graminis avenae</i> 1 and <i>P. graminis avenae</i> recorded by Levine	2.56±0.25	10.5	1.89±0.16	11.8		

It will be seen that there is a significant difference in the length and the width of the aecidiospores of the two forms of *P. graminis tritici*. Form 46 has spores which are shorter and narrower than those of Form 11.⁵ The difference in the shape of the two is therefore not significant, the difference divided by the probable error being only 2.2. For purposes of further comparison, the constants for all the 150 measured spores of these two forms were determined, and are used as representing those of *P. graminis tritici*.

Levine reports that, of the different varieties of *P. graminis*, the aecidiospores of *P. graminis tritici* have the largest arithmetical mean for both length and width. In the cases under consideration, it will be seen that the aecidiospores of *P. graminis avenae* 1 are significantly longer than those of *P. graminis tritici* 11 and 46, and probably they are significantly wider. The difference in the shape is significant. Assuming that the differences in the methods employed do not preclude a general comparison of the results, it will be further seen that there

are differences between the measurements of spores of *P. graminis tritici* as given by Levine and those herein recorded. In length the difference is probably not significant, but the Australian aecidiospores are significantly wider. Again, in the case of the aecidiospores of *P. graminis avenae*, the measurements given by Levine show that the spores obtained in Australia are significantly longer and wider than the American spores.

UREDOSPORES.

The variety of *P. graminis* which occurs on rye, and known as *P. graminis secalis* E. and H., has so far not been determined in Australia. In all cases examined, the stem rust on rye has proved to be one or other of the well-known forms of *P. graminis tritici* E. and H. On barley the stem rust is also *P. graminis tritici*. Oats commonly are attacked by *P. graminis avenae* E. and H. On cereals in Australia, then, the only stem rusts known are *P. graminis tritici* and *P. graminis avenae*. Other varieties of *P. graminis* occur on certain grasses, but these are not included in these measurements.

McAlpine (1906) records the rust on these plants, and gives the measurements of uredospores of *Puccinia graminis* Pers. as a composite species. He records a length of 20-36 μ and a width of 14-18 μ . It will be noted that these figures are unlike those found for the variety *P. graminis tritici* as a whole, but are in fair agreement with those given by *P. graminis avenae* as a whole.

Of *P. graminis tritici* and *P. graminis avenae*, Levine reports that the former has the larger uredospores in regard to both length and width. Taking the totals of the spores measured, it will be seen that the same thing applies to the Australian rusts.

A comparison of these two varieties of *Puccinia graminis* with those recorded in the United States is of interest.

(a). *P. graminis tritici*.

In all, thirteen physiologic forms were available for measurement. The results are set out in Tables 3-5, in which, after the measurements of the individual forms, are given the dimensions for the total of the eight forms which have occurred naturally in Australia, and then the sum total of all thirteen forms used.

A comparison of types is shown in Table 6.

It will be seen that the results of measurements of all thirteen forms, when compared with those given by Levine, show that the local types are shorter and narrower than those recorded in America. In length the difference is significant, though not so positive as in the width. The same thing applies in the comparison of the American results with those obtained from the eight naturally-occurring Australian forms.

Of the individual forms, the only one common to the two sets of measurements is Form 27. Levine compared two isolations of this form, one from India with another from California. He found an appreciable difference in the width of the spores from the two sources, but considers that there is no conclusive evidence of them having different morphological identities. He remarks that this Form 27 was the most variable, as regards shape, of all his stock cultures. The measurements herein reported, when compared with Levine's, show very significant differences as regards length, width, and shape. Apart altogether from the

TABLE 3.
Variations and constants for length of uredospores of *Puccinia graminis tritici*.

Form No.	Spore classes in microns.												Size Limits.	Constants.			
	20-46	22-32	24-18	26-04	27-90	29-76	31-62	33-48	35-34	37-20	39-06	40-92		42-78	44-64	Mean.	Standard Deviation.	Coefficient of Variability.
43	1	6	6	12	13	23	21	13	3	2				20-46-37-20	29-39±0.24	3.58±0.17	12.10±0.58
44	1	2	3	8	9	28	20	13	9	6	1			20-46-39-06	30-79±0.24	3.56±0.17	11.53±0.56
54		3	6	12	21	30	13	9	5	1				22-32-37-20	29-29±0.21	3.08±0.15	10.05±0.48
34		1	1	6	14	26	28	22	1	1				22-32-37-20	30-02±0.17	2.58±0.12	8.21±0.39
11	1	1	9	14	15	37	13	7	3					20-46-35-34	28-96±0.21	3.09±0.14	10.7±0.51
33		3	5	11	11	18	19	20	7	4	2			22-32-39-06	30-02±0.25	3.73±0.18	12.18±0.6
46		2	9	9	11	17	21	15	9	4	1			22-32-40-92	32-08±0.27	4.09±0.19	12.72±0.62
45			1	3	4	9	13	34	15	15	5	1		24-18-40-92	33-55±0.21	3.18±0.16	10.65±0.56
45A		1	1	6	7	14	14	25	19	7	3	2	1	22-32-42-78	32-08±0.25	3.73±0.18	11.4±0.5
55		1	2	8	8	18	18	28	10	5	1	1		22-32-40-92	31-64±0.24	3-39±0.16	10-70±0.52
27		1	3	5	5	9	21	30	12	11	2	1		22-32-40-92	32-53±0.27	3-51±0.17	9-26±0.44
16			2	3	6	13	15	26	21	9	3	1	1	24-18-44-64	33-05±0.23	3-48±0.17	10-5±0.51
New Form		4	25	33	26	9	3							24-18-33-48	28-37±0.14	2-08±0.09	7-36±0.35
Total Aust.	2	16	22	64	85	159	144	165	77	46	14	5	1	20-46-42-78	31-25±0.09	3-68±0.06	11-75±0.20
Sum Total	3	21	45	122	155	262	221	251	120	70	21	7	1	20-46-44-64	31-04±0.07	3-70±0.05	11-90±0.16

TABLE 4.
Variations and constants for width of uredospores of *Puccinia graminis tritici*.

Form No.	Spore classes in microns.							Size Limits.	Constants.		
	11-16	13-02	14-88	16-74	18-60	20-46	22-32		Mean.	Standard Deviation.	Coefficient of Variability.
43	6	53	31	10	16-74-22-32	19-44±0-09	1-40±0-07	7-21±0-34
44	9	69	17	5	16-74-22-32	18-94±0-08	1-21±0-06	6-42±0-31
54	3	3	40	38	16	14-88-22-32	17-56±0-13	1-93±0-09	11-0 ±0-55
34	4	15	48	23	10	14-88-22-32	18-97±0-12	1-77±0-08	9-34±0-44
11	2	24	60	14	4	14-88-20-46	18-43±0-08	1-23±0-06	6-67±0-32
33	14	56	26	4	16-74-22-32	18-33±0-09	1-34±0-06	7-3 ±0-35
46	29	33	36	2	..	14-88-20-46	16-95±0-11	1-58±0-08	9-30±0-44
45	..	1	10	47	42	..	..	13-02-18-60	17-30±0-09	1-28±0-06	7-37±0-35
45A	..	2	10	29	22	..	..	11-16-18-60	15-98±0-13	1-85±0-09	11-59±0-56
55	13	30	48	6	3	14-88-22-32	17-78±0-11	1-67±0-08	9-4 ±0-45
27	..	1	15	25	51	7	1	13-02-22-32	17-69±0-11	1-68±0-09	9-05±0-43
16	..	1	16	28	54	1	..	13-02-20-46	17-45±0-10	1-48±0-07	8-50±0-41
New Form	..	1	1	3	40	47	9	14-88-22-32	19-72±0-09	1-37±0-07	6-92±0-33
Total Aust.	2	11	96	172	358	117	44	11-16-22-32	18-14±0-05	2-01±0-03	11-02±0-188
Sum Total	2	13	130	266	619	212	58	11-16-22-32	18-25±0-04	1-88±0-03	10-3 ±0-14

TABLE 5
Variations and constants for shape of uredospores of *Puccinia graminis tritici*.

Form No.	Ratio of length to width.										Size Limits.	Constants.		
	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0		Mean.	Standard Deviation.	Coefficient of Variability.
43	15	17	40	22	6						1.57 ± 0.015	0.22 ± 0.011	14.0 ± 0.68	
44	5	13	38	25	16	3					1.69 ± 0.015	0.23 ± 0.011	13.60 ± 0.66	
54	12	29	36	16	6	1					1.55 ± 0.015	0.22 ± 0.011	14.18 ± 0.69	
34	1	16	31	40	9	2	1				1.70 ± 0.014	0.21 ± 0.010	12.35 ± 0.60	
11	5	17	45	22	9	2					1.74 ± 0.015	0.22 ± 0.011	12.63 ± 0.61	
33	6	15	28	31	17	1	2				1.69 ± 0.017	0.25 ± 0.012	14.8 ± 0.77	
46	2	2	16	16	38	14	6	4			1.98 ± 0.021	0.31 ± 0.015	15.65 ± 0.77	
45		3	11	22	29	15	12	5	3		2.03 ± 0.021	0.31 ± 0.015	15.25 ± 0.75	
45A		2	12	18	21	21	10	6	6	4	2.11 ± 0.026	0.38 ± 0.018	18.09 ± 0.87	
55	3	6	17	35	28	5	3	2	1		1.84 ± 0.019	0.28 ± 0.013	15.2 ± 0.74	
27	1	6	18	31	21	17	4	2			1.88 ± 0.019	0.28 ± 0.013	14.89 ± 0.73	
16	4	4	11	25	31	14	9	4	2		1.99 ± 0.021	0.31 ± 0.015	15.58 ± 0.76	
New Form	3	50	36	11							1.51 ± 0.010	0.15 ± 0.007	9.94 ± 0.47	
Total Aust.	38	88	201	194	153	61	32	17	12	4	1.79 ± 0.0081	0.339 ± 0.0057	18.90 ± 0.33	
Sum Total	53	180	339	314	231	95	47	23	14	4	1.77 ± 0.0061	0.324 ± 0.0043	18.25 ± 0.25	

TABLE 6.

Summary of differences between the dimensions of the means of uredospores of *Puccinia graminis tritici*.

Types compared.	Length.		Width.		Shape.	
	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.
<i>P. graminis tritici</i> at large as recorded by Levine and the total of the 13 forms measured in Australia ..	1.36±0.20	6.8	1.54±0.07	22.0		
<i>P. graminis tritici</i> at large as recorded by Levine and the total of the 8 forms naturally occurring in Australia ..	1.15±0.21	5.5	1.65±0.08	20.6		
Total of all 13 forms measured in Australia and the total of the 8 forms naturally occurring in Australia ..	0.21±0.11	1.9	0.11±0.06	1.8	0.02±0.01	2.0
<i>P. graminis tritici</i> 27 recorded by Levine and the same form isolated from English straw in Australia..	2.59±0.39	6.7	1.84±0.14	13.1	0.324±0.026	12.5
<i>P. graminis tritici</i> 43 compared with <i>P. graminis tritici</i> 46 ..	2.70±0.36	7.5	2.49±0.14	17.8	0.41±0.026	15.8
<i>P. graminis tritici</i> 45 compared with <i>P. graminis tritici</i> 45A..	0.87±0.33	2.6	1.32±0.15	8.8	0.08±0.033	2.7

differences in methods of measuring, there may be a difference in the genetic constitutions of the rusts obtained from the different sources. Furthermore, the form measured locally was obtained from aecidial infections produced on barberries from Welsh wheaten straw. It is known that this aecidial stage may give rise to the occurrence of new physiologic forms under certain conditions. The genetic constitution of the form used may be different from the isolations dealt with in the United States.

Taking the eight naturally-occurring Australian forms, some interesting facts come to light. It has elsewhere been pointed out that Forms 43, 44 and 54 show rather marked similarities in parasitic capabilities. Indeed, the separation of Forms 44 and 54 is not easy. An examination of the uredospore measurements of these three forms shows that there are striking similarities in length, width and shape. But morphology alone cannot be taken as a guide to specialization. The contrast in parasitism between these three forms and Form 34—which at present is the predominant form in Australasia—is most marked. And yet Form 34 conforms closely to the measurements given for the Forms 43, 44, and 54. The artificially-produced Form 11, which is parasitically rather similar to Form 34, and was derived as a hybrid between it and Form 43, differs but slightly from it

biometrically. And yet again, the rather weakly parasitic Form 33, obtained in the uredospore stage from Dr. Levine, agrees in measurements with these two virulent forms, 11 and 34. These six forms together constitute a group with biometric similarities.

Turning next to the other four forms which occur naturally in Australia, viz., Forms 46, 45, 45A, and 55, it will be seen that they show similarities in their measurements. As a group they are longer and narrower than the first group. This is strikingly reflected in the measurements of the shapes. As previously reported (Waterhouse, 1923) this difference may be noted in a casual examination of the uredospores. They are much more variable in shape, and much longer and narrower. The actual differences between Forms 43 and 46 are set out and are very significant.

Conforming to this group of forms, in which the uredospores are relatively long and narrow, are the overseas Forms 16 and 27 derived from India and Wales respectively. The longest spore measured came from the lot of Form 16, being more than 44μ in length.

Of special interest is the remaining form, designated the "New Form" (Waterhouse, 1929). It may be remembered that this was obtained from aecidia on a barberry as a hybrid between Forms 34 and 43. The uredospores are the most uniform of those met. They are the shortest of any of the forms measured, having a mean length of only $28.37 \pm 0.14 \mu$. They are shorter than those of any form recorded by Levine. Amongst the Australian measurements, they approximate most closely to those of Form 11, which had its origin on the barberry at the same time and in much the same fashion as the New Form. Not only is this "New Form" shorter, but at the same time its mean width is the greatest of the forms measured. From this it follows that in shape it is also unique, the mean of the ratio of length to width being 1.51 : 1.

(b). *P. graminis avenae*.

Five forms of this rust have been determined from material collected in Australia. One further isolation has been made from aecidiospores produced on a barberry infected by teleutospores present on oat straw collected in Ireland. Unfortunately, before the measurements were made, one of the five Australian forms was lost. The two stock cultures of it died during very hot summer conditions. The measurements of the others are given in Tables 7-9, together with the dimensions for the total of the Australian forms, and then for the sum total of all five forms measured.

A number of comparisons may be usefully made as shown in Tables 10-11.

If a comparison be allowable with the dimensions of *P. graminis avenae* at large as recorded by Levine, it will be seen that uredospores of the rust, as measured in Australia, are significantly shorter and narrower. The same applies to the total of the Australian measurements in comparison with the type from Ireland. Even though strict comparison between the Australian measurements and those given by Levine be not permissible, such comparisons can be made between the Australian measurements and those of the Irish rust; these were all made under identical conditions. That the uredospores of the Australian rust are smaller than those of the overseas type is further borne out by a comparison of the stock culture of *P. graminis avenae* 1, which originally came from Werribee, Victoria, and the Irish culture of *P. graminis avenae* 1. The differences

TABLE 7.
Variations and constants for length of uredospores of *Puccinia graminis avenae*.

Form No.	Spore classes in microns.										Size Limits.	Constants.			
												Mean.	Standard Deviation.	Coefficient of Variability.	
	20-46	22-32	24-18	26-04	27-90	29-76	31-62	33-48	35-34	37-20					39-06
1 (Aust.)	1	8	20	22	28	12	9	8	4	3	22-32-33-48	28-68	±0-18	9-33	±0-45
1 (Irish)	1	1	10	10	17	21	26	8	4	3	24-18-39-06	31-53	±0-22	10-35	±0-50
2	1	4	16	16	28	25	12	7	2		24-18-37-20	30-53	±0-18	8-90	±0-42
3	1	7	24	25	34	10	16	7	2	1	20-46-33-48	27-81	±0-18	2-72	±0-13
Total Aust.	5	16	66	62	103	60	42	14	4	4	26-04-39-06	30-51	±0-21	2-97	±0-14
Sum Total	1	17	76	92	120	87	68	22	8	4	20-46-39-06	29-41	±0-10	10-14	±0-24
											20-46-39-06	29-99	±0-10	3-14	±0-07

TABLE 8.
Variations and constants for width of uredospores of *Puccinia graminis avenae*.

Form No.	Spore classes in microns.								Size Limits.	Constants.			
										Mean.	Standard Deviation.	Coefficient of Variability.	
	13-02	14-88	16-74	18-60	20-46	22-32							
1 (Aust.)	2	15	66	66	16	1	14-88-22-32	18-58	±0-09	1-25	±0-06	6-75	±0-32
1 (Irish)	4	13	60	60	23		14-88-20-46	18-64	±0-09	1-38	±0-07	7-38	±0-35
2	1	15	37	40	7		13-02-20-46	17-43	±0-11	1-59	±0-08	9-13	±0-44
3	3	19	57	57	21		14-88-20-46	18-53	±0-09	1-34	±0-06	7-23	±0-35
7	1	27	49	49	23		14-88-20-46	18-49	±0-09	1-87	±0-07	7-40	±0-35
Total Aust.	21	98	212	212	67	1	13-02-22-32	18-26	±0-05	1-46	±0-04	8-00	±0-19
Sum Total	1	25	111	272	90	1	13-02-22-32	18-33	±0-05	1-59	±0-03	8-67	±0-18

TABLE 9.
Variations and constants for shape of uredospores of *Puccinia graminis avenae*.

Form No.	Ratio of length to width.										Size Limits.	Constants.					
												Mean.	Standard Deviation.	Coefficient of Variability.			
	1-0	1-2	1-4	1-6	1-8	2-0	2-2	2-4	2-6								
1 (Aust.)		5	22	40	30	3	7	1	1		1-2-2-0	1-61	±0-010	0-151	±0-007	9-37	±0-45
1 (Irish)			14	30	34	13	12	4	2		1-4-2-6	1-75	±0-016	0-242	±0-012	13-72	±0-66
2		8	10	22	30	20	6	1			1-88	±0-019	0-28	±0-013	14-8	±0-72	
3			24	45	16	6	1				1-58	±0-014	0-22	±0-010	12-92	±0-63	
7			4	41	27	12	5	1			1-71	±0-015	0-218	±0-010	12-75	±0-62	
Total Aust.		13	70	148	103	41	18	5	2		1-2-2-6	1-69	±0-009	0-25	±0-006	14-51	±0-35
Sum Total		13	84	178	137	54	25	6	3		1-2-2-6	1-70	±0-008	0-24	±0-005	14-20	±0-31

TABLE 10.
Summary of differences between the means of the dimensions of uredospores of *Puccinia graminis avenae*.

Types compared.	Length.		Width.		Shape.	
	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.
Types of all forms measured in Australia and the U.S.A. type recorded by Levine..	1.49±0.18	8.3	1.61±0.09	17.9		
Types of all Australian forms and the form derived from straw from Ireland ..	2.12±0.23	9.2	0.38±0.10	3.8	0.06±0.018	3.3
A form derived from oat straw from Ireland and a similar form obtained from Australian straw ..	2.85±0.34	8.5	0.06±0.13	0.46	0.142±0.019	7.5

TABLE 11.
Summary of differences between the means of the dimensions of uredospores of *Puccinia graminis avenae*.

Types compared.	Length.		Width.		Shape.	
	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.
<i>P. graminis avenae</i> 1 and <i>P. graminis avenae</i> 2 ..	1.84±0.255	7.2	1.15±0.133	8.6	0.27±0.021	12.8
<i>P. graminis avenae</i> 1 and <i>P. graminis avenae</i> 3 ..	0.87±0.255	3.3	0.05±0.12	0.6	0.03±0.037	0.9
<i>P. graminis avenae</i> 1 and <i>P. graminis avenae</i> 7 ..	1.83±0.28	6.5	0.09±0.125	0.7	0.10±0.018	0.55
<i>P. graminis avenae</i> 2 and <i>P. graminis avenae</i> 3 ..	2.71±0.255	10.6	1.10±0.14	7.9	0.30±0.024	12.5
<i>P. graminis avenae</i> 2 and <i>P. graminis avenae</i> 7 ..	0.01±0.28	0.03	1.06±0.14	7.6	0.17±0.024	7.1
<i>P. graminis avenae</i> 3 and <i>P. graminis avenae</i> 7 ..	2.70±0.28	9.7	0.04±0.129	0.3	0.13±0.021	6.5

in width are not significant, but they are certainly significant in regard to both length and shape of uredospores. It has already been pointed out that, as regards colour of pustule, and a striking tendency to produce teleutospores quickly on seedling leaves of oats and grasses, this Irish rust is obviously different from the stock culture of *P. graminis avenae* 1, so common in Australia.

Taking next the forms naturally occurring in Australia, comparisons are instructive. Form 1 is significantly different from Form 2 as regards length, width, and shape of uredospores. Parasitically these two forms are markedly different. Very striking biometrical differences are also seen to exist between Forms 2 and 3. But, as tested on the standard differentials, the differences between them are comparatively slight. As in the case of *P. graminis tritici*, it is therefore clear that there is no definite parallelism between differences in regard to morphology and parasitism.

Turning now to a comparison between the total of all the forms of *P. graminis tritici* measured, and the total of all the forms of *P. graminis avenae*, some interesting facts emerge. In Table 12 the two varieties, delimited in this way, are compared.

TABLE 12.
Summary of the differences between the means of the dimensions of uredospores of
13 forms of *P. graminis tritici* and 5 forms of *P. graminis avenae*.

Types compared.	Length.		Width.		Shape.	
	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.
Total of 13 forms of <i>P. graminis tritici</i> and 5 forms of <i>P. graminis avenae</i> ..	1.05 ± 0.12	8.8	0.08 ± 0.10	0.8	0.07 ± 0.01	7.0

It is seen that the variety *P. graminis tritici*, thus delimited, has uredospores which are significantly longer than those of *P. graminis avenae*. No difference occurs in the width, but the shape is necessarily different. It may be pointed out that these differences in length and shape of the two varieties are not as great as the differences which exist between certain of the physiologic forms of one or other of these two varieties of *P. graminis*.

Levine (1923) found that the means for the length and width of the uredospores of *P. graminis tritici* were $32.40 \pm 0.19 \times 19.70 \pm 0.06 \mu$, and for *P. graminis avenae*, $28.50 \pm 0.15 \times 19.94 \pm 0.07 \mu$. This close approximation of the two widths is confirmed by the Australian results, as is also the greater length of the wheat rust form.

(c). *Puccinia triticina*.

It has been pointed out that in Australia there are two physiologic forms. These cannot be differentiated on the standard set of varieties used by Mains and Jackson, but on "Thew" the separation is absolute. Australian Form 1 produces flecks, whilst Australian Form 2 produces "4" reactions. Certain other varieties behave in the same way.

Measurements of uredospores of the two forms are shown in Table 13.

A comparison of the two forms is set out in Table 14.

It will be seen that the second form is significantly longer and narrower than the first and, as is to be expected, significantly different in shape.

McAlpine gives the measurements of the uredospores as 20 to 28 μ in length and 18 to 21 μ in width. It will be seen that as regards length, these limits agree

TABLE 13.
Variations and constants for length, width, and shape of uredospores of two Australian physiologic forms of *Puccinia triticina*.
LENGTH.

Form No.	Spore classes in microns.										Size Limits.	Constants.		
	16-74	18-60	20-46	22-32	24-18	26-04	27-90	29-76	Mean Length.	Standard Deviation.		Coefficient of Variability.		
Aust. 1			9	18	35	31	7		24.35 ± 0.133	1.97 ± 0.094	8.1 ± 0.39			
Aust. 2				13	24	45	11	7	25.13 ± 0.120	1.77 ± 0.084	7.08 ± 0.34			

WIDTH.

Form No.	Spore classes in microns.										Size Limits.	Constants.		
	16-74	18-60	20-46	22-32	24-18				Mean Length.	Standard Deviation.		Coefficient of Variability.		
Aust. 1	1	18	54	26	1				20.61 ± 0.093	1.375 ± 0.065	6.67 ± 0.316			
Aust. 2	6	46	41	7					19.51 ± 0.095	1.4 ± 0.067	7.17 ± 0.34			

SHAPE.

Form No.	Ratio of length to width.										Size Limits.	Constants.		
	1-0	1-1	1-2	1-3	1-4	1-5	1-6	1-7	Mean Length.	Standard Deviation.		Coefficient of Variability.		
Aust. 1	4	38	26	19	12	1			1.20 ± 0.0074	0.11 ± 0.0053	9.17 ± 0.43			
Aust. 2	1	8	20	30	25	5	10	1	1.33 ± 0.0074	0.11 ± 0.0053	8.28 ± 0.39			

TABLE 14.
Summary of differences between the means of the dimensions of uredospores of
two Australian physiologic forms of *Puccinia triticina*.

Types compared.	Length.		Width.		Shape.	
	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.
Australian 1 and Australian 2	0.78 ± 0.147	5.2	1.10 ± 0.13	8.5	0.13 ± 0.01	13.0

with those found in Australian Form 1. In width there is not the same agreement, but the figures approach more nearly to those of Australian Form 2. It would seem probable, therefore, that both the forms were present when McAlpine carried out his work.

TELEUTOSPORES.

The identity of the uredospores taken for measurement can be accurately determined, and so one can be certain that a particular form and only that form is being dealt with. Teleutospores are somewhat more difficult to identify with certainty. In the cases in point, the teleutospores measured were obtained from naturally-occurring straw which had also carried uredospores whose identity was established. Only the one physiologic form was present in each case, and it is reasonable to suppose that this form is also represented by the teleutospores which were measured.

McAlpine (1906) gives the teleutospore dimensions for *Puccinia graminis* as a composite species as 35-63 × 14-25 μ, with an average of 52 × 18 μ. He states that in size the teleutospores are very variable. No indication is given as to whether the measurements of length were made from the exterior of the apex to the point of attachment of the pedicel, and for width across the septum separating the two cells. At the last-mentioned spot a constriction usually occurs, and it seems probable that the maximum width of the spores was actually measured. Taking the average figures for the measured teleutospores of *P. graminis tritici* and *P. graminis avenae* together, it will be seen that the length ranges from 30 to 74 μ, and the width from 11 to 22 μ, with an average of 45 × 16 μ.

(a). *P. graminis tritici*.

Teleutospores of only three Australian forms were available for measurement. Their dimensions, followed by those for the sum total, are given in Table 15.

Comparisons of the forms measured are set out in Table 16.

Comparing the total of the three Australian forms with the measurements given by Levine, it will be seen that the Australian rust is significantly shorter and narrower. The greater variability is striking.

Between the three Australian forms there are differences. Forms 34 and 43 differ significantly in length and width. Form 34 is longer and wider than 43. It is much more variable in length. In shape there is no appreciable difference between the two. Between Forms 34 and 46 there are again differences. Form 34 is significantly longer than 46, the shortest of the three forms. The difference in width is not appreciable, but in shape the difference is significant.

TABLE 13.
Variations and constants for length, width, and shape of uredospores of two Australian physiologic forms of *Puccinia triticina*.
LENGTH.

Form No.	Spore classes in microns.										Constants.		
	Size Limits.										Mean Length.	Standard Deviation.	Coefficient of Variability.
	16-74	18-60	20-46	22-32	24-18	26-04	27-90	29-76	Size Limits.				
Aust. 1			9	18	35	31	7				24.35 ± 0.133	1.97 ± 0.094	8.1 ± 0.39
Aust. 2				13	24	45	11	7			25.13 ± 0.120	1.77 ± 0.084	7.06 ± 0.34

WIDTH.

Form No.	Spore classes in microns.										Constants.		
	Size Limits.										Mean Length.	Standard Deviation.	Coefficient of Variability.
	16-74	18-60	20-46	22-32	24-18	Size Limits.							
Aust. 1	1	18	54	26	1						20.61 ± 0.093	1.375 ± 0.065	6.67 ± 0.316
Aust. 2	6	46	41	7							19.51 ± 0.095	1.4 ± 0.067	7.17 ± 0.34

SHAPE.

Form No.	Ratio of length to width.										Constants.		
	Size Limits.										Mean Length.	Standard Deviation.	Coefficient of Variability.
	1-0	1-1	1-2	1-3	1-4	1-5	1-6	1-7	Size Limits.				
Aust. 1	4	38	26	19	12	1					1.20 ± 0.0074	0.11 ± 0.0053	9.17 ± 0.43
Aust. 2	1	8	20	30	25	5	10	1			1.33 ± 0.0074	0.11 ± 0.0053	8.28 ± 0.39

TABLE 14.
Summary of differences between the means of the dimensions of uredospores of
two Australian physiologic forms of *Puccinia triticina*.

Types compared.	Length.		Width.		Shape.	
	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.
Australian 1 and Australian 2	0.78±0.147	5.2	1.10±0.13	8.5	0.13±0.01	13.0

with those found in Australian Form 1. In width there is not the same agreement, but the figures approach more nearly to those of Australian Form 2. It would seem probable, therefore, that both the forms were present when McAlpine carried out his work.

TELEUTOSPORES.

The identity of the uredospores taken for measurement can be accurately determined, and so one can be certain that a particular form and only that form is being dealt with. Teleutospores are somewhat more difficult to identify with certainty. In the cases in point, the teleutospores measured were obtained from naturally-occurring straw which had also carried uredospores whose identity was established. Only the one physiologic form was present in each case, and it is reasonable to suppose that this form is also represented by the teleutospores which were measured.

McAlpine (1906) gives the teleutospore dimensions for *Puccinia graminis* as a composite species as 35-63 × 14-25 μ , with an average of 52 × 18 μ . He states that in size the teleutospores are very variable. No indication is given as to whether the measurements of length were made from the exterior of the apex to the point of attachment of the pedicel, and for width across the septum separating the two cells. At the last-mentioned spot a constriction usually occurs, and it seems probable that the maximum width of the spores was actually measured. Taking the average figures for the measured teleutospores of *P. graminis tritici* and *P. graminis avenae* together, it will be seen that the length ranges from 30 to 74 μ , and the width from 11 to 22 μ , with an average of 45 × 16 μ .

(a). *P. graminis tritici*.

Teleutospores of only three Australian forms were available for measurement. Their dimensions, followed by those for the sum total, are given in Table 15.

Comparisons of the forms measured are set out in Table 16.

Comparing the total of the three Australian forms with the measurements given by Levine, it will be seen that the Australian rust is significantly shorter and narrower. The greater variability is striking.

Between the three Australian forms there are differences. Forms 34 and 43 differ significantly in length and width. Form 34 is longer and wider than 43. It is much more variable in length. In shape there is no appreciable difference between the two. Between Forms 34 and 46 there are again differences. Form 34 is significantly longer than 46, the shortest of the three forms. The difference in width is not appreciable, but in shape the difference is significant.

TABLE 15.
Variations and constants for length, width, and shape of teleuto-spores of three Australian physiologic forms of *Puccinia graminis tritici*.
LENGTH.

Form No.	Spore classes in microns.												Size Limits.	Constants.			
	LENGTH.													Mean.	Standard Deviation.	Coefficient of Variability.	
	29-76	33-48	37-20	40-92	44-64	48-36	52-08	55-80	59-52	63-24	66-96	70-68					74-40
34..	1	4	13	12	20	15	10	10	9	3	2	1	47.69 ± 0.58	8.64 ± 0.42	17.67 ± 0.89
43..	6	19	22	18	25	6	3	3	1	1			43.64 ± 0.41	6.07 ± 0.29	13.87 ± 0.69
46..	1	11	25	19	12	3	2	2	4	2			41.66 ± 0.40	5.89 ± 0.28	14.10 ± 0.68
Total	2	21	57	59	52	19	15	11	11	4	2	1	44.32 ± 0.25	7.40 ± 0.20	16.70 ± 0.47

WIDTH.

Form No.	Spore classes in microns.												Size Limits.	Constants.			
	WIDTH.													Mean.	Standard Deviation.	Coefficient of Variability.	
	11-16	13-02	14-88	16-74	18-60	20-46	22-32										
34..	8	28	32	21	8	3							16.78 ± 0.15	2.20 ± 0.11	13.10 ± 0.63
43..	21	45	41	8	1								14.63 ± 0.14	2.79 ± 0.10	14.28 ± 0.68
46..	2	5	35	29	4								16.41 ± 0.13	1.95 ± 0.09	11.9 ± 0.58
Total	16	34	108	72	54	13	3						15.90 ± 0.075	2.27 ± 0.063	14.25 ± 0.41

SHAPE.

Form No.	Ratio of length to width.												Size Limits.	Constants.			
	SHAPE.													Mean.	Standard Deviation.	Coefficient of Variability.	
	1-5	2-0	2-5	3-0	3-5	4-0	4-5	5-0	5-5								
34..	4	15	19	28	19	6	2	1					3.01 ± 0.056	0.826 ± 0.039	27.58 ± 1.38
43..	1	14	24	26	13	10	4	1					3.00 ± 0.036	0.823 ± 0.039	26.80 ± 1.37
46..	1	30	36	18	9	2	2	1					2.95 ± 0.098	0.809 ± 0.033	20.00 ± 1.56
Total	6	59	79	72	41	18	8	2					2.92 ± 0.027	0.82 ± 0.022	28.12 ± 0.895

TABLE 16.
Summary of differences between the dimensions of the means of teleutospores of
Puccinia graminis tritici.

Types compared.	Length.		Width.		Shape.	
	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.	Difference in means in microns.	Difference divided by P.E.
The U.S.A. type recorded by Levine and the total of 3 Australian forms ..	7.48±0.55	13.6	0.77±0.142	5.4		
Form 34 and Form 43 ..	4.25±0.71	6.0	2.25±0.21	10.7	0.08±0.079	1.0
Form 34 and Form 46 ..	6.23±0.71	8.8	0.37±0.20	1.9	0.66±0.074	8.9
Form 43 and Form 46 ..	1.98±0.57	3.5	1.88±0.19	9.9	0.74±0.074	10.0

Comparing Forms 43 and 46, it is seen that Form 43 is significantly longer and narrower than Form 46. There is also a difference in shape. These are just the reverse of the results of the uredospore measurements, which showed that 46 is longer and narrower than 43.

(b). *P. graminis avenae*.

Two sets of material were available for measurement. One batch of oat straw came from Cowra, N.S.W. Uredospores from this straw showed the form to be *P. graminis avenae* 1. The other batch came from Ireland and was in part used to infect a barberry. From the aecidiospores, uredospore cultures were obtained. The form present proved to be *P. graminis avenae* 1. The results are given in Table 17.

A comparison of types is given in Table 18.

It will be seen that the results given by Levine are intermediate in length and width between those of the Australian and the Irish rusts. Statistically there is no significant difference between the Irish and the United States rusts, but the difference in width between the Australian and the United States types may be significant. Comparing the Australian and the Irish forms, the former is the longer. The difference in length is significant, and this probably is also the case in width and shape. The uredospore measurements showed that the Irish was significantly longer than the Australian rust.

Photomicrographs of some of the spore forms used in the measurements are shown in Plate iii. It is obvious that these cannot have as great a value as the biometrical determinations for identifying forms. As far as possible, truly representative spores of the various forms were photographed to illustrate the types, but a small group of spores considered alone may be misleading. Taken in conjunction with the measurements they are instructive.

SUMMARY AND CONCLUSIONS.

Spore measurements have been made of aecidiospores, uredospores, and teleutospores of physiologic forms of varieties of *Puccinia graminis* and of uredospores of *P. triticina*.

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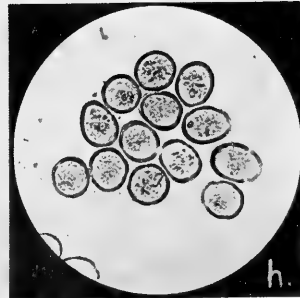
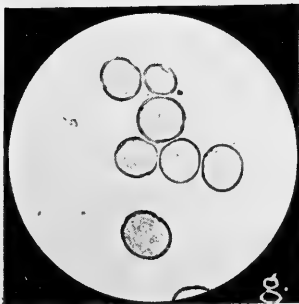
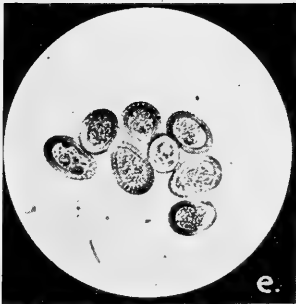
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EXPLANATION OF PLATE III.

Photomicrographs made under uniform conditions of uredospores of *Puccinia* spp. (× 250).

- a. Uredospores of *P. graminis tritici* 43.
- b. Uredospores of *P. graminis tritici* 46.
- c. Uredospores of *P. graminis tritici* 11.
- d. Uredospores of *P. graminis tritici* "New Form".
- e. Uredospores of *P. graminis avenae* 1.
- f. Uredospores of *P. graminis avenae* 2.
- g. Uredospores of *P. triticina* 1.
- h. Uredospores of *P. triticina* 2.

Grateful acknowledgment is made of help given by Mr. H. G. Gooch in the photographic work.



Uredospores of *Puccinia* spp.

AUSTRALIAN COLEOPTERA*. NOTES AND NEW SPECIES. VII.

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

(Plate iv; one Text-figure.)

[Read 30th April, 1930.]

Family BUPRESTIDAE.

MELOBASIS AUROCINCTA, n. sp.

Oblong. Head obscure coppery bronze, pronotum and elytra purplish-black with some metallic gleams, elytra with golden lateral vitta, extending from behind humeral swelling nearly to apex, a similarly coloured mark at base in front of humeral swelling and at suture behind scutellum. Underside and legs a fiery copper colour, prosternum with cyaneous stains.

Head narrower than apex of prothorax, with short pubescence, finely punctate, eyes little prominent. Prothorax bisinuate at base, very feebly so at apex; sides very lightly widened behind middle and rather abruptly narrowed behind, hind angles a little produced, scarcely acute; disc finely and densely punctate, the punctures—especially towards sides—showing a transverse arrangement, a small mediobasal fovea, but no medial line. Scutellum small, longitudinally sulcate. Elytra rounded at shoulders, lightly compressed at basal third, separately rounded at apex, apical margins serrulate; each elytron with two moderately raised costae, the more prominent one, not far from suture, extending from near base to near apex, the other, external to the first, only prominent on apical third; a short sutural costa indicated; hind part of suture also a little raised, and smooth longitudinal lines visible between the costae; surface otherwise with round punctures, somewhat irregular in size and distance apart, showing metallic gleams in each puncture. Prosternum densely and finely punctate, metasternum sulcate, abdomen strongly punctate, apical segment strongly bispinose.

Dimensions: 12 × 4 (+) mm.

Habitat.—Western Australia (Du Boulay in Fry Coll., British Museum).

A single male example belongs to Group 1, Section B, of my Revision, from the rest of which it is very distinct. The costae are less prominent than in other species; the metallic punctures of the elytra can be readily seen with a good lens or binocular. Holotype in British Museum.

MELOBASIS PARVULA, n. sp.

Oblong; glabrous. Head, pronotum, scutellum, femora and underside metallic green, elytra bright metallic purple, becoming darker towards apex, tibiae dark.

Head, including eyes, not wider than apex of prothorax, front rather flat, without impression, densely punctate. Prothorax: Apex and base very lightly bisinuate; sides nearly straight, very feebly narrowed towards apex, posterior angles subrectangular; disc very finely (more finely and less densely than head)

* Includes description of one new species from New Guinea.

and closely punctate; a faint indication of smooth medial line, with a minute fovea at base and a feeble impression at apex. Elytra: basal two-thirds subparallel, apical margins minutely serrulate; disc closely punctate, the apical half showing some linear arrangement; a tendency to rugosity or fine granulation towards sides. Prosternum densely, abdomen strongly but less closely, punctate, metasternum sulcate, apex of abdomen with two short spines.

Dimensions: 6 × 2.5 mm.

Habitat.—Central Australia: Hermannsburg (H. J. Hillier).

A single example sent, amongst other Buprestidae, from the British Museum, is clearly distinct from described species. In size and general facies near *M. terminata* Kerr.,* but, besides the different colour of the elytra, the apex and base of pronotum are less bisinuate than in that species, which also has the head wider than apex of pronotum. Holotype in British Museum.

STIGMODERA (CASTIARINA) IMITATOR, n. sp. Plate iv, figure 6.

Oblong. Head and pronotum bronze, elytra with narrow basal margins, suture, two fasciae (extending the full width) and wide apical margin black; underside nitid green, glabrous; legs blue.

Head and pronotum densely and finely punctate. Prothorax widest behind middle, base and apex lightly sinuate. Elytra slightly widened at shoulders and constricted behind them; apex with moderate lunation, each with a rather long external and a scarcely defined sutural spine; disc finely striate-punctate, intervals almost impunctate, lightly convex, 3 and 5 subcostate, underside minutely punctate.

Habitat.—New South Wales: National Park, Newport, Kuring-gai Chase (Carter), Blue Mountains (G. F. Bryant and H. J. Carter). Queensland: Stanthorpe (E. Sutton).

A species so like in size, form and pattern to *S. vigilans* Kerr., that the author possesses two examples that were determined by the late C. O. Waterhouse as *vigilans* Kerr., after a comparison with the type. Mr. K. G. Blair has, however, sent me one of Kerremans' examples marked "type", together with one of *imitator*, taken by Mr. Bryant on the Blue Mountains. I find both species in my collection (placed under *vigilans*) but they are clearly distinct by the following comparison:

	<i>vigilans</i> Kerr.	<i>imitator</i> , n. sp.
<i>Head and pronotum</i>	black (with cyaneous gleams in places)	bronze
<i>Underside</i>	blue	green
<i>Prothorax</i>	widest at middle disc irregularly, rather sparsely punctate	widest behind middle disc densely, finely punctate
<i>Elytral intervals</i>	3, 5, 7, 9 somewhat costate	3-5 very lightly costate
<i>Habitat</i>	Victoria (1 example from Blue Mountains, N.S.W.)	N.S.W. and S. Queensland

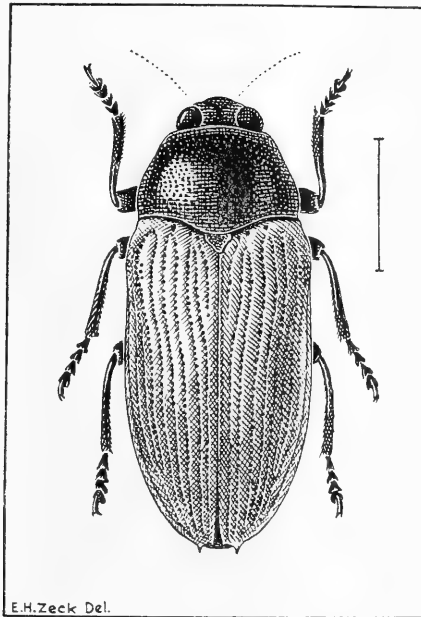
Holotype in Coll. Carter.

* *M. terminata* Kerr., in its wide head and elytral sculpture, approaches *Pseudanilara*.

STIGMODERA (CASTIARINA) INTACTA, n. sp.

♂. Oblong-ovate; glabrous. Head, pronotum, underside and appendages bright green, elytra yellow, save for a narrow basal margin green.

Head sulcate, strongly, not densely, punctate. Prothorax: Apex moderately, base strongly, bisinuate, all angles produced and acute, the anterior more strongly so, widest and rounded near base, sides thence obliquely converging to apex, nearly parallel towards base, this one and three-fourths times the width of apex; disc rather convex, the greatest convexity on front half, with large, well-separated round punctures on basal half, the punctures smaller and closer towards apex, nowhere rugose; a smooth medial line at basal third, the basal sinuate outline almost unbroken, except for small fovea between scutellum and hind angles.



Stigmodera intacta, n. sp.

Scutellum scutiform, brassy-green, sparsely punctate. Elytra obliquely widened to humeral swelling, compressed behind this, widest at middle, each apex bispinose, the external spine much the longer, a lunate interspace between each pair, sutural margins divergent towards apex; apical margins entire. Prosternum finely, transversely strigose in front, medial area sparsely punctate only; abdomen glabrous, with minute shallow punctures; apical segment rounded.

Dimensions: 19 × 8 mm.

Habitat.—Queensland (Fry Coll., in British Museum).

♀. Latet.

A single male example is the only one I have seen, but it is so distinct as to deserve a name. Amongst the larger of the subgenus, coloured like *planata* Cart. (? *auricollis* Thoms.), and *moribunda* Saund., it is readily separated by

large size, bispinose apices, and the curious convexity of the anterior area of the pronotum. Holotype in British Museum.

STIGMODERA (CASTIARINA) AERATICOLLIS, n. sp.

Mr. H. W. Brown has recently sent me three examples of a *Castiarina* from Wembley Park, W.A., that can only be distinguished from *S. dilatata* Cart., from the same district, by (1) larger size, 15 × 5 mm., (2) head, pronotum and underside brassy-bronze (instead of blue), (3) pronotum more coarsely and closely punctate and a slightly different outline—sides more rounded, and (4) elytral margins near apex more decidedly sanguineous.

Mr. Cedric Deane has lately sent two more, from Tammin, W.A., that are identical. But for (3) it might have been held to be merely varietal, but it must be considered distinct from this sculptural difference. Otherwise my description and figure (These PROCEEDINGS, 1927, 226, 227,) will serve for the above. Holotype in Coll. Carter.

The figure of *C. gebhardti* Obenb. corresponds rather closely, but this author only compares it with *affabilis* Kerr., without even mentioning the colour of the pronotum and underside. As *affabilis* is described as having the underside blue, and the pronotum "*bronze verdatre*", it would appear that *gebhardti* is very close to *dilatata* and still nearer to *sagittaria* L. & G.

Family TENEBRIONIDAE.

CESTRINUS CARBO, n. sp.

Oblong-ovate; coal-black, subopaque. Antennae and tarsi brownish, the upper surface, especially at sides, sparsely clad with short, bristly, black hairs.

Head granulose, epistoma arcuate, antennae stout, submoniliform, scarcely reaching the base of prothorax, third segment rather longer than 4-5 combined, 11 longer and wider than the preceding. Prothorax transverse, arcuate-emarginate in front, subtruncate at base, widest, and widely rounded, in front of middle, thence converging sinuously behind, and with a tendency to become sinuous before the acute anterior angle*, posterior angles obtuse; surface coarsely granulose-punctate; a slight, but variable, medial depression, sometimes little evident. Elytra wider than prothorax at base, with lines of approximate punctures set in shallow grooves, intervals wider than grooves, slightly raised, but flat and finely granulose-setose, the setae very short and depressed. Prosternum very convex, with a steep declivity towards the front, the prosternal process arcuately bilobed and wide; whole underside strongly granulose-setose; legs stout, fore tibiae slightly curved.

Dimensions: 7.8 × 4 (vix) mm.

Habitat.—South Queensland: Stanthorpe (E. Sutton and H. J. Carter).

Fifteen examples of the species before me show distinction from the western *C. brevis* Champ., in its black and granulose surface, its more oval and wider form, its much stouter appendages, and wider prosternal process. It is altogether a more robust and convex insect, the underside especially showing differences of structure and sculpture, *brevis* being rather coarsely punctured, without granules. From *C. trivialis*, it is separated by the more widely transverse

* This anterior sinuosity variably evident in examples seen.

prothorax, with sides more widely rounded, the posterior angles obtuse, antennae less widened towards apex, the bilobed prosternal process, *et multa alia*. Holotype in Coll. Carter.

C. aspersus Blkb.—Specimens from Mount Lofty, South Australia, agree with description. I am quite in accord with Mr. Blair (These PROCEEDINGS, 1919, 531) that this cannot be well distinguished from *brevis*. Both have a mixture of light and dark setae, the general colour of the Mt. Lofty examples being paler than that of *brevis*.

DYSARCHUS BROWNI, n. sp.

Widely oval; black, subnitid. Antennae, tibiae and tarsi rufescent.

Head: Clypeus subtruncate, sinuate at sides, separated from front by wide depression, surface strongly tuberculate, eyes bordered by row of tubercles, mentum feebly notched at apex, reticulate-rugose; antennae short, stout, sublinear, the segments closely adapted, little enlarged at apex. Prothorax widest behind middle, apex strongly emarginate, the widely reflexed margins produced in front to form obtusely rounded anterior angles; base slightly bisinuate, posterior angles widely obtuse, sides evenly rounded, margins widely foliate and reflexed, extreme border scarcely, or only very finely, crenulate; disc very convex, closely rugose-pustulose, reticulate-rugose on margins, finely pustulose at base and apex; with two raised nitid areas in front of middle; medial line indicated near base by a rather wide depression. Scutellum transverse, finely and closely tuberculose. Elytra widely oval and convex, at base as wide as prothorax, shoulders obsolete, margins nitid and raised at and behind base, everywhere without crenulation, not evident from above on apical half, each with three nitid, but little raised, costae, not interrupted, but slightly diverted by invading punctures; the suture also raised and finely tuberculate, a fourth feebly indicated line of irregular tubercles between the third costa and margin, also, between the other costae, even less evident but perceptible lines; surface otherwise densely rugose-punctate, the punctures contiguous and cell-like. Prosternum coarsely rugose-pustulose on flanks, mesosternum and metasternum punctate, abdomen rather sparsely punctate, finely so on apical segments.

Dimensions: 15-16 × 9 mm.

Habitat.—Western Australia: Lake Grace (H. W. Brown).

Two examples sent by this indefatigable collector are readily distinguished from the other western species by the combination of widely ovate form, evenly rounded and closely sculptured pronotum, and the elytra with only three clear and uninterrupted costae on each. The protibial spur is unusually well developed. Holotype in Coll. Carter.

DYSARCHUS PERCOSTATUS, n. sp.

Ovate; opaque-black. Antennae, tibiae and tarsi rufescent.

Head: Clypeus widely excised in middle, sinuate at sides, these reflexed and subangulate in front of eyes; the clypeus scarcely definitely separated from front, eyes bordered by carina, antennae similar to those of *browni*. Prothorax arcuate-emarginate at apex, the wide upturned foliate margins forming rather sharply rectangular front angles, base rather strongly bisinuate, hind angles produced backwards and obtuse; sides very widely rounded, abruptly (subangulately) narrowed behind the middle, extreme border scarcely crenulate, disc densely

and finely pustulose throughout except on margins, here rugose-punctate. Elytra less widely ovate than *browni*, shoulders more defined by reflexed epipleural fold, margins more explanate, evident from above throughout, crenulate and subundulate; each with three strongly raised costae, the third narrower and less raised than the other two and showing a tendency to interruption near apex; between the third costa and margin two little-defined rows of small pustules, a similar row between the other costae and a better defined row between first costa and suture, the last also slightly raised, but less so than the main costae. Mentum truncate at apex, closely pustulose; sternal area rugose, pustulose on propleurae; abdomen more strongly punctate than in *browni*.

Dimensions: 14 × 8 (vix) mm.

Habitat.—Western Australia: Lake Grace (H. W. Brown).

A single example sent with *browni* as from the same region is quite distinct in its narrower less convex form, its different (subangulate at sides) prothorax, and the strongly raised elytral costae, these almost entire, showing only a slight tendency to break up into tubercles at the extreme apex. Holotype in Coll. Carter.

ONOSTERRHUS GRANULATUS, n. sp.

Ovate, convex; subnitid black. Tarsi piceous, underside glabrous, more nitid than above.

Head: Epistoma subtruncate, its angles rounded, its surface with some longitudinal wrinkles, canthus raised and ear-like, forehead finely and rather closely punctate, antennae 1-2 short and bead-like, 3 cylindrical, as long as 4-5 together; 4-6 successively shorter and wider at apex, 7 subtriangular, 8-10 sub-spherical, 11 pyriform. Prothorax 3 × 5.5 mm.; apex truncate-emarginate, its angles acutely produced in front of eyes, base bisinuate, hind angles forming acute teeth pointing backwards; sides well rounded, gently sinuate in front, more strongly behind; lateral border convex and moderately wide, lightly channelled within, disc minutely and sparsely punctate, slightly explanate laterally. Scutellum widely transverse. Elytra considerably wider than prothorax at base, shoulders rounded, rather closely covered with large granules of irregular size, these sometimes forming transverse or curved ridges; three longitudinal rows of more pronounced granules forming subcostate ridges, equally spaced on each elytron, external margins very narrowly horizontal on front half, unseen from above. A small triangular tooth on submentum, prosternum sulcate between coxae, post-intercoxal process widely truncate. Abdomen lightly wrinkled longitudinally, mid tibiae feebly pubescent, others, also underside, glabrous.

Dimensions: 12 × 8 mm.

Habitat.—Central Australia: Petermann Ranges (Dr. H. Basedow).

A single example, probably ♀, is easily distinguished from its allies by the pronounced granulose surface of the elytra. In the pronotal structure and general shape it is nearest *O. acuticollis* Cart., but the angles of prothorax are even more prominent than in that species. Holotype in the South Australian Museum.

BYALLIUS ANDERSONI, n. sp. Plate iv, figure 8.

Oblong, obovate; dull brownish-black. Antennae and tarsi reddish.

Head: Epistoma truncate in front, sinuate and obliquely widened at sides, densely and finely rugose-punctate, forehead channelled, antennae robust, 3 cylin-

dric, as long as 4-5 combined, 4-7 obconic, 8-10 subrectangular, 11 oval. Prothorax: Base wider than apex, widest behind middle; apex truncate between strongly produced, acute front angles, these pointing forwards; base truncate, sides subsinuate in front, thence widening, with a slightly irregular outline, rather abruptly narrowed and sinuate before the dentate hind angles, these pointing obliquely outwards, extreme border rather thick, punctate and recurved, forming a channel within; disc thickly and strongly punctate, with a transverse depression near base. Elytra much wider than prothorax at base, widest behind middle, epipleural fold recurved, margins a little explanate; each with three well marked, but irregular costae; intervals coarsely irregularly reticulate and rugose-punctate. Prosternum densely, metasternum more sparsely, punctate, abdomen finely strigose-punctate, the two apical segments finely and densely punctate.

Dimensions: 15-19 × 7.5-9 mm.

Habitat.—New South Wales: Mullaley to Coonabarabran.

I took eight examples in December, 1929, some in the Pillaga Scrub near Garrawilla homestead, and others near Timor (near the Warrumbungle Mountains). The species is superficially allied to *B. punctatus* mihi, from which it is readily distinguished by the dentate hind angles, the more prominent front angles and the strongly punctate surface of the prothorax. In *punctatus* the elytral ridges and costae carry punctures, while in *andersoni* the elytral punctures are confined to the depressed parts. I have named it after my genial host, Mr. Alexander Anderson, of Garrawilla Station, Mullaley. Holotype and allotype in Coll. Carter.

BEPLEGENES LACHRYMOSA, n. sp. Plate iv, figure 7.

Elongate-ovate; upperside dark bronze, moderately nitid, glabrous; underside nitid-black, tarsi reddish.

Head: Labrum prominent, epistoma evenly arcuate and thick, terminating in raised antennal orbits, behind this a small nitid tubercle; whole surface closely rugose-punctate with a short occipital sulcus; eyes narrow, transverse and entire; antennae scarcely reaching base of prothorax, rather stoutly submoniliform, third segment elongate (about one and a half times as long as 4), apical segments successively widened, 11 asymmetrically pyriform, twice as large as 10. Prothorax: Apex and base more or less truncate, all angles rounded off, sides with two pronounced teeth, the anterior of these (slightly in front of middle) the larger; disc unevenly rugose, medial sulcus throughout its length, an irregular depression on each side near middle. Scutellum triangular. Elytra elongate-ovate, converging at apex to the width of prothorax, epipleurae not continuous to shoulder, extreme border only seen from above towards apex, elsewhere concealed by raised broken ninth interval; third, fifth, seventh and ninth intervals nitid, convex, intermittently constricted, those on the seventh and ninth more sharply and narrowly convex; sutural interval convex and narrow, the second, fourth and sixth wide and subopaque, less raised than the rest and undulating to correspond with constrictions of the adjacent intervals. Underside impunctate.

Dimensions: 11-12 × 3.5-4 mm.

Habitat.—North Queensland: Millaa-Millaa (F. H. Taylor).

I am indebted to Mr. Taylor, of the Institute of Tropical Medicine, for this interesting addition to the Tenebrionidae. Two examples, probably the sexes, sent; the larger, having slightly more robust fore tarsi and hind tibiae, I take

to be male. The characters are typical of *Beplegenes*, though the size is smaller than in the other three recorded species, and the sculpture is unique. This suggests the specific name from a rough resemblance to the well known *Ptomaphila tachrymosa*. Holotype and allotype in Coll. Carter.

SEIROTRANA ACUTICOLLIS, n. sp.

Oblong-oval; nitid dark bronze above, nitid black beneath; antennae and tarsi dark.

Head rugose-punctate, a nitid stirrup-shaped impression on forehead, antennae stout, submoniliform, segments a little elongate, 3 about one and a half times as long as 4, 8-10 subtriangular, 11 large, pyriform. Prothorax: Apex strongly arcuate-emarginate, anterior angles unusually produced forward and acute; base truncate, sides widest and rounded in front of middle, rather strongly sinuate before the subrectangular (with a tendency to acute) hind angles; margins entire, moderately thickened; disc very minutely punctate with larger irregular punctures more than usually prominent; these large and sparse on medial area, smaller and crowded near hind angles and along margin. Scutellum transversely triangular. Elytra wider than prothorax at base, rather flat, raised border evident throughout from above, punctate-striate, the punctures in the two sutural striae small, elongate and close, in the others large, irregular in size and distance, the third, fifth, seventh and ninth intervals consisting of elongate tumuli of irregular length, and generally separated by a puncture, those on the third scarcely evident except near apex, intervals otherwise flat and impunctate and without smaller pustules. Underside nearly impunctate, the epipleurae only with large round punctures.

Dimensions: 9-10 × 4-5 (vix) mm.

Habitat.—Queensland: Stanthorpe (E. Sutton and Wieldt).

Nine examples before me are readily separated from others of my Group ii (These PROCEEDINGS, 1925, 242) by the strongly produced front angles of prothorax, and the elytral tumuli occupying the full width of the intervals and which, on a larger scale, are of similar style to those of *S. tumulosa* Cart. Holotype and allotype in Coll. Carter.

SEIROTRANA JOHNSTONENSIS, n. sp.

Oblong-ovate, dark bronze.

Head and pronotum densely and finely punctate. Prothorax: Apex emarginate, the anterior angles prominent and subacute, with extreme tips blunt, base truncate; sides widely rounded, widest at middle, thence obliquely, scarcely sinuately narrowed to the rather widely obtuse posterior angles; lateral margins entire; disc with a few larger punctures irregularly scattered among the dense (cellulose) ground punctures. Scutellum strongly transverse. Elytra wider than prothorax at base, seriate-punctate, the punctures small and close near suture, larger externally, the striae subobsolete; intervals impunctate and flat, save for nodules; the fifth, seventh and ninth intervals with narrow elongate nodules more or less over their whole length, those on the third only on apical declivity, the suture and first two intervals quite flat. Pronotum and epipleurae sparsely punctate, abdomen finely strigose.

Dimensions: 11 × 4½ mm.

Habitat.—Queensland: Johnstone River (E. Mackness).

A single specimen with mutilated antennae is so distinct as to deserve description. In my table (These PROCEEDINGS, 1925, 242) it comes under "elytral nodules longitudinal" and can only be confused with *S. parallela* Germ., and *S. bimetallica* Cart., both of which are larger, with raised suture and the third interval raised or nodulose throughout, the former also having the pronotum little widened at sides. The unusually fine cellulose-punctate ground sculpture of the pronotum is characteristic of the new species. Holotype in Coll. Carter.

Family CISTELIDAE.

CHROMOMOEA SUTURALIS, n. sp.

Head (including palpi and basal segments of antennae), the greater part of pronotum, the elytral suture (narrowly) and whole underside red; a wide medial vitta on pronotum and the greater part of elytra dark metallic green; antennae (except basal segments) dark; legs testaceous, knees of mid and post femora narrowly dark. Sides and apex of elytra, also sides of abdomen with light recumbent pubescence; head, especially clypeus, with longer upright hair.

Head and pronotum with fine, rather close punctures; eyes widely separate and moderately prominent; antennae having segment 3 longer than 4, 4-10 subequal and subconic, 11 shorter and more slender than 10. Prothorax subrectangular with front angles rounded and depressed; wider than long (2.5 × 3 mm.), apex and base truncate, medial sulcus clearly impressed on basal half, hind angles rectangular. Elytra much wider than prothorax at base and nearly four times as long, sides parallel for the greater part, shoulders rounded; striate-punctate, the striae shallow, the close seriate punctures appearing as transverse hatching, intervals almost flat, except near apex, and themselves finely punctate and cross-wrinkled; legs slender, tibiae simple, hind tarsi with basal segment as long as the rest combined; sternal area finely punctate, abdomen nitid and impunctate.

Dimensions: ♂, 13 × 4 mm.; ♀, 16 × 5 mm.

Habitat.—New South Wales: East Dorrigo (W. Heron).

Two examples, the sexes, taken by Mr. Heron, are very distinct from other described species by combination of large size, metallic elytra and vittate pronotum. It belongs to the *violacea* Cart., *major* Cart., and *oculata* Cart. group, but is easily distinguished by colour. Holotype and allotype in Coll. Carter.

CHROMOMOEA METALLICA, n. sp.

Upper side brown-bronze, glabrous; head and pronotum subopaque, elytra nitid metallic-bronze; antennae and palpi reddish, the former slightly infusate towards apex; underside and legs dark brown, basal half of femora testaceous, tarsi red.

Head less finely and closely punctate than prothorax, eyes rather prominent and widely separated, antennae elongate (the eighth segment opposite shoulders when extended backwards), 3-10 subequal in length and breadth, each feebly enlarged at apex, 11 lanceolate, as long as 10. Prothorax cylindrical, about as long as wide, front angles rounded off and depressed, hind angles rectangular, densely and finely cellulose-punctate, without medial line. Scutellum widely oval. Elytra considerably wider than prothorax and two and a half times as long as it; apices separately rounded; striate-punctate, striae clearly impressed, seriate punctures uniform in size and evenly placed, slightly impinging on sides of intervals, these

very lightly convex, with a single row of minute punctures on each. Underside glabrous, almost impunctate.

Dimensions: 7 × 2.2 mm.

Habitat.—North Queensland: Millaa-Millaa (F. H. Taylor).

A single female, sent by its captor, is quite distinct from any described species by its glabrous, metallic surface. In general facies it is not very unlike *C. unicolor* Bates, which is, however, strongly pubescent, with much coarser punctures on pronotum and elytra and with more robust legs and antennae. Holotype in Coll. Carter.

OMMATOPHORUS BOOPS, n. sp.

Upperside and underside castaneous red, nitid; sides of elytra infuscate, legs testaceous (dark at knees only), upper surface sparsely clad with long upright hairs.

Head: The narrow triangular forehead with large punctures, not very close; eyes contiguous anteriorly, occupying greater part of head; antennae very stout, linear, segments 3–11 subequal, covered with short dense hair. Prothorax strongly transverse, sides rounded and converging in front, hind corners subrectangular, base lightly bisinuate; disc strongly, densely punctate. Elytra slightly widest behind middle; striate-punctate, the striae little evident, seriate and interstitial punctures equally large, the intervals flat and transversely wrinkled, surface strongly pubescent, the long hairs most evident at sides and apical third.

Dimensions: 6 × 2 mm.

Habitat.—North Queensland: Millaa-Millaa (F. H. Taylor).

A single male captured by Mr. Taylor is very like *O. mastersi* Macl. in general coloration, but differs widely* in (1) approximate eyes, (2) much more densely punctate head and pronotum, (3) less clearly defined striae and seriate punctures (*O. mastersi* is without cross wrinkles on intervals of elytra), and (4) testaceous legs. Holotype in Coll. Carter.

HYBRENIA CLERMONTIA, n. sp.

Black; subnitid glabrous above, lightly pilose beneath; antennae (especially apical segments), palpi and tarsi red.

Head densely punctate, eyes very prominent, rather widely separated in both sexes (in ♂ by about half the diameter of one eye), antennae long and tapering, 3 much longer than 4, 4–11 successively shorter and narrower. Prothorax moderately convex, apex and base subtruncate, sides rounded in front, nearly straight on basal half, or slightly widened at the acute hind angles; disc densely and clearly punctate, medial line only faintly indicated near base. Elytra considerably wider than prothorax at base and more than thrice as long; striate-punctate, intervals wide, flat and minutely pustulose, the striae very narrow, with close punctures occupying their width; sternal regions with round, distant punctures, abdomen scarcely punctate with short, recumbent hair.

Dimensions: 17 × 7 mm.

Habitat.—Queensland: Clermont district (Dr. K. K. Spence).

* In *mastersi* Macl., the eyes are closer in the ♂ than in the ♀, but are clearly separated throughout their length.

A large species, recognizable by the combination of glabrous black, scarcely nitid surface, flat and pustulose elytral intervals, the pustules small and close, distinct under a binocular. Holotype and allotype in Coll. Carter.

Hybrenia dentipes Cart.—Described from ♂ only, seems to be a common Queensland species. I have recently seen examples, including the sexes, from Townsville and Clermont.

Family DRYOPIDAE.

STETHOLUS PAPUANUS, n. sp. Plate iv, figures 1-3.

Elongate-oblong; nitid black above, beneath fuscous with a thick clothing of short greyish hair; antennae, tibiae and tarsi reddish-brown, underside of femora reddish at base.

Head, with eyes, much wider than apex of prothorax, eyes large, round and prominent, surface finely and closely punctate and lightly clothed with downy hair; antennae short (very much as in *S. elongatus* Cart. and Zeck), first segment stout, curved, thrice as long as second, these two hairy and much stouter than the succeeding; 3-4 cup-shaped, 5-10 transverse, more or less perfoliate, 11 pyriform. Prothorax: Apex truncate, base rather strongly bisinuate, narrowest at apex, widest near base, sides strongly and obliquely widening from apex to near base (subsinate near apex through slight impression on each side), the posterior angles bidentate, formed by a deep subcircular excision, each tooth acute; surface finely punctate, sparsely clad with short hair. Scutellum large, triangular, with rounded sides. Elytra wider than prothorax and four times as long; shoulders prominent and tumid, subparallel (slightly widest behind middle), separately rounded at apex; striate-punctate, the striae well marked, but not deep, seriate punctures finer near suture, coarse towards sides, intervals almost flat, minutely punctate and pilose. Prosternum very short, almost exactly as in *S. elongatus* C. & Z., with narrow, elongate process longitudinally carinate in middle, metasternum smooth and nitid in middle, closely pubescent elsewhere, abdomen with dense recumbent pubescence, legs very long and hairy, post tarsi with apical segment as long as rest combined.

Dimensions: 6-7 × 2 (+) mm.

Habitat.—North-east Papua: Mt. Lamington, 1,300 feet (C. T. McNamara).

Seven examples sent from the South Australian Museum, amongst other Papuan Coleoptera. The species is a close ally of *S. elongatus* from New South Wales; its notable distinctions are (1) shape of prothorax, and (2) coarser seriate sculpture of the elytra. In *elongatus* the pronotum has a strong groove which separates a sort of anterior lobe; in *papuanus* this groove is represented by a feeble depression towards each side near apex, forming a light sinuation at the margin, but the general outline is similar except for the curiously bidentate hind angles. Holotype in the South Australian Museum.

SIMSONIA DEANEI, n. sp. Plate iv, figures 4, 5.

Nitid dark bronze above, beneath fuscous at sides, dark in the middle; antennae testaceous, the apical segments dark.

Head and pronotum rather closely pitted with round punctures, pronotum bilobed, each lobe very convex and separated by a nearly straight transverse depression at anterior third, forming a light sinuation at sides; lateral margins

narrowly horizontal, their anterior angles rounded off. Scutellum large, sub-circular. Elytra wider than prothorax at base, lightly obovate, margins not explanate or perceptibly serrate; striate-punctate, the striae well marked, the seriate punctures large, round and of uniform size, placed about half the diameter of one apart, intervals transversely wrinkled and minutely punctate. Prosternum and metasternum sparsely and coarsely punctate, the prosternal process wider and shorter than in *S. purpurea* and *S. wilsoni*, with raised margins and a distinct medial carina.

Dimensions: 2 (+) mm. long.

Habitat.—Queensland: Tambourine Mountain (C. Deane).

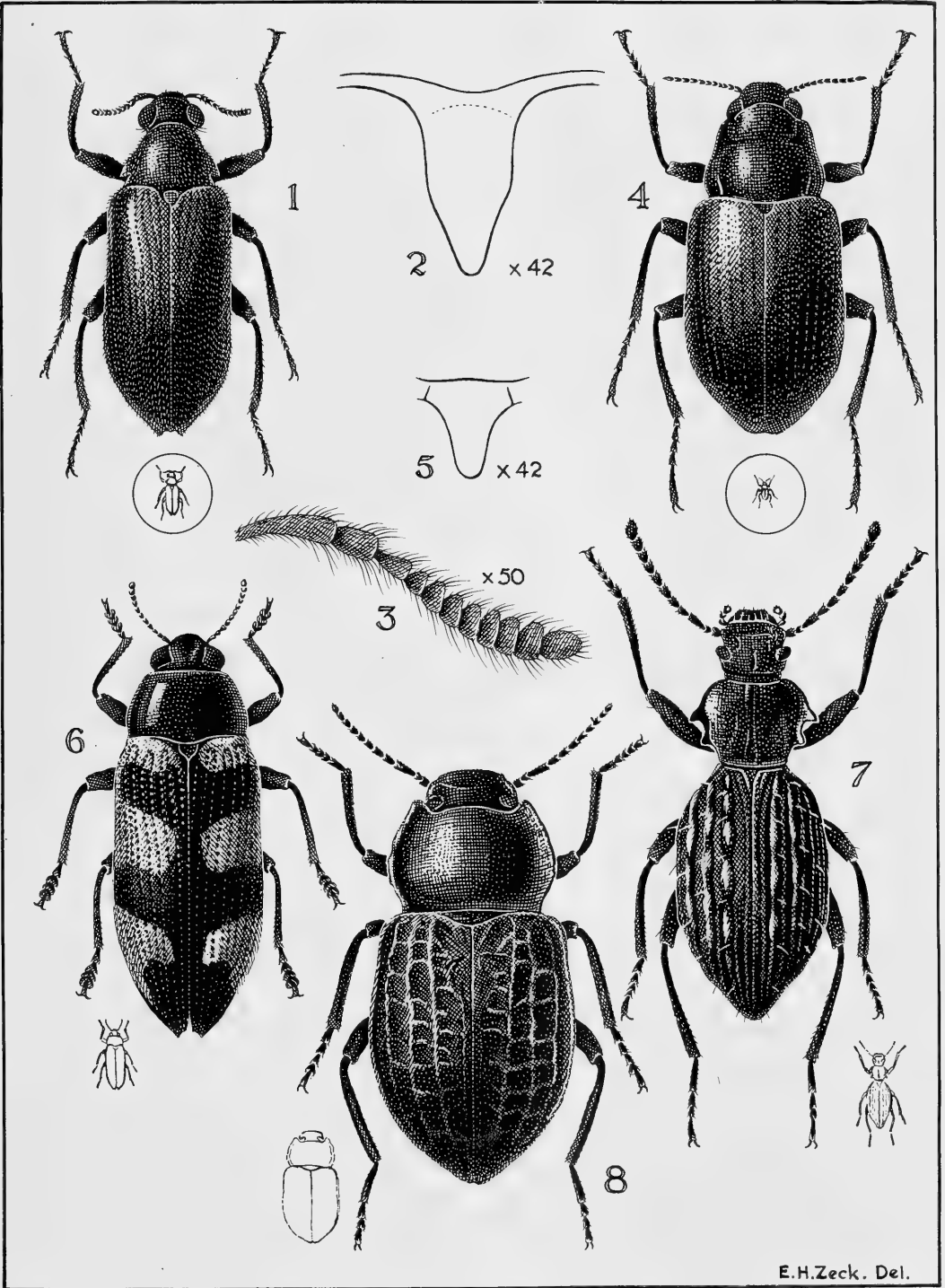
A pair, sent by their captor, show a species distinguished from its allies, *S. purpurea* and *S. wilsoni*, by its wider form, especially of the prothorax, the different elytral sculpture, and very different prosternal process, this wider and carinate. Holotype in Coll. Carter.

AUSTROLIMNIUS LURIDUS, C. & Z., var. SUFFUSUS, n. var.

Amongst the examples of *A. politus* King from the Allyn River we find four examples that differ from the typical *politus* very much as *A. luridus* does in form and sculpture, but are distinct from both *politus* and *luridus* in markings. On the elytra the pale markings largely overrun the whole area, leaving undefined longitudinal patches and a moderately wide lateral area black. This may ultimately be found to be a distinct species, and at least is worth a name.

EXPLANATION OF PLATE IV.

1. *Stetholus papuanus* Cart.
 2. Sternal process of *S. papuanus*.
 3. Antenna of *S. papuanus*.
 4. *Simsonia deanei* Cart.
 5. Sternal process of *S. deanei*.
 6. *Stigmodera imitator* Cart.
 7. *Beplegenes lachrymosa* Cart.
 8. *Byallius andersoni* Cart.
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E.H.Zeck. Del.

REVISION OF AUSTRALIAN OENOCHROMIDAE (LEPIDOPTERA). III*.

By A. JEFFERIS TURNER, M.D., F.E.S.

[Read 21st May, 1930.]

Genus 25. OENOCHROMA.

Gn., *Lep.*, ix, p. 184; Prout, *Gen. Insect.*, Oenochrom., p. 40.

Face with short anterior cone of scales. Palpi moderately long, obliquely ascending; second joint thickened, with loosely appressed hairs; terminal joint short, obtuse, porrect. Antennae of ♂ unipectinate, towards apex simple. Thorax stout; densely hairy beneath. Femora hairy. Fore tibiae sometimes with an apical hook. Forewings with 5 from middle of cell, 9 and 10 long stalked, 9 anastomosing with 8 forming a long and extremely narrow areole (probably the connection formed by the basal part of 9 not always developed), 11 free but closely approximated to both 10 and 12. Hindwings with 3 and 4 closely approximated at origin or connate, 5 from middle of cell, 6 and 7 closely approximated at origin or connate, 12 closely approximated to middle third of cell, thence diverging. Type *O. vinaria* Gn.

A characteristically Australian genus of moderate size showing little variation in structure, except that a hook is developed on the fore tibiae in the four species, *pallida*, *privata*, *polyspila* and *cycnoptera*. This should not lead to generic separation, as these species are normal in all other respects, and do not seem to be specially closely allied. *O. vinaria* which has no tibial hook is very closely allied to *pallida*. The tarsi are spinulose except in *O. infantilis*.

Key to Species.

- | | |
|---|---------------------------|
| 1. Hindwings with termen straight or nearly so | 2 |
| Hindwings with termen not straight | 7 |
| 2. Forewings with apices shortly falcate | 3 |
| Forewings with apices not falcate | 4 |
| 3. Fore tibiae without apical hook | <i>vinaria</i> . 159 |
| Fore tibiae with apical hook | <i>pallida</i> . 160 |
| 4. Fore tibiae with apical hook; wings with postmedian transverse band best marked on underside | <i>privata</i> . 163 |
| Fore tibiae without apical hook; wings without postmedian band | 5 |
| 5. Forewings without trace of antemedian line | <i>orthodesma</i> . 161 |
| Forewings with a dotted antemedian line | 6 |
| 6. Wings and markings more or less tinged with crimson | <i>phyllomorpha</i> . 162 |
| Wings without any crimson tinge | <i>subustaria</i> . 164 |
| 7. Hindwings rounded | 8 |
| Hindwings angled at or beneath middle | 16 |
| 8. Forewings green or greenish-tinged | 9 |
| Forewings not greenish | 10 |

* Continued from these PROCEEDINGS, IV, 1930, 40.

9.	Forewings with an oblique yellow postmedian line	<i>cerasiplaga</i> .	165
	Forewings with postmedian line very obscure, whitish	<i>infantilis</i> .	173
10.	Forewings with three oblique reddish lines	<i>ochripennata</i> .	166
	Forewings not so		11
11.	Wings with numerous whitish spots	<i>polyspila</i> .	167
	Wings without whitish spots		12
12.	Forewings with a whitish-edged subterminal line		13
	Forewings without subterminal line		14
13.	Hindwings with transverse hyaline discal mark	<i>turneri</i> .	170
	Hindwings without hyaline discal mark	<i>lissoscia</i> .	171
14.	Forewings with white antemedian and postmedian lines	<i>alpina</i> .	172
	Forewings without white lines		15
15.	Hindwings grey with antemedian and median transverse lines	<i>decolorata</i> .	168
	Hindwings white without lines	<i>cycnoptera</i> .	169
16.	Wings with hyaline discal marks	<i>quadrigramma</i> .	175
	Wings without hyaline discal marks	<i>vetustaria</i> .	174

159. OENOCHROMA VINARIA.

Gn., *Lep.*, ix, p. 185, Pl. 7, f. 2.—*Monoctenia decora* Wlk., *Char. Undescr. Lep.*, p. 76.—*Monoctenia vinaria* Meyr., *Proc. LINN. SOC. N.S.W.*, 1889, p. 1206.

Usually at once distinguishable by its crimson coloration, but some examples have pale-grey wings. These may be distinguished from *pallida* by the dark oblique line of forewings as well as by the crimson cilia. Mr. D. Goudie bred this species from larvae feeding on *Grevillea* sp.

North Queensland: Herberton. Queensland: Nambour, Caloundra, Brisbane, Toowoomba. New South Wales: Ebor, Sydney, Jervis Bay, Mt. Kosciusko (5,000 feet). Victoria: Melbourne, Beaconsfield, Birchip, Ararat. South Australia: Mt. Lofty, Adelaide. Western Australia: Perth, Dundas, Cunderdin.

160. OENOCHROMA PALLIDA.

Warr., *Novit. Zool.*, 1898, p. 231.—*Monoctenia pallidula* Luc., *Proc. Roy. Soc. Qld.*, 1898, p. 69 (published in 1899).

♂. 38-46 mm. ♀. 44-50 mm. Head and thorax pale-ochreous-grey, in ♀ pinkish-tinged; lower margin of face crimson-fuscous. Palpi 2; crimson-fuscous; lower surface and base whitish. Antennae crimson-fuscous, apical half whitish; pectinations in ♂ 6, apical two-fifths to one-half simple. Abdomen pale-ochreous-grey, in ♀ pinkish-tinged; beneath whitish. Legs whitish-ochreous, largely suffused with ochreous, and on anterior femora with dark-crimson, apices of all joints crimson-fuscous; fore tibiae with an anterior apical hook. Forewings elongate-triangular, costa straight almost to apex, apex acute, slightly produced, termen strongly sinuate beneath apex, apex bowed above middle, more strongly so in ♀, oblique; pale-ochreous-grey, in ♀ pinkish-tinged; costa coarsely strigulated with blackish or dark-fuscous; a very faint, pale, slightly outwardly curved, transverse line at one-fifth; a subcostal discal spot before middle, dark-fuscous or brown with hyaline centre; a straight whitish-ochreous line edged posteriorly with ochreous-brown from costa shortly before apex to two-thirds dorsum; a dark-brown or dark-fuscous marginal lunule on termen beneath apex; cilia ochreous-brown, apices sometimes fuscous. Hindwings with apex rounded, termen nearly straight; as forewings; postmedian line only slightly beyond middle, straight; a slight reddish-fuscous suffusion, in ♀ larger and pale-centred, on middle of costa. Under-side similar; forewings with a circular purple-fuscous blotch on dorsal end of antemedian line; lines reduced to fuscous or reddish-fuscous dots.

In the greyer forms of *O. vinaria* the postmedian lines of both wings are dark-edged anteriorly. Any doubt as to the distinctness of this species is resolved by the presence of the fore tibial hook.

North Australia: Melville Island. Queensland: Brisbane, Toowoomba. New South Wales: Broken Hill. Victoria: Ararat. Western Australia: Perth.

161. OENOCROMA ORTHODESMA.

Monoctenia orthodesma Low., *Trans. Roy. Soc. S. Aust.*, 1894, p. 84.—*Oenochroma erubescens* Prout, *Gen. Insect.*, Oenochrom., p. 42.

♂, ♀. 54-56 mm. Head and thorax pale-ochreous-grey. Palpi $1\frac{1}{2}$; pale-ochreous-grey sometimes pinkish-tinged. Antennae pale-ochreous-grey, towards base pinkish-tinged; pectinations in ♂ 6, apical third simple. Abdomen grey-whitish faintly pinkish-tinged; beneath ochreous-whitish. Legs pale-ochreous, apices of all joints pinkish. Forewings elongate-triangular, costa straight almost to apex, apex pointed, termen bowed above middle, oblique; pale-ochreous-grey; costal edge sometimes ochreous towards base; no antemedian line; sometimes a median, subcostal, ochreous, discal dot; postmedian line from costa near apex to two-thirds dorsum, straight, ochreous, edged anteriorly with pale-yellow, slender towards costa, more pronounced towards dorsum; cilia ochreous. Hindwings with apex rounded, termen straight; colour as forewings, but tinged with pink at apex; postmedian line straight, from three-fifths costa not reaching dorsum. Underside whitish-ochreous; forewings with a fuscous-crimson tornal blotch.

Queensland: Brisbane, Southport. New South Wales: Sydney, Jervis Bay.

162. OENOCROMA PHYLLOMORPHA.

Monoctenia phyllomorpha Low., *Proc. Linn. Soc. N.S.W.*, 1899, p. 86.—*Monoctophora stillans* Luc., *Proc. Roy. Soc. Qld.*, 1900, p. 44.—*Monoctenia subcarnea* Warr., *Novit. Zool.*, 1902, p. 348.

♂, ♀. 40-44 mm. Head and thorax pale-ochreous-grey usually suffused with pinkish. Palpi $1\frac{1}{2}$; pinkish above, whitish with some pinkish irroration beneath. Antennae ochreous-whitish, more or less suffused with pinkish; pectinations in both sexes 6, apical fourth simple. Abdomen ochreous-whitish. Legs ochreous-whitish with some pinkish irroration. Forewings elongate-triangular, costa straight to near apex, apex acutely pointed, termen slightly sinuate beneath apex, nearly straight in ♂, slightly bowed in ♀; pale-ochreous-grey, more or less suffused with pinkish, rarely with fine fuscous transverse strigulae; markings rosy, fuscous-rosy, or fuscous; antemedian line from one-third costa to one-third dorsum, but usually obsolete towards costa, often interrupted, or reduced to dots; no discal dot; postmedian from beneath costa near apex to two-thirds dorsum, slightly sinuate, sometimes interrupted or reduced to dots; cilia fuscous, bases ochreous. Hindwings with apex rounded, termen straight; as forewings but without antemedian line. Underside of both wings grey-whitish with fuscous discal dot and postmedian line.

The impunctate antennae are alike in both sexes; an unusual character.

North Queensland: Cairns, Townsville. Queensland: Brisbane. New South Wales: Newcastle.

163. OENOCROMA PRIVATA.

Hypographa privata Wlk., *Cat. Brit. Mus.*, xxi, p. 286.—*Monoctenia hypotaenaria* Gn., *Ann. Soc. Ent. Fr.*, 1864, p. 15.—*Monoctenia subustaria* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, p. 1209, *nec* Wlk.

♂, ♀. 34-52 mm. Head and thorax pale-grey. Palpi in ♂ 1½, in ♀ 2; pale-grey. Antennae ochreous-grey; pectinations in ♂ 6, apical fourth simple. Abdomen pale-grey. Legs grey, more or less mixed with whitish; anterior tibiae with apical hook. Forewings elongate-triangular, costa straight almost to apex, apex acute, slightly produced, termen sinuate beneath apex, bowed in middle, oblique; pale-grey; some fine fuscous costal strigulae; first line and discal dot obsolete; a post-median band, sometimes containing a median darker line, edged anteriorly by an oblique outwardly curved series of fine fuscous dots from midcosta to one-third dorsum, posteriorly by a similar line from three-fourths costa to three-fourths dorsum, band sometimes faintly ferruginous; cilia pale-grey, apices sometimes suffused or barred with fuscous. Hindwings with apex rounded, termen straight; as forewings; postmedian band more distinct, ferruginous or suffused with fuscous. Underside similar, but postmedian band much more distinct and ferruginous on both wings, dilated towards costa, narrowed towards dorsum, posterior edge irregularly dentate.

New South Wales: Sydney, Jervis Bay, Katoomba, Mittagong. South Australia: Penola.

164. OENOCHROMA SUBUSTARIA.

Phallaria subustaria Wlk., *Cat. Brit. Mus.*, xxi, 283.—*Monoctophora caprina* Luc., *Proc. Roy. Soc. Qld.*, 1900, 145.

♂, ♀. 36-42 mm. Head and thorax pale-grey. Palpi in ♂ 1½, in ♀ 2; pale-grey. Antennae pale-grey; pectinations in ♂ 6, apical fourth simple. Abdomen pale-grey, beneath whitish. Legs fuscous, more or less mixed with whitish, except anterior pair; posterior pair mostly whitish. Forewings elongate-triangular, costa straight almost to apex, apex acute, termen sinuate beneath apex, bowed above middle, more so in ♀, oblique; pale-grey with sparsely scattered fuscous scales; some short fuscous strigulae on costa; antemedian line at one-third, represented by three dark-fuscous dots, beneath costa, on cubital and on anal vein; discal dot obsolete; second line represented by a series of dark-fuscous dots, slightly sinuate, from costa shortly before apex to two-thirds dorsum; cilia pale-grey, sometimes pinkish-tinged, apices suffused or barred with fuscous. Hindwings with apex rounded, termen straight; as forewings but without antemedian line; postmedian line at three-fifths, nearly straight, becoming obsolete towards costa. Underside pale-grey; forewings with dotted postmedian line; hindwings with median discal dot, dotted postmedian line, and in ♂ with a small, subapical, dark-fuscous or reddish fuscous, subapical blotch.

Superficially similar above to *O. privata*, but easily distinguished by the underside, in addition to the absence of a fore tibial hook.

Queensland: Brisbane, Stradbroke Is. New South Wales: Jervis Bay.

165. OENOCHROMA CERASIPLAGA.

Oenochroma cerasiplaga Warr., *Novit. Zool.*, 1914, 425.—*Oenochroma artia* Turn., *Trans. Roy. Soc. S. Aust.*, 1922, 292.

Western Australia: Perth, Dardanup.

166. OENOCHROMA OCHRIPENNATA.

Phallaria ? ochripennata Wlk., *Cat. Brit. Mus.*, xxi, 284.—*Diamuna gastropacharia* Wlk., *ibid.*, 289.—*Monoctenia ochripennata* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1205.

Western Australia:

167. OENOCHROMA POLYSPILA.

Monoctenia polyspila Low., Proc. Linn. Soc. N.S.W., 1897, 263.—*Oenochroma guttilinea* Warr., *Novit. Zool.*, 1903, 260.—*Oenochroma polyspila* Prout, *Gen. Insect.*, *Oenochrom.*, Pl. 1, f. 9.

♂. 32-38 mm. Head crimson-grey. Palpi 1½; grey. Antennae pale-crimson-grey becoming crimson-fuscous towards base; pectinations 6, ochreous, apical third simple. Thorax pale-grey tinged with crimson and ochreous, darker anteriorly. Abdomen ochreous-whitish, with slight crimson irroration; beneath whitish. Legs whitish irrorated, and apices of joints annulated, with fuscous. Forewings elongate-triangular, costa straight, apex acute, termen rounded, slightly sinuate beneath apex, oblique; pale-ochreous-grey rosy-tinged; some scattered basal spots, and four oblique lines of spots white irrorated with fuscous, broadly margined with fuscous crimson; first line from one-third costa to one-fourth dorsum; second from two-thirds costa to mid-dorsum; third and fourth equidistant, parallel; a short fuscous streak on termen beneath apex; cilia ochreous, on apex fuscous. Hindwings with termen slightly rounded; as forewings, but with only three lines of dots. Underside whitish; forewings with a postmedian fuscous line terminating in a subdorsal fuscous blotch; hindwings with a smaller fuscous blotch on costa at two-thirds.

♀. 40-42 mm. Colour uniform grey-pink; spots on wings much smaller, often clear white, with very fine fuscous margins. Antennae simple.

North Queensland: Cape York, Townsville.

168. OENOCHROMA DECOLORATA.

Warr., *Novit. Zool.*, 1896, 354

Head and thorax grey. Abdomen pale-grey. Forewings grey with fine darker irroration; antemedian represented by a short reddish line from costa; discal spot dark-grey, indistinct, followed by an obscure oblique central shade; postmedian line pale-ferruginous edged anteriorly with whitish; cilia purplish. Hindwings with termen rounded; grey; an antemedian purplish transverse line; a median ferruginous transverse line, becoming purplish towards costa, edged anteriorly with whitish. Underside of forewings whitish, with a postmedian series of dots on veins, and a small purple tornal blotch; of hindwings white along dorsum, termen broadly suffused with ferruginous.

I do not know this species. The above is a translation of Warren's description.

North Queensland: Cedar Bay near Cooktown.

169. OENOCHROMA CYCNOPTERA.

Monoctenia cycnoptera Low., *Trans. Roy. Soc. S. Aust.*, 1894, 84.—*Oenochroma simplex* Warr., *Novit. Zool.*, 1897, 206.

♂. 36-42 mm. ♀. 52 mm. Head and thorax pale-grey. Palpi 2; pale-grey. Antennae whitish-ochreous; unipectinate in both sexes, apical two-fifths simple, pectinations in ♂ 4, in ♀ 1½. Abdomen pale-grey. Legs grey-whitish; anterior pair pale-grey; anterior tibiae with strong apical hook. Forewings narrowly triangular, costa straight almost to apex, apex pointed, in ♀ acute, termen sinuate beneath apex, bowed above middle, strongly oblique; pale-grey, with sparse dark-fuscous irroration or strigulae; a very faint oblique line from three-fourths dorsum towards apex, but scarcely reaching half-way, faintly ochreous; cilia pale-brownish or pale-ochreous with dark-fuscous bars opposite veins, and dark-fuscous for a short distance beneath apex. Hindwings with termen gently rounded; whitish

with slight dark-fuscous irroration towards termen and dorsum; cilia whitish. Underside whitish-grey; forewings with a fuscous discal mark and a fuscous or reddish blotch above tornus.

South Australia: Cardilho Downs, Lake Mulligan. Western Australia: Merredin. North-west Australia: Roeburne.

170. *OENOCHROMA TURNERI*.

Monoctenia turneri Luc., *Proc. Roy. Soc. Qld.*, 1892, 82.

♂, ♀. 45-48 mm. Head and thorax grey. Palpi 1½; grey, towards base reddish-tinged. Antennae grey; pectinations in ♂ 3. Abdomen grey; beneath purple-grey with transverse red bars. Legs grey with some fuscous and reddish irroration. Forewings elongate-triangular, costa bisinuate, apex obtusely pointed, termen bowed above middle, strongly oblique; grey with scanty fuscous irroration or strigulation; a short, strongly outwardly oblique white line from one-third costa, and a similar line on costa at two-thirds; a suffused darker oblique shade from one-third costa to near base of dorsum; a median, subcostal, transverse, red, discal mark; between this and apex a suffusedly darker area containing two or three red longitudinal streaks, a fine dentate line from a white mark on two-thirds costa to two-thirds dorsum; a subterminal fuscous line edged posteriorly by a white line, slightly wavy; cilia dark-grey. Hindwings with termen rounded; colour and cilia as forewings; a median, discal, transverse, bisinuate, hyaline mark; a slightly waved fuscous transverse line beyond middle; a transverse dark-grey shade before discal mark, and two similar but interrupted shades in terminal area. Underside of forewings pale-grey with slight fuscous strigulation; a transverse grey shade before middle; a dark-fuscous short outwardly oblique line followed by a small triangular spot on costa near apex; two incomplete, sinuate, interrupted, fuscous subterminal lines; a suffused dark-grey tornal blotch; of hindwings similar, but suffused with reddish; two longitudinal red streaks near tornus.

I have described this from the type in my collection and a ♀ in that of Mr. W. B. Barnard, and I know of a third example. It is near *O. lissoscia* which, however, lacks the dentate postmedian line on forewings, the hyaline discal mark on hindwings, and the red streaks.

Queensland: Brisbane.

171. *OENOCHROMA LISSOSCIA*.

Turn., *Trans. Roy. Soc. S. Aust.*, 1922, 292.

Queensland: National Park (3,500 feet).

172. *OENOCHROMA ALPINA*, n. sp.

Oenochroma alpina Goldfinch MS.

♀. 75 mm. Head and thorax fuscous. Palpi 1½; fuscous. Antennae reddish-fuscous. Abdomen fuscous. Legs reddish-fuscous. Forewings triangular, costa straight, apex rather acutely pointed, termen longer than dorsum, rounded, slightly sinuate beneath apex, strongly oblique; fuscous; costal edge narrowly whitish, strigulated with fuscous; a rather broad whitish line from two-fifths costa, bent inwards beneath costa, thence narrowly curved outwards, thence obliquely inwards to one-third dorsum, with a slight angle outwards on anal vein; a whitish line from costa shortly before apex, at first narrow but gradually becoming broader,

slightly outwardly curved, and strongly oblique to two-thirds dorsum; cilia fuscous. Hindwings with termen rounded; red; a rather broad, whitish subterminal line from three-fourths dorsum, becoming less distinct towards costa; a small fuscous tornal suffusion prolonged along anal vein; cilia reddish, on tornus and dorsum grey. Underside similar, but disc of forewings suffused with red except towards costa and termen, and without first line; hindwings reddish-fuscous.

A very fine and distinct species. Type in Coll. Goldfinch.

New South Wales: Mt. Kosciusko (5,000 feet), in December; one specimen.

173. OENOCHROMA INFANTILIS.

Prout, *Gen. Insect.*, *Oenochrom.*, p. 42.

♂. 30 mm. ♀. 32 mm. Head and thorax whitish tinged with greenish. Palpi 1½; whitish with some crimson irroration. Antennae whitish; pectinations in ♂ 10, apical two-fifths simple. Abdomen and legs whitish. Forewings rather broadly triangular, costa straight almost to apex, apex pointed, termen nearly straight, oblique; greenish-white; an obscure, whitish, outwardly oblique line from one-third dorsum about half-way across disc; a second, similar, straight line from two-thirds dorsum almost to apex; a similar, parallel, subterminal line; cilia crimson-fuscous, on apex, tornus, and dorsum whitish. Hindwings with termen only slightly rounded; as forewings, but only postmedian line present. Underside whitish.

North Australia: Darwin, Melville Is. North Queensland: Chillagoe.

174. OENOCHROMA VETUSTARIA.

Balliace vetustaria Wlk., *Cat. Brit. Mus.*, xxi, 1860, 290.—*Monoctenia digglesaria* Gn., *Ann. Soc. Ent. Fr.*, (4) iv, 1864, 15; Meyrick, *Proc. Linn. Soc. N.S.W.*, 1889, 1207.

♀. 52-54 mm. Head pale-grey. Palpi 1½; whitish with a few crimson scales. Antennae grey. Thorax brownish-grey; anterior third pale-grey, the two colours separated sharply on a straight transverse line. Abdomen grey with slight brownish and dark fuscous irroration. Legs whitish irrorated with brown and fuscous. Forewings elongate-triangular, costa straight almost to apex, apex acute, produced, termen sinuate, bowed above middle, costal half obtusely dentate; grey with a few dark-fuscous scales, suffused with brownish except on a pale oblique band from dorsum before middle extending more than half-way to costa; a pale straight line from two-thirds dorsum almost to apex; cilia fuscous. Hindwings with termen acutely angled on vein 4, wavy; as forewings, but pale band is basal, and pale line transverse, slightly beyond middle. Underside of forewings suffused with brownish towards tornus; a transversely oval, annular, fuscous-brown, discal spot; a short fuscous-brown band from mid-dorsum not reaching middle of disc; postmedian line indicated by a few fuscous dots; of hindwings, grey irrorated with fuscous-brown, and suffused with brownish towards termen.

Though this very distinct species has a wide distribution it has been rarely taken.

Queensland: Nambour, Brisbane. Tasmania: Bothwell, Launceston.

175. OENOCHROMA QUADRIGRAMMA.

Galanageia quadrigramma Luc., *Proc. Roy. Soc. Qld.*, 1900, 148.

♂. 48-52 mm. Head white with a few fuscous or brownish scales; face brown. Palpi $1\frac{1}{4}$; purple mixed with whitish and fuscous, basal joint brown. Antennae fuscous with white bars towards base, towards apex whitish-ochreous; pectinations in ♂ 6, apical one-fifth simple. Thorax brown. Abdomen brown, on mid-dorsum with bars of fuscous mixed with white. Legs fuscous-brown suffused and irrorated with white. Forewings elongate-triangular, costa straight, towards apex sinuate, apex pointed, termen strongly bowed above middle, obtusely dentate below middle; brown, sometimes with darker strigulae; costa strigulated with fuscous mixed with white; no antemedian line; a large, oval or reniform, subcostal, discal spot beyond middle; whitish, with a few darker scales, containing a hyaline crescent on its anterior margin, with a hyaline dot above it, both of these edged posteriorly with fuscous; a nearly straight but slightly waved pale line from costa shortly before apex to dorsum, shortly after middle; cilia brown, on tornal half of termen crimson-fuscous, bases white. Hindwings with termen strongly angled on vein 3, slightly curved above angle, with a slight angle beneath apex, more strongly dentate towards tornus; colour, discal spot, and cilia as forewings; the discal spot interrupts a pale transverse antemedian line edged anteriorly with fuscous. Underside similar.

A very distinct species, but allied to *O. vetustaria*.

Queensland: Coomera near Southport (R. Illidge. Dr. Lucas's type now in South Australian Museum), National Park (3,000 to 3,500 feet) in March. Three specimens.

Genus 26. ANTICTENIA.

Prout, *Gen. Insect.*, Oenochrom., p. 43.

Face smooth, not projecting. Tongue well-developed. Palpi short (under 1), porrect; second joint loosely rough-haired beneath; terminal joint small. Antennae short (under $\frac{1}{2}$); in ♂ imparipectinate, the inner pectinations short, outer long, extreme apex simple. Thorax stout, densely hairy beneath. Femora hairy. Tarsi finely spinulose. Forewings with 11 free, 10 and 9 long-stalked, their common stalk anastomosing with 8, 10 soon separating, 9 anastomosing for a longer distance (1 ♀), but more commonly 10 is free, and the portion of 9 connecting 10 and 8 is not developed (4 ♂, 3 ♀), so that 10 appears free, and 9 appears stalked with 8. Hindwings with 3 and 4 somewhat approximated, 5 from above middle of cell (about three-fifths from 4), 6 and 7 connate or short-stalked, 12 approximated to cell from one-fourth to middle.

Monotypical. Allied to *Oenochroma*, but differing in the antennae, palpi, and some details of the neuration.

176. ANTICTENIA PUNCTIUNCULIS.

*Monoctenia punctiunculus** Luc., *Proc. Roy. Soc. Qld.*, 1892, 84.—*Oenochroma leucospila* Warr., *Novit. Zool.*, 1898, 230.

♂. 40-44 mm. ♀. 44-55 mm. Head and thorax pale-grey often reddish-tinged. Palpi less than 1; pale-grey sometimes reddish-tinged. Antennae whitish-grey; in

* This is an evident misprint. Lucas intended to call this species *M. punctiunculis* (ablative plural), the *Monoctenia* with the little dots. Compare *Leucania labeculis* Luc. described on the same page. Both Lucas and Warren fixed on the same character for their names, that is, the whitish spots in the dark blotches on the underside of the hindwings.

♂ bipectinated to apex, inner row 1, outer row 5. Abdomen pale-grey, sometimes reddish-tinged, with sparse fuscous irroration. Legs pale reddish or grey. Forewings elongate-triangular, costa straight almost to apex, apex obtusely pointed, termen slightly bowed above middle, strongly oblique; pale grey, often reddish-tinged, with some fuscous strigulae; basal area to antemedian line darker, antemedian line from one-third costa to one-third dorsum, outwardly curved, slightly dentate, fuscous-brown or brown; a median, subcostal, fuscous, discal dot; postmedian line from costa near apex to two-thirds dorsum, nearly straight, fuscous or brown with pale anterior edge; a subapical fuscous or brownish spot; cilia reddish-grey or fuscous. Hindwings with termen only slightly rounded; as forewings but without antemedian line; a transverse line just beyond middle. Underside of forewings similar, but without antemedian line; of hindwings similar, with in addition a small reddish apical blotch containing two whitish marginal spots.

North Queensland: Townsville. Queensland: Duaringa, Yeppoon, Brisbane, Toowoomba.

Genus 27. CARTHAEA.

Wlk., *Cat. Brit. Mus.*, xiv, 1314; Prout, *Gen. Insect.*, Oenochrom., p. 44.

Face flat, but clothed with dense hairs so as to appear projecting. Palpi rather long, obliquely ascending; second joint clothed with long hairs; terminal joint rather long, cylindrical, obtuse. Antennae slightly over $\frac{1}{2}$; in ♂ bipectinate to apex, pectinations long. Thorax stout, hairy with a slight posterior crest, densely hairy beneath. Femora and tibiae densely hairy. Tarsi strongly spinulose. Forewings with 7 and 8 stalked, 9 and 10 long-stalked, areole not developed (owing to disconnection of 8 and 9), 11 free. Hindwings with cell about $\frac{1}{2}$, 3 and 4 separate, 5 from somewhat above middle of cell, 7 from before upper angle well separated from 6, 12 somewhat approximated to cell as far as middle, gradually diverging. Frenulum strongly developed.

There is only one species which is confined to Western Australia. This magnificent insect, from its large size, and ample wings bearing large ocelli, somewhat resembles the Saturniadae.

177. CARTHAEA SATURNIOIDES.

Wlk., *Cat. Brit. Mus.*, xiv, 1314.

♂, ♀. 80-98 mm. Head and thorax grey with fine white irroration; face ochreous-brown. Palpi $2\frac{1}{2}$; pale grey, second joint fringed with dense ochreous-brown hairs. Antennae grey; pectinations in ♂ 10, ochreous-brown. Abdomen ochreous-brown; dorsum, except margins, fuscous grey. Forewings triangular, costa gently arched, apex subrectangular, termen rounded; grey or brownish-grey, finely irrorated with whitish; a broad white line, edged posteriorly with dark grey, from one-fourth costa, outwardly oblique and sinuate, with a strong posterior tooth beneath middle, thence inwardly sinuate to one-fourth dorsum; a median, circular, subcostal ocellus, brown edged with blackish and containing a slender whitish lunule, its extremities directed posteriorly; a broad white line, edged anteriorly with dark grey, from three-fourths costa, crenulate, outwardly curved, sinuate towards tornus, on which it ends; cilia brownish-grey. Hindwings with termen gently rounded; whitish-grey, apical area widely suffused with crimson; a large, circular, median ocellus, blackish, containing a fine incomplete bluish ring, excentric outwardly, with a short line of the same colour on its inner side; a curved line posterior to this, crimson becoming brown towards



dorsum, edged posteriorly with a whitish line; a transversely elongate crimson blotch towards apex; cilia grey, towards apex of wing crimson-brown. Underside whitish-grey; a large posterior crimson suffusion on forewings; ocelli of both wings as on upper surface of hindwings; a postmedian line crimson in forewings, brown in hindwings, in both edged posteriorly by a white line.

Western Australia: Waroona, Collie, Guildford, Jandikot.

Genus 28. GASTROPHORA.

Gn., *Lep.*, ix, 187; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1202; Prout, *Gen. Insect.*, *Oenochrom.*, p. 44.

Face shortly rough-haired. Palpi moderate, porrect; second joint with long rough hairs beneath; terminal joint short. Antennae in ♂ more than $\frac{1}{2}$, bipectinate to apex, pectinations long; in ♀ less than $\frac{1}{2}$, shortly bipectinate to apex. Thorax stout, hairy beneath. Abdomen stout, disproportionately long. Femora hairy. Posterior tibiae smooth. Tarsi very minutely spinulose. Forewings with 6 separate, connate, or stalked with 7, 8, 9 and 10 stalked, 9 anastomosing with 8, forming a narrow areole, 11 free. Hindwings with cell about one-half in ♂, three-fifths in ♀, 5 from well above middle of cell (two-thirds), 6 and 7 short-stalked, 12 approximated to cell to three-fourths, gradually diverging.

Contains only one species, which is large, very distinct and confined to eastern Australia. Structurally its chief peculiarities are the unduly long abdomen, difference of wing-shape in the two sexes, and stalking of 6 and 7 of hindwings.

178. GASTROPHORA HENRICARIA.

Gn., *Lep.*, ix, 187, Pl. xxi, f. 4; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1202; Prout, *Gen. Insect.*, *Oenochrom.*, Pl. i, f. 7.

Queensland: Brisbane, Mt. Tambourine, Stanthorpe. New South Wales: Glen Innes. Victoria: Melbourne, Beaconsfield, Gisborne. South Australia: Mt. Lofty.

Genus 29. ARHODIA.

Gn., *Lep.*, ix, p. 185; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1201; Prout, *Gen. Insect.*, *Oenochrom.*, p. 45.

Face smooth, not projecting. Palpi short, ascending, shortly rough-haired, terminal joint minute. Antennae of ♂ bipectinate, pectinations long; of ♀ shortly bipectinate, but not to apex. Thorax stout, hairy beneath. Femora hairy. Fore tibiae with subapical hair-tuft on flexor surface. Posterior tibiae without middle spurs. Tarsi not spinulose. Forewings without areole (owing to disconnection of 8 and 9), 9 and 10 stalked, 11 free. Hindwings with 5 from above middle of cell (three-fifths to two-thirds), 6 and 7 closely approximated at origin, almost connate, 12 approximated to cell from one-fourth to middle, gradually diverging.

There is only one species, which varies much in size and colour, but is easily recognized.

179. ARHODIA LASIOCAMPARIA.

Gn., *Lep.*, ix, p. 186; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1202.—*Arhodia retractaria*, Wlk., *Cat. Brit. Mus.*, xxi, 282.—*Nigasa subpurpurea* Wlk., *ibid.*, 287.—*Arhodia semirosea* Wlk., *Trans. Ent. Soc. Lond.*, (3) i, 267.—*Monoctenia ozora* Swin., *Ann. Mag. Nat. Hist.*, (7) ix, 1902, 167.

North Queensland: Cape York, Cairns. Queensland: Clermont, Brisbane, Toowoomba, Charleville, Stanthorpe. New South Wales: Sydney. Victoria: Melbourne, Beaconsfield, Warragul, Marysville, Gisborne, Sea Lake. Tasmania: Hobart. South Australia: Mt. Lofty, Pinnaroo. Western Australia: Perth. North-west Australia: Sherlock River.

Genus 30. HOMOSPORA.

Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 229; Prout, *Gen. Insect.*, *Oenochrom.*, p. 45.

Face with strong conical corneous projection. Palpi short, ascending, shortly rough-scaled; terminal joint minute. Antennae bipectinate to apex, pectinations long in ♂, short in ♀. Thorax stout, hairy beneath. Femora hairy. Posterior tibiae without middle spurs. Tarsi not spinulose. Forewings with 9 and 10 stalked, 9 anastomosing with 8 to form a long narrow areole, 11 closely approximated to 12, or anastomosing at a point with 12. Hindwings with 5 from well above middle of cell (three-fourths), 6 and 7 connate, 12 closely approximated to cell as far as middle, gradually diverging.

Monotypical; allied to *Arhodia*.

180. HOMOSPORA RHODOSCOPA.

Onychodes ? rhodoscopa Low., *Trans. Roy. Soc. S. Aust.*, 1902, 228.—*Homospora procrita* Turn., *ibid.*, 1904, 230.—*Homospora lymantriodes* Prout, *Novit. Zool.*, 1913, 391.

North Queensland: Stewart River, Townsville. North-west Australia: Derby, Hammersley Range, Sherlock River.

I think *lymantriodes* is merely a paler local race of this species.

Genus 31. GERUSIA.

Warr., *Novit. Zool.*, 1907, 118; Prout, *Gen. Insect.*, *Oenochrom.*, p. 54.

Face not projecting, smooth, with a slight tuft on lower margin. Palpi moderate or rather short, porrect or slightly ascending; second joint rough-scaled; terminal joint short. Antennae in ♂ bipectinate to apex, pectinations long, in ♀ shortly bipectinate, apex simple. Thorax moderately stout, somewhat hairy beneath. Femora hairy. Anterior tibiae with a slender hair-tuft on flexor surface. Posterior tibiae with two pairs of spurs. Tarsi minutely spinulose. Forewings with 11 anastomosing first with 12 and then with 10, 9 and 10 long-stalked, 9 anastomosing with 8 to form a long narrow areole. Hindwings with 5 from middle of cell, 6 and 7 separate, 12 anastomosing strongly with cell to about middle.

Type, *G. virescens* Warr., from New Guinea. Immediately distinguished from its allies by the anastomosis of 12 of hindwings with cell. This has apparently been an independent development, as there appears to be no close relationship to *Hypographa*. There are three known Australian species, all variable, and several in New Guinea.

- | | |
|--|-------------------------|
| 1. Wings with distinct transverse lines | 2 |
| Wings without distinct transverse lines | <i>rubricosa</i> . 183 |
| 2. Hindwings densely strigulated | <i>excusata</i> . 181 |
| Hindwings not, or only slightly, strigulated | <i>multicolor</i> . 182 |

181. GERUSIA EXCUSATA.

Monoctenia excusata Wlk., *Cat. Brit. Mus.*, xxi, 280.

♂, ♀. 38-50 mm. Head whitish or grey-whitish; face fuscous or brown, inferior tuft whitish. Palpi $1\frac{1}{2}$; reddish-brown or fuscous, more or less mixed with whitish or pale-ochreous. Antennae grey, near base whitish; pectinations in ♂ 8, in ♀ $1\frac{1}{2}$. Thorax grey, sometimes tinged with brownish or whitish-ochreous. Abdomen grey, sometimes ochreous-tinged, sometimes with pairs of fuscous dorsal dots. Legs whitish or pale-ochreous variably strigulated with reddish-brown and fuscous. Forewings triangular, costa in ♂ slightly and evenly arched, in ♀ strongly sinuate, apex pointed, slightly produced, more so in ♀, termen obtusely angled on veins 6 and 4, thence strongly oblique; grey, usually ochreous- or brownish-tinged, with some scattered fuscous strigulae; a fuscous line from one-fifth costa to one-third dorsum, strongly bent outwards from margins, more or less developed; a suffused fuscous median line from midcosta obliquely outwards, angled in disc and continued to mid-dorsum, but this is not always present; an angled line from three-fourths costa, slender and usually dotted beneath angle, to three-fourths dorsum; sometimes a short fuscous streak from costa before apex, edged posteriorly with white; beneath this are frequently two blackish dots; sometimes a blackish spot above tornus; cilia fuscous, sometimes tinged with ochreous or reddish-brown, on tornus grey. Hindwings with termen rounded, crenulate or in ♀ dentate towards apex; pale-ochreous densely strigulated with fuscous; a wavy fuscous antemedian transverse line; a more rounded and slightly dentate postmedian line; often some fuscous suffusion before termen; cilia as forewings. Underside similar but more ochreous; markings less distinct; sometimes a dark-fuscous blotch on forewing beyond middle, and a white dot or elongate mark beneath apex.

Queensland: Brisbane, Toowoomba, National Park (3,000 feet). New South Wales: Katoomba. Victoria: Melbourne.

182. GERUSIA MULTICOLOR.

Onychodes multicolora Luc., *Proc. Roy. Soc. Qld.*, 1892, 81.—*Onychodes rubra* Warr., *Novit. Zool.*, 1897, 27.

♂, ♀. 40-44 mm. Head whitish or grey-whitish; face brown, inferior tuft whitish. Palpi $1\frac{1}{4}$; brown or reddish-brown, sometimes mixed with whitish. Antennae grey, towards base grey-whitish; pectinations in ♂ 10, in ♀ 2. Thorax grey or grey-whitish. Abdomen grey or grey-whitish; sometimes with a median dorsal series of fuscous spots. Legs brownish; posterior pair grey-whitish. Forewings triangular, costa in ♂ slightly and evenly arched, in ♀ sinuate, apex acute, slightly produced, more strongly so in ♀, termen angled or dentate on veins 6 and 4, thence strongly oblique; pale-grey or grey-whitish, sometimes pinkish- or purplish-tinged; transverse lines variably developed, very distinct, or slender, or even obsolete, brownish or fuscous; first from one-fourth costa to one-fourth dorsum, outwardly curved; second from two-fifths costa to mid-dorsum, slightly outwardly curved, suffused; third from two-thirds costa, outwardly oblique, acutely angled beneath costa, thence inwardly oblique and sinuate to three-fourths dorsum; in some examples the second and third lines are partly double; sometimes a subcostal discal dot precedes third line; rarely a small fuscous apical suffusion; more often one or two subapical fuscous dots; cilia dark-grey or brownish, pale-grey on tornus. Hindwings with termen rounded, slightly angled on veins 6 and 4; as forewings, but sometimes suffused with pale pink; without first line;

sometimes a subterminal series of fuscous spots. Underside grey or brownish; markings usually less distinct; sometimes a white patch strigulated with fuscous on dorsum of hindwing.

Like *G. excusata*, very variable. From that species it may best be distinguished by the absence of heavy strigulation of hindwings, the shorter palpi, and the longer antennal pectinations.

North Queensland: Herberton, Mackay. Queensland: Gympie, Brisbane, Toowoomba. New South Wales: Sydney, Mittagong.

183. GERUSIA RUBRICOSA, n. sp.

rubricosus, reddish.

♀, 46-52 mm. Head pinkish-white; face brown, inferior tuft pinkish-white. Palpi $1\frac{1}{4}$; pale-reddish. Antennae pale-grey, towards base pinkish-white; pectinations in ♀ 2: Thorax and abdomen pale-reddish. Legs pale-reddish. Forewings triangular, costa in ♀ slightly sinuate, apex acute and produced, termen strongly bowed, not distinctly angled; pale-reddish; sometimes a few scattered fuscous scales; lines slightly darker, suffused, or partly obsolete; first at one-fifth, outwardly curved; second at two-fifths, rather broadly suffused; third from two-thirds costa to two-thirds dorsum, strongly sinuate, towards dorsum nearly approximated to second line; one or two whitish subapical dots surrounded by fuscous irroration; cilia concolorous. Hindwings with termen rounded, sometimes slightly angled on veins 6 and 4; as forewings, but paler. Underside of forewings whitish, except towards costa in basal two-thirds; terminal area and whole of hindwings darker red; apical markings of forewings more distinct.

North Queensland: Cairns. Queensland: Brisbane, Toowoomba. Three specimens; type in Coll. Barnard.

Genus 32. CIRCOPETES.

Prout, *Gen. Insect.*, Oenochrom., p. 53.

Face not projecting, slightly rough-scaled. Palpi short, obliquely ascending; second joint thickened with dense rough scales; terminal joint short. Antennae of ♂ bipectinate to apex, pectinations long, of ♀ dentate. Thorax stout, beneath densely hairy. Femora hairy. Posterior tibiae with two pairs of spurs. Tarsi spinulose. Forewings with 11 free, 10 and 9 long-stalked from cell, 9 anastomosing with 8 soon after origin, forming a long narrow areole, but sometimes the connecting part of 9 is not developed, leaving the areole open. Hindwings with 3 and 4 separate, 5 from much above middle of cell (two-thirds), 6 and 7 connate or closely approximated at origin, 12 closely approximated to cell from one-fourth to two-thirds.

Monotypical. Best distinguished from *Onychodes* by the origin of 5 of hindwings from much nearer 6 than 4; from *Gerusia* by the non-anastomosis of 12 with cell.

184. CIRCOPETES OBTUSATA.

Monoctenia obtusata Wlk., *Cat. Brit. Mus.*, xxi, 279; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1207.—*Monoctenia himeroides* Wlk., *ibid.*, 279.—*Arhodia modesta* Warr., *Novit. Zool.*, 1904, 485.

♂, ♀, 48-60 mm. Head pale-grey; face reddish-fuscous, lower edge, sometimes lateral edges, and some irroration, ochreous-whitish. Palpi 1; ochreous-whitish

irrorated with reddish-fuscous; terminal joint reddish-fuscous. Antennae pale-grey; pectinations in ♂ 8. Thorax and abdomen pale-grey. Legs grey-whitish irrorated with reddish-fuscous. Forewings elongate-triangular, costa straight, apex pointed, very slightly produced, termen sinuate beneath apex, strongly bowed above middle, thence only slightly rounded; pale-grey with fine fuscous strigulae more or less developed; a short oblique fuscous costal mark at one-fourth, with dots on median and anal veins indicating antemedian line; an oblique suffused fuscous mark on midcosta, indicating a median line, angulated beneath costa, but rarely developed; usually a fuscous, pale-centred, discal dot beyond middle; sometimes a fuscous mark on three-fourths costa, indicating commencement of a fine postmedian line, which is rarely present; cilia fuscous, apices usually whitish. Hindwings with termen gently rounded, wavy; colour as forewings; a transverse, fuscous, antemedian line; usually followed by a pale-centred discal dot; dorsal edge, except near base, whitish irrorated with dark-fuscous. Underside of forewings grey with pale-centred discal dot, and large, round, blackish, supraternal blotch; of hindwings like upperside, but with also usually a dark grey tornal suffusion prolonged to mid-disc, and sometimes a similar apical spot.

North Queensland: Cairns, Herberton, Townsville. Queensland; Gayndah, Brisbane, Toowoomba. Victoria: Melbourne. Tasmania: Lilydale. Western Australia: Perth, Waroona.

Genus 33. ONYCODES.

Gn., *Lep.*, ix, 142; Prout, *Gen. Insect.*, *Oenochrom.*, p. 51.

Face smooth, not projecting. Palpi short or moderate, obliquely ascending; second joint shortly rough-scaled; terminal joint minute. Antennae bipectinate in both sexes, pectinations in ♂ very long, in ♀ moderate, extending to apex or nearly to apex. Thorax stout or moderate, moderately hairy beneath. Femora slightly hairy. Anterior tibiae with a long slender subterminal tuft on flexor surface. Posterior tibiae with two pairs of spurs. Tarsi minutely spinulose. Forewings with 11 free, or anastomosing with 12, 10 and 9 stalked, 9 connected with 8 soon after separating to form a long narrow areole, but sometimes the connecting bar fails to chitinize, leaving the areole open. Hindwings with 3 and 4 separate, 5 from middle of cell, 6 and 7 separate, connate, or short-stalked, 12 approximated to cell from one-fourth to middle, gradually diverging.

Type, *O. traumataria* Gn. *O. lutosaria* Gn. differs from this species in the stronger palpi and the anastomosis of 11 and 12 of the forewings, but I regard these differences as only specific.

185. ONYCODES TRAUMATARIA.

Gn., *Lep.*, ix., 143, Pl. ix, f. 8.—*Chilma flagrantaria* Wlk., *Cat. Brit. Mus.*, xxvi, 1692.

♂. 40-48 mm. Head pinkish-white; fillet yellow; face dark-red. Palpi 1, slender; ochreous-whitish, pinkish-tinged. Antennae pale-ochreous-grey; pectinations darker, very long (16) and extending to apex. Thorax yellow or orange, anteriorly pale-pink. Abdomen yellow or orange, sometimes with a few paired fuscous dorsal dots. Legs pinkish-ochreous. Forewings triangular, costa straight, sinuate before apex, apex pointed, termen slightly rounded, sinuate beneath apex; 11 free; yellow, orange, or ochreous, with few fine fuscous strigulae; a pinkish broadly-suffused line on costa before middle; dark-fuscous costal spots on

middle, three-fourths, and before apex; a brownish-ochreous line extends from subapical spot to three-fifths dorsum, variably developed, sometimes entire and straight, sometimes represented by a series of spots, which may be curved inwards above dorsum and succeeded by a large supraternal spot; extreme apex pink or pinkish-white; cilia brownish-fuscous, beneath apex sometimes pink. Hindwings with termen slightly rounded, not produced at tornus; as forewings, except for costal and apical markings. Underside darker; forewings, except dorsal and apical areas, more or less suffused with reddish; hindwings with reddish blotches on apex and tornus.

♀. 38-44 mm. Head and thorax pale-grey, pinkish-white, or crimson. Antennal pectinations 2. Forewings with termen doubly sinuate, apex produced; greyish-ochreous, pinkish-white, or crimson, more heavily strigulated and spotted than in ♂. Hindwings vary similarly.

This handsome and variable species is found in the southern mountains and Tasmania. Though often similar to the following species, it may always be distinguished by the hindwings not being produced at tornus, and by the ♂ antennae.

New South Wales: Barrington Tops, Mt. Kosciusko (4,500 feet). Victoria: Beaconsfield, Lorne, Sale, Gisborne, Mt. St. Bernard (5,000 feet). Tasmania: Hobart, Beaconsfield, Ulverstone, Zeehan, Strahan.

186. ONYCODES RUBRA.

♀ *Xenosuma rubra* Luc., *Proc. Roy. Soc. Qld.*, 1891, 81.—♂ *Arrhodia ? illidgei* Luc., *Proc. Linn. Soc. N.S.W.*, 1893, 139.

♂. 34-36 mm. Head whitish; fillet orange; face fuscous. Palpi 1, slender; ochreous or reddish, towards base whitish. Antennae pale-ochreous; pectinations 10, reduced to serrations at apex. Thorax and abdomen pale-ochreous or whitish-grey. Legs pale-ochreous irrorated and annulated with brownish-fuscous. Forewings triangular, costa straight, sinuate before apex, apex round-pointed, termen slightly rounded; 11 free; pale ochreous or whitish-grey, with some fine fuscous strigulae; costal edge ochreous; three small fuscous dots on veins representing basal line; a fuscous costal spot at middle, and a second, larger, at three-fourths; a fuscous line from costa near apex to dorsum at or beyond middle, sometimes reduced to a series of dots; sometimes followed by a large dark-fuscous supra-tornal spot, which may be double; sometimes a very slender, whitish, dentate, subterminal line; extreme apex tinged with pink; cilia brownish-ochreous. Hindwings with termen slightly rounded, produced at tornus; colour, cilia and transverse line as forewings. Underside ochreous or grey with slender postmedian line on forewings.

♀. 45-50 mm. Head pinkish or crimson, fillet orange, face reddish. Antennal pectinations 2½. Forewings with costa doubly sinuate, apex produced; pinkish-grey, pinkish-ochreous, or crimson; markings usually indistinct; a small fuscous dot on costa at three-fourths, which rarely gives rise to a brownish-ochreous line, angulated beneath costa, to dorsum beyond middle; the line from costa before apex is sometimes distinct, but often reduced to a series of minute dots, sometimes a dark-fuscous spot before dorsum.

Like the preceding, this is a variable species. Lucas's type *rubra* is in my collection.

Queensland: Caloundra, Brisbane. New South Wales: Sydney.

187. ONYCODES LUTOSARIA.

Arhodia ? lutosaria Feld., *Reise Novara*, Lep., Pl. 124, figs. 15, 16.—*Onychodes lutosaria* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1200.

♀. 72 mm. Head fuscous-brown, anteriorly greyish-ochreous; fillet pink; face fuscous-brown, inferior tuft ochreous-whitish. Palpi 1½, thickened with densely appressed scales; ochreous-yellow spotted with crimson, apex greyish-ochreous. Antennae pink, more whitish towards apex; pectinations in ♀ 1. Thorax stout; greyish-ochreous; underside ochreous-yellow. Abdomen greyish-ochreous, posteriorly with a median dorsal line and some scattered irroration crimson. Legs ochreous-yellow spotted with crimson, anterior pair crimson except coxae. Forewings elongate-triangular, costa straight, slightly sinuate before apex, apex pointed, strongly produced, termen rather strongly bowed in middle, thence nearly straight; 11 anastomosing with 12; greyish-ochreous with crimson fuscous spots; costal edge crimson; a few fuscous strigulae beneath costa, above dorsum, and in posterior part of disc; a spot beneath costa at one-fifth, another on midcosta, a third on costa at three-fourths; a small subcostal median discal spot; a subdorsal spot at one-fourth, and two placed transversely at middle; a slightly sinuate line from apex to three-fourths dorsum, at first continuous and crimson-tinged, but soon reduced to a series of small spots; a subterminal spot above middle, two spots below middle posterior to oblique line, and one above tornus; cilia greyish-ochreous, beneath apex crimson-tinged. Hindwings somewhat elongate, termen gently rounded; pale orange; a crimson fuscous discal spot; a grey tornal suffusion; a curved, acutely-dentate, transverse, postmedian line; three crimson-fuscous spots arranged parallel to termen towards tornus; cilia pale-orange, towards tornus crimson-tinged, on tornus grey. Underside orange-yellow, with crimson-fuscous strigulae and discal spots; upper part of oblique line of forewing developed; a large irregular supraternal blotch on hindwings crimson-fuscous and white.

Queensland: National Park (2,500 feet). New South Wales: ———. Victoria: Fernshaw, Beaconsfield, Lorne, Gisborne.

Genus 34. CERNIA.

Wlk., *Cat. Brit. Mus.*, xx, 267; Prout, *Gen. Insect.*, Oenochrom., p. 51.

Face smooth, not projecting. Palpi moderate in ♂, long in ♀, porrect; second joint thickened with loosely appressed scales; terminal joint short in ♂, longer in ♀, cylindrical, obtuse. Antennae of ♂ shortly bipectinate, towards apex simple. Thorax stout, beneath densely hairy. Femora hairy. Posterior tarsi with two pairs of spurs; in ♂ dilated with internal groove and tuft. Tarsi minutely spinulose. Forewings with 10 from stalk of 7, 8, 9, 11 from cell anastomosing first with 12, then with 10, 10 approximated to 9 but not anastomosing, areole absent. Hindwings with 3 and 4 separate, 5 from much above middle of cell (two-thirds), 6 and 7 separate, 12 approximated to cell from one-fourth to middle, abruptly diverging.

Monotypical. The neuration is curiously identical with that of some Geometridae; nevertheless, I think it should be referred here.

188. CERNIA AMYCLARIA.

Wlk., *Cat. Brit. Mus.*, xx, 267.—*Pseudoterpna diphtherina* Meyr., *Trans. Ent. Soc. Lond.*, 1889, 496.—*Monoctenia odontias* Low., *Trans. Roy. Soc. S. Aust.*, 1894, 83.—*Aspidoptera ambiens* Luc., *Proc. Roy. Soc. Qld.*, 1899, 147.

♂, ♀. 32-38 mm. Head dark-reddish; face with paired whitish spots at upper and lower margins; palpi in ♂ 2, in ♀ 2½; dark-reddish, bases of joints and extreme apex whitish. Antennae whitish-ochreous, towards base dark-reddish; pectinations in ♂ 2. Thorax and abdomen pale-grey, more or less pinkish-tinged. Legs whitish mottled with dark-red; posterior tibiae of ♂ dilated with internal groove and tuft. Forewings triangular, rather narrow, costa straight to near apex, apex pointed, termen strongly rounded, crenulate; pale-grey, more or less pinkish-tinged; costal edge ochreous strigulated with dark-red and dark-fuscous; a median, subcostal, discal dot or transverse mark, fuscous or reddish; a fuscous sinuate line of dots from four-fifths costa to three-fourths dorsum, continuous towards costa, on dorsum followed by a short parallel dark-fuscous streak; terminal edge reddish; cilia dark-fuscous, apices usually white in concavities. Hindwings with costa emarginate towards apex, apex acutely rectangular, termen angled on vein 4, wavy, but not rounded above and beneath angle; colour and cilia as forewings; a small grey-whitish blotch, irrorated and capped with blackish on costa above emargination at two-thirds; from this proceeds a line of fine dots, sometimes obsolete to two-thirds dorsum. Underside similar, markings distinct, sometimes a suffused reddish terminal blotch above middle in both wings.

North Queensland: Dunk Is., Townsville. Queensland: Duaringa, Gayndah, Brisbane, Southport, Coolangatta, Toowoomba. New South Wales: Sydney, Jervis Bay. Also from New Guinea.

Genus 35. EUMELEA.

Duncan, *Nat. Hist. Exot. Moths.* 1841, p. 215; Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1197; Prout, *Gen. Insect.*, *Oenochrom.*, p. 61.

Face smooth, lower edge slightly prominent. Palpi rather long, ascending, rather slender; second joint shortly rough-scaled; terminal joint smooth, cylindrical, obtuse. Antennae nearly as long as forewings, slender, and simple in both sexes. Thorax slender, slightly hairy beneath. Legs very long and slender. Femora hairy. Posterior tibiae with two pairs of spurs. Tarsi minutely spinulose. Forewings with 7, 8, 9 stalked, no areole, 10 and 11 arising separately from cell, 11 anastomosing first with 12, then with 10. Hindwings with 3 and 4 separate, 5 from well above middle of cell (three-fifths to two-thirds), 6 and 7 stalked, 12 approximated to cell as far as middle, thence gradually diverging.

Type, *E. rosalia* Stoll. Prout gives *sanguinata* Warr. (*rosalia* Dunc., *nec* Cram.) as the type, but in Seitz' *Macrolepidoptera* he does not mention Warren's species, and apparently merges it in *rosalia*. A singular and isolated genus.

The species are both similar and variable and yet await a final division, but the Australian forms are at present three, all from Queensland, and can be certainly distinguished.

- 1. Forewings with a nearly straight strongly oblique postmedian line from three-fourths costa *duponchelii*. 191
- Forewings with postmedian line curved, from before two-thirds costa 2
- 2. Wings finely strigulated; posterior tibiae of ♂ smooth *rosalia*. 189
- Wings coarsely strigulated; posterior tibiae of ♂ hairy on flexor surface *stipata*. 190

189. EUMELEA ROSALIA.

Stoll, *Cram. Pap. Exot.*, iv, 1781, 152, Pl. 368; *Eumelea sanguinata* (Warr.) *australiensis* Warr., *Novit. Zool.*, 1897, 29.

♂, 48-54 mm.; ♀, 52-58 mm. Head yellow; anterior part of crown and upper part of face more or less mixed with crimson. Palpi in ♂ 2-2½, in ♀ 2½-3; yellow, more or less mixed with crimson. Antennae five-sixths; dark-reddish becoming ochreous-whitish towards apex. Thorax and abdomen yellow, sometimes reddish-tinged. Legs yellowish, more or less irrorated with crimson-red; posterior tibiae of ♂ fringed with long hairs on flexor surface. Forewings triangular, costa gently and evenly arched, apex round-pointed, termen slightly rounded, slightly oblique; yellow or orange, rather coarsely strigulated with crimson-red or grey; the following markings are usually traceable: an outwardly curved line from one-fifth costa to one-fifth dorsum; a pale-centred, subcostal, discal spot before middle; a suffused, outwardly curved line from two-thirds costa to three-fifths dorsum; rarely also a suffused subterminal line; cilia yellow, reddish-fuscous, or crimson-red. Hindwings with termen slightly rounded; colour and cilia as forewings; a suffused median transverse line; often a small yellow apical spot. Underside similar.

Distinct from *E. stipata* in wing-shape, coloration, longer palpi, and hairy posterior tibiae of ♂. It is incompletely sexually dimorphic; most of the males are crimson-red, but very few females; most of the females are yellow, but very few males; the distinction between red forms and yellow is, however, bridged by intermediate forms. This species is certainly *australiensis* Warr.; for its identification with *rosalia* Stoll I rely on Mr. L. B. Prout.

North Queensland: Cairns, Herberton, Townsville. Queensland: Yeppoon. Also from the Archipelago.

190. *EUMELEA STIPATA*, n. sp.

Eumelea rosalia form *stipata* Prout, *Seitz Macrolep.*, Indo-Aust. Geom. p. 32.

♂, 45-50 mm.; ♀, 55 mm. Head crimson; fillet and two spots on lower margin of face yellow. Palpi 1½, in ♀ 2; external surface crimson, lower margin and internal surface yellow. Antennae five-sixths; dark crimson becoming grey towards apex. Thorax and abdomen crimson. Legs pale-yellow mixed with crimson; posterior tibiae of ♂ smooth. Forewings triangular, costa straight but arched before apex, apex rounded, termen nearly straight, moderately oblique; pale-crimson, sometimes yellowish-tinged, finely and densely strigulated throughout with dark-crimson; costal edge narrowly yellow interrupted by strigulae; usually no markings, but sometimes obscure antemedian and postmedian lines and a pale-centred discal spot partly developed; cilia crimson. Hindwings with termen gently rounded; colour and cilia as forewings. Underside similar.

The smooth posterior tibiae of the ♂ are sufficient evidence that this species is distinct from the following. By the practised eye it may be readily distinguished by its uniform dark-crimson coloration in contrast to the yellow and red of the latter species.

North Queensland: Cape York, Cooktown, Cairns. It has not yet been recognised outside Australia, but doubtless will be.

191. *EUMELEA DUPONCHELII*.

Montrousier, 1856.—*Eumelea obliquifascia* Warr., *Novit. Zool.*, 1894, 375.

♀. 60-63 mm. Head yellow; some irroration on crown and upper half of face, red. Palpi 2½; yellow irrorated with red. Thorax and abdomen yellow mixed with

crimson-red. Legs yellow mixed with fuscous-crimson. Forewings triangular, costa moderately and uniformly arched, apex pointed, termen slightly rounded, moderately oblique; orange-yellow coarsely strigulated and spotted with orange-brown; an incomplete outwardly curved line from one-fifth costa to one-fourth dorsum; a broadly suffused, nearly straight line from three-fourths costa to dorsum beyond middle; a pale-centred, subcostal, discal spot before middle; cilia fuscous. Hindwings with termen very slightly rounded; colour and cilia as forewings; a suffused transverse line before middle. Underside similar.

I have only two ♀ examples, but understand that the colour varies as in *rosalia*. For the identification I am indebted to Mr. L. B. Prout.

North Queensland: Cairns, Innisfail. Also from New Guinea and Moluccas.

Genus 36. CELERENA.

Wlk., *Trans. Ent. Soc. Lond.*, 1862, 71; Prout, *Gen. Insect.*, Oenochrom., p. 96.

Face smooth, rounded, slightly projecting. Palpi rather short, ascending, rather slender; second joint shortly rough-scaled; terminal joint short, smooth-scaled. Antennae of ♂ simple. Thorax rather slender; hairy beneath. Femora hairy. Hindlegs of ♂ much modified and distorted. Tarsi not spinulose. Forewings with 11 and 10 long-stalked, their common stalk anastomosing with 12, 10 approximated to 9 (sometimes anastomosing with it). Hindwings with 3 and 4 separate, 5 from above middle of cell, 6 and 7 approximated at origin, 11 from near base, running into 12, 12 parallel but not approximated to cell as far as middle, thence gradually diverging.

Type, *C. divisa* Wlk., from India. A rather large Papuan genus, of which one species occurs in India, and one reaches North Queensland. It appears to be rather distantly allied to *Eumelea*, but shows important differences in the neururation. The males show many secondary sexual characters.

192. CELERENA GRISEOFUSA.

Warr., *Novit. Zool.*, 1896, 281; Turn., *Trans. Roy. Soc. S. Aust.*, 1922, 294.

Antennae of ♂ with a dorsal median tuft of long scales. Abdomen of ♂ densely hairy beneath. Hindlegs of ♂ with femora short, thickened, and densely hairy; tibiae much dilated, densely hairy, with long crooked median spurs and a single terminal spur; first tarsal joint much swollen. Forewing of ♂ with a large basal fovea beneath, elongate and gradually disappearing distally, unscaled above and beneath.

North Queensland: Claudie River. Also from New Guinea (Fergusson Is.).

Genus 37. AXIAGASTA, n. gen.

ἀξιαγαστος, worthy of admiration.

Face smooth, not projecting. Palpi of ♂ short, ascending, closely appressed to face; second joint thickened with appressed scales; terminal joint minute; of ♀ moderate, porrect; second joint rather slender; terminal joint moderate, cylindrical, obtuse. Antennae of ♂ bipectinate, towards apex dentate, pectinations moderate. Thorax moderate, not crested; beneath somewhat hairy. Femora smooth. Posterior tibiae with two pairs of spurs. Tarsi not spinulose. Forewings with 5 from much above middle of cell, 7, 8, 9 stalked, 10 and 11 long-stalked, their common stalk anastomosing with 12. Hindwings with 3 and 4 separate, 5 from much above middle of cell (three-fourths), 6 and 7 separate, 12 approximated to cell to beyond middle, thence gradually diverging.

The difference in the palpi of the two sexes is noteworthy. The genus is allied to *Zeuctophlebia*, the neuration of the forewings differing in the non-development of the basal connecting portion of 9 between 10 and 8, so that 9 has been "captured" by 8.

193. AXIAGASTA RHODOBAPHES, n. sp.

ροδοβαφης, rosy-suffused.

♂, 26 mm.; ♀, 32 mm. Head and thorax whitish tinged with rosy; face more or less fuscous. Palpi of ♂ 1, ascending and appressed to face; of ♀ 2, porrect; rosy mixed with fuscous, towards base white. Antennae grey-whitish; pectinations in ♂ 5, ochreous-fuscous. Abdomen whitish, towards base rosy tinged, apices of segments and some irroration fuscous. Legs rosy; femora and posterior pair whitish. Forewings triangular, costa straight, slightly arched before apex, apex round-pointed, termen rounded, oblique; whitish suffused with pale-rosy with some fine sparse fuscous irroration; costal edge deeper rosy; a very faint, outwardly curved line from two-fifths costa to two-fifths dorsum; a similar line from four-fifths costa to four-fifths dorsum, indented above dorsum; both lines are obsolete in ♀; a faint, fuscous, median, transverse, subcostal, discal mark; an interrupted dark-fuscous terminal line; cilia whitish, rosy-tinged. Hindwings with termen rounded; as forewings but without first line; discal mark more distinct. Underside paler; without lines, but with dark-fuscous discal spots on both wings.

Queensland: Gayndah in November; two specimens received from Dr. Hamilton Kenny.

Genus 38. AMPHICLASTA.

Turn., *Trans. Roy. Soc. S. Aust.*, 1906, 132; Prout, *Gen. Insect.*, Oenochrom., p. 50.

Face somewhat projecting, clothed with rough scales. Tongue present. Palpi moderate, porrect; second joint densely clothed with rough scales; terminal joint very short, obtuse. Antennae of ♂ bipectinate, base and apical one-sixth simple, pectinations moderate (3). Thorax stout, with a small posterior crest above; beneath densely hairy. Femora hairy. Posterior tibiae with two pairs of spurs. Tarsi finely spinulose. Forewings with 7, 8, 9 stalked, 10 and 11 long-stalked from cell, 10 anastomosing with 9 to form an apparent areole. Hindwings with 3 and 4 separate, 5 from middle of cell, 6 and 7 separate, 12 closely approximated to cell as far as two-thirds, separating rather abruptly.

Monotypical. The long-stalking of 10 and 11 is an exceptional character. The true areole has been lost; the apparent areole represents the posterior portion of the double areole that is found in other genera.

194. AMPHICLASTA LYGAEA.

Turn., *Trans. Roy. Soc. S. Aust.*, 1906, 132.

New South Wales: Bourke. Victoria: Birchip. South Australia: Pinnaroo.

Genus 39. ZEUCTOPHLEBIA.

Warr., *Novit. Zool.*, 1896, 355; Prout, *Gen. Insect.*, Oenochrom., p. 32.

Face smooth without tuft. Tongue present. Palpi moderate, porrect, thickened with appressed scales; terminal joint concealed. Antennae of ♂ bipectinate, pectinations long, not extending to apex. Thorax and abdomen slender;

the former hairy beneath. Femora smooth. Tarsi spinulose. Forewings with 7 and 8 stalked from upper angle of cell, 9, 10 and 11 long-stalked, their common stalk anastomosing with 12; 9 and 10 then anastomosing with 8 to form a large areole from which 8, 9, 10 arise by a common stalk. Hindwings with 6 and 7 approximated at origin, 12 connected with cell at about one-third by 11, closely approximate to cell to about two-thirds, thence diverging.

Type, *Z. squalidata* Wlk. This genus is isolated. In neuration it is nearest *Celerena*, but there can be no really close relationship. *Zeuctophlebia* differs from all other genera, in which 12 of the hindwings is closely appressed to the cell, by the retention of vein 11, and this must be an archaic character. In my introductory remarks, 11 is said to run into 12. This is quite incorrect; 11 anastomoses strongly with 10, while 12 anastomoses at a point with their common stalk.

Key to Species.

1. Face red; apex of forewing acute *squalidata*. 195
 Face grey; apex of forewing not acute *tapinodes*. 196

195. ZEUCTOPHLEBIA SQUALIDATA.

Fidonia squalidata Wlk., *Cat. Brit. Mus.*, xxvi, 1671.—*Zeuctophlebia rufipalpis* Warr., *Novit. Zool.*, 1896, 355.

♂, ♀. 22-30 mm. Head pale-reddish; face dark-red. Palpi 1½; red mixed with dark-fuscous. Antennae grey; pectinations in ♂ 6. Thorax grey tinged with reddish and irrorated with fuscous. Abdomen whitish, bases of segments irrorated with dark-fuscous and rarely also with reddish. Legs dark-fuscous, more or less mixed with red; tarsi annulated with whitish-ochreous. Forewings triangular, costa slightly arched, apex acute, termen slightly rounded, slightly oblique; whitish more or less suffused with pale-reddish and irrorated with dark-fuscous; costal edge reddish; first line from one-third costa to one-third dorsum, slender, reddish-fuscous, sometimes slightly dentate; a median, subcostal, blackish, discal dot; second line from two-thirds costa obliquely outwards, acutely angled in disc above middle; thence nearly straight to two-thirds dorsum, slender, whitish, edged on both sides with reddish-fuscous; usually a subterminal series of dark-fuscous dots with pale haloes; a terminal series of dark-fuscous dots; cilia whitish, bases reddish-tinged, with a fuscous median line. Hindwings with termen rounded; as forewings, but without first line. This attractive little species deserved a better name.

North Queensland: Herberton. Queensland: Yeppoon, Gympie, Nambour, Brisbane, Stradbroke Is., Mt. Tambourine, Coolangatta, National Park (3,000 ft.), Toowoomba, Bunya Mts. (3,000 feet), Killarney. Tasmania: Launceston.

196. ZEUCTOPHLEBIA TAPINODES.

Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 228.

♂, ♀. 23-26 mm. Head pale-grey; face darker. Palpi 1; whitish, apex grey. Antennae grey; pectinations in ♂ 8. Thorax and abdomen grey with a few fuscous scales. Legs grey; posterior pair ochreous-whitish. Forewings triangular, costa straight to near apex, apex round-pointed, termen slightly rounded, slightly oblique; pale-grey sparsely irrorated, and costa strigulated, with fuscous; first line from one-fourth costa to one-fourth dorsum, usually represented by three fuscous dots, rarely continuous, sometimes obsolete; a median, subcostal, blackish, discal dot; sometimes a faint, fuscous, transverse, median line just posterior to

discal dot; postmedian line from three-fourths costa to two-thirds dorsum, slender, fuscous, sinuate, finely dentate; sometimes a faint fuscous subterminal line; cilia grey. Hindwings with termen rounded; grey; a fuscous discal dot at about one-third; sometimes a faintly darker transverse line at one-third; sometimes a very slender dentate transverse line beyond middle; an interrupted fuscous terminal line; cilia grey.

Queensland: Caloundra in August, Stradbroke Island, Coolangatta in November; six specimens.

Genus 40. PHYSETOSTEGE.

Warr., *Novit. Zool.*, 1896, 99; Prout, *Gen. Insect.*, *Oenochrom.*, p. 86.

Face smooth, not projecting. Tongue well developed. Palpi moderate, ascending; second joint thickened with appressed hairs; terminal joint short, porrect, obtuse. Antennae of ♂ bipectinate, towards apex simple, each pectination ending in a long terminal bristle. Thorax and abdomen moderately slender; the former not hairy beneath. Femora smooth. Posterior tibiae of ♂ slightly dilated with internal groove and tuft. Tarsi minutely spinulose. Forewing of ♂ with a large sub-basal fovea between cell and anal vein; 2 from two-thirds, 3 from shortly before angle, areole present, 10 arising separately from areole, 11 anastomosing first with 12 and then with areole. Hindwings with 2 from three-fifths, 3 from shortly before angle, 5 from middle, 6 and 7 separate, 7 arising from shortly before angle, 12 swollen at base, connected with cell near base, thence diverging.

So far only one species has been recorded. This and the following genus are allied to *Encryphia*.

197. PHYSETOSTEGE MIRANDA.

Warr., *Novit Zool.*, 1896, 99.

♂, 36 mm.; ♀, 42 mm. Head and thorax reddish-brown. Palpi 2½; reddish-brown. Antennae reddish-brown; pectinations in ♂ 3½, apical one-sixth simple. Abdomen reddish-brown, apices of third, fourth and fifth segments white or whitish on dorsum. Legs reddish-brown partly suffused with fuscous; tarsi broadly annulated with whitish. Forewings triangular, rather narrow, costa straight except near base and apex, apex pointed, termen very slightly rounded, rather strongly oblique; reddish-brown with fine fuscous strigulations most developed towards costa; antemedian line from one-third costa to one-third dorsum, slightly outwardly curved, dark-reddish; an inconspicuous, median, subcostal, dark, transverse, discal mark; postmedian from beneath three-fourths costa to two-thirds dorsum, angled obtusely outwards above middle, incurved above and below angle, dark-reddish edged posteriorly with pale-reddish-ochreous; cilia reddish. Hindwings with termen strongly rounded; as forewings, but without antemedian line and discal mark; postmedian angled in middle and slightly dentate, sometimes preceded by a fuscous or blackish suffusion towards costa.

My examples closely correspond to the New Guinea form. I have not seen any like those described by Warren as *miranda rufata*, which perhaps is a distinct species.

North Queensland: Kuranda near Cairns in September, October and November; three specimens received from Mr. F. P. Dodd. Also from New Guinea.

Genus 41. NOREIA.

Wlk., *Cat. Brit. Mus.*, xxiv, 1092; Prout, *Gen. Insect.*, Oenochrom., p. 84.

Face smooth, not projecting. Tongue well developed. Palpi short, ascending, rather slender; terminal joint minute. Antennae of ♂ shortly ciliated. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Posterior tibiae of ♂ slightly dilated with internal groove and tuft. Tarsi spinulose. Forewings with 2 from two-thirds, 3 from near angle, areole present, 7, 8, 9, 10 stalked from areole, 11 anastomosing first with 12, then with areole. Hindwings of ♂ sometimes with a tuft of hairs on vein 2 on underside; 2 from three-fourths, 3 from near angle, 5 from about middle, 6 and 7 separate, 7 arising shortly before upper angle, 12 approximated to cell near base, thence diverging.

Type, *N. perdensata* Wlk., from India. A genus of about ten species ranging from India to New Guinea. It is allied to *Physctostege* and *Encryphia*.

198. NOREIA VINACEA.

Prout, *Novit. Zool.*, 1899, 13.—*Idiodes loxosticha* Turn., *Trans. Roy. Soc. S. Aust.*, 1906, 135.

♂, ♀. 44 mm. Head whitish-grey; face fuscous-brown. Palpi short, not reaching middle of face; fuscous-brown. Antennae grey, towards base ochreous-tinged. Thorax and abdomen grey, purplish-tinged. Legs ochreous-grey. Forewings triangular, costa straight to two-thirds, thence arched, apex acute, very slightly produced, termen straight, slightly oblique; grey, purplish-tinged; costal edge pale-ochreous; antemedian line from one-fifth costa to one-third dorsum, slender, straight, fuscous-brown; a subcostal, dark-fuscous, discal dot before middle; a well-marked, straight, fuscous-brown line from apex to two-thirds dorsum, sometimes connected by a fine line with three-fourths costa; cilia concolorous. Hindwings with termen moderately rounded; in ♂ with a small tuft of pale hairs on vein 2 at about one-fourth on underside; as forewings, but without antemedian line, discal dot at about one-third, minute or obsolete; postmedian at about middle, transverse.

Mr. L. B. Prout informs me that there is a long series from Queensland in Coll. Rothschild, and that he considers my name to be a synonym of *N. vinacea*.

North Queensland: Kuranda near Cairns in April and May; two specimens received from Mr. F. P. Dodd. Also from New Guinea.

Genus 42. ENCRYPHIA.

Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 228.

Face smooth, without tuft. Palpi moderately long, porrect; second joint thickened with appressed hairs; terminal joint short, obtuse. Antennae of ♂ bipectinate, pectinations slender, moderately long, not extending to apex, each accompanied by a long bristle (about twice its length), which arises proximally from its base. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Posterior tibiae of ♂ dilated with internal groove and tuft. Tarsi spinulose. Forewings with 11 from cell anastomosing first with 12 and then with 10, 10 stalked with 7, 8, 9, anastomosing again with 9 beyond 7, from areole so formed 8, 9, 10 arise by a common stalk. Hindwings with 6 and 7 separate, 7 arising before angle, 12 connected by a short bar with cell near base, thence gradually diverging.

Only the following species is known. The double areole has been modified by the staking of vein 10 and the long anastomosis with vein 12, but is essentially the same structure as that of *Nearcha* and *Taxeotis*. The antennal structure is peculiar. The connection in the hindwings of 12 with the cell represents vein 11, which has been lost in most of the genera.

199. ENCRYPHIA FRONTISIGNATA.

Tacparia ? *frontisignata* Wlk., *Cat. Brit. Mus.*, xxvi, 1523.—*Tephрина punctilineata* Wlk., *ibid.*, xxxv, 1661.—*Nearcha paraptila* Meyr., *Proc. Linn. Soc. N.S.W.*, 1889, 1156.—*Encryphia argillina* Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 228.

♂, ♀. 30-38 mm. Head grey, sometimes reddish or ochreous-tinged; face purple-fuscous. Palpi 2½ to 2½; ochreous-fuscous. Antennae grey; pectinations in ♂ 1½. Thorax and abdomen grey, sometimes reddish or ochreous-tinged, sometimes with sparse dark-fuscous irroration; abdomen in ♂ with two pairs of dense fuscous lateral tufts. Legs grey, sometimes reddish or ochreous-tinged. Forewings triangular, costa nearly straight, arched before apex, apex pointed, termen slightly rounded, slightly oblique; grey, sometimes reddish or ochreous-tinged, with more or less fuscous irroration or strigulation, sometimes confined to costal area; costal edge reddish-ochreous; first line from one-fourth costa to one-fourth dorsum, in ♂ reduced to three or more dark fuscous dots partly surrounded by ferruginous-fuscous scales, rarely obsolete, in ♀ continuous, reddish-ochreous sometimes mixed with fuscous, rarely obsolete; a median subcostal, dark-fuscous, discal mark or dot, sometimes faint or obsolete; postmedian line from three-fourths costa to before two-thirds dorsum, strongly outwardly curved in ♂ with subcostal and median rounded projections, in ♀ only slightly curved, in ♂ formed of dark fuscous dots usually connected by a ferruginous-fuscous line, in ♀ slender and like first line, but sometimes broadly suffused with fuscous; sometimes a subterminal series of fuscous dots; cilia concolorous. Hindwings with termen rounded; as forewings, but without first line and discal dot.

North Queensland: Townsville. Queensland: Bundaberg, Eidsvold, Gayndah, Brisbane, Rosewood, Toowoomba, Dalby.

Genus 43. DERAMBILA.

Wlk., *Cat. Brit. Mus.*, xxvi, 1630; Prout, *Gen. Insect.*, *Oenochrom.*, p. 72.

Face smooth, not projecting. Tongue present. Palpi moderate, slender, smooth-scaled, porrect or ascending; second joint with an apical whorl of short hairs; terminal joint minute. Antennae of ♂ ciliated. Thorax and abdomen slender; the former smooth beneath. Legs long and slender. Femora smooth. Posterior tibiae without middle spurs; in ♂ more or less dilated; terminal spurs in ♂ sometimes minute or absent. Tarsi not spinulose. Forewings with 2 from middle of cell, 3 and 4 widely separate, 5 from middle, 6 from upper angle, 7, 8, 9 stalked from before angle, 10 absent (coincident with 9), 11 connate with 7, 8, 9, immediately running into 12. Hindwings with 2 from middle, 3 and 4 widely separate, 5 from middle, 6 and 7 connate or stalked, 12 approximated to cell opposite origin of 11, which runs into it, thence diverging.

Type, *D. punctisignata* Wlk., from Africa. The genus is of moderate size, characteristic of the African and Indo-Malayan regions, extending to the coast of North Queensland and North Australia.

Key to Species.

- | | |
|---|------------------------|
| 1. Hindwings with 6 and 7 long-stalked | 2. |
| Hindwings with 6 and 7 connate or short-stalked | <i>permensata.</i> 203 |
| 2. Palpi 2 | 3 |
| Palpi 1½ | <i>liosceles.</i> 202 |
| 3. Forewings with submarginal line and several dots in median area | <i>idiosceles.</i> 201 |
| Forewings without submarginal line and with only one dot in median area | <i>catherina.</i> 200 |

As the species are very similar, I give a key based on the ♂ secondary characters.

- | | |
|--|------------------------|
| 1. Antennae biciliate in tufts, ciliations long | 2 |
| Antennae evenly ciliated, ciliations moderate or short | 3 |
| 2. Posterior tibiae grooved externally and without terminal tuft | <i>catherina.</i> 200 |
| Posterior tibiae not grooved but with terminal tuft | <i>idiosceles.</i> 201 |
| 3. Posterior tibiae wholly smooth | <i>liosceles.</i> 202 |
| Posterior tibiae densely hairy on internal surface | <i>permensata.</i> 203 |

200. DERAMBILA CATHERINA.

Zanclopteryx permensata Meyr., PROC. LINN. SOC. N.S.W., 1892, 674, nec Wlk.—
Derambila catherina Prout, *Gen. Insect.*, Oenochrom., p. 74.

♂, ♀. 20-23 mm. Head and thorax white. Palpi 2; white; second joint with an apical, terminal with a subapical, fuscous ring. Antennae whitish-grey; in ♂ biciliate in tufts, ciliations 3. Abdomen white; dark-fuscous dorsal dots on third and fourth, and sometimes also on second, segments; underside grey. Legs pale-grey; femora and posterior pair white; posterior tibiae of ♂ thickened and deeply grooved on their external surface, terminal spurs short, tarsi longer than tibiae. Forewings triangular, costa straight, apex acute, termen very slightly rounded; white with pale-fuscous dots; costal edge sometimes strigulated with fuscous; a subcostal dot at three-fifths, a subdorsal dot at one-third, and a dot on median slightly beyond them; a slightly darker median discal dot; a line of fine dots from five-sixths costa, at first parallel to termen, bent inwards below middle, and ending on two-thirds dorsum; a darker series of interneural terminal dots; cilia white. Hindwings with termen rounded; 6 and 7 stalked; white with fuscous dots; a median discal dot; a line of fine dots from three-fourths costa to three-fourths dorsum, strongly outwardly curved; terminal dots and cilia as forewings.

This is a common species in North Queensland, but has not yet been recorded south of Townsville. The ♂ may be easily recognized by the structure of the posterior legs.

North Australia: Darwin. North Queensland: Cape York, Dunk Is., Palm Is., Townsville, Charters Towers.

201. DERAMBILA IDIOSCELES, n. sp.

ἰδιοσκελής, with peculiar legs.

♂, ♀. 20-24 mm. Head and thorax white. Palpi 2; white; second joint with an apical, terminal with a subapical, fuscous ring. Antennae grey, towards base whitish; in ♂ biciliate in tufts; ciliations 3. Abdomen white; a blackish transverse bar on third segment, sometimes also a blackish dot on second segment; underside grey. Legs white; anterior pair fuscous; posterior tibiae of ♂ somewhat

enlarged, smooth, terminal spurs minute; a dorsal terminal tuft of scales, tarsi two-thirds, first tarsal joint shorter than second. Forewings triangular, costa straight to near apex, apex acute, termen slightly sinuate; white with pale-fuscous markings; a few pale-fuscous strigulae on costa towards base; a line from one-fourth costa to one-fourth dorsum, outwardly oblique from both margins, interrupted and widely open in middle; a blackish median discal dot; a dot between this and mid-costa, and two dots in a line between this and mid-dorsum; a nearly straight line of dots from five-sixths costa to three-fourths dorsum, interrupted beneath middle; two or three subterminal dots; an interrupted pale-fuscous submarginal line; a terminal series of black interneural dots; cilia white. Hindwings with termen rounded; 6 and 7 stalked; white with pale-fuscous markings; a sinuate, median, transverse line of dots; several dots in disc following this; an interrupted subterminal line, strongly outwardly curved in middle; submarginal line, terminal dots, and cilia as forewings.

The terminal tuft and minute spurs of the ♂ posterior tibiae, together with the first joint of ♂ posterior tarşi being shorter than first joint, are peculiar characters. The markings are more numerous than in *catherina* and differently arranged.

North Australia: Melville Is. North Queensland: Cape York. Five specimens.

202. *DERAMBILA LIOSCELES*, n. sp.

λειοσχελης, smooth-legged.

♂. 28 mm. Head and thorax white; centre of face more or less grey. Palpi $1\frac{1}{4}$; white; apex of second joint grey. Antennae whitish-grey; terminal joints expanded at apices; evenly and shortly ciliated ($\frac{1}{2}$) in ♂. Abdomen white; sometimes a transverse, blackish, dorsal bar on third segment; underside grey. Legs whitish; anterior pair grey; posterior tibiae of ♂ somewhat enlarged, smooth, without spurs; posterior tarsi of ♂ about three-fourths. Forewings triangular, costa straight to two-thirds, thence arched, apex acute, termen slightly sinuate; white with pale-fuscous markings; a dot on dorsum at one-fourth and another on median beyond this; a median discal dot; a slightly sinuate line of dots from five-sixths costa to dorsum slightly beyond middle; a submarginal line, not always distinct; a terminal series of blackish interneural dots, sometimes narrowly connected; cilia white. Hindwings with termen rounded; 6 and 7 short-stalked; white with pale-fuscous markings; a median discal mark; a subterminal series of fine dots from five-sixths costa, at first rounded, thence strongly sinuate and bent to end on dorsum at three-fifths; submarginal line, terminal dots, and cilia as forewings.

North Queensland: Kuranda near Cairns in November and May; two specimens received from Mr. F. P. Dodd. Also from Timor.

203. *DERAMBILA PERMENSATA*.

Zanclopteryx permensata Wlk., *Cat. Brit. Mus.*, xxvi, 1619.—*Zanclopteryx guttilinea* Wlk., *ibid.*, xxxvi, 1635.

♂, ♀. 30-32 mm. Head white, anterior margin grey; face, except margins, grey. Palpi $1\frac{1}{4}$, ascending, terminal joint porrect; white; terminal joint and apex of second joint fuscous. Antennae whitish-grey; in ♂ evenly and moderately ciliated ($1\frac{1}{2}$). Thorax white. Abdomen white; underside grey; in ♂ with a

median pale ochreous tuft of hairs. Legs white; anterior pair grey; posterior tibiae of ♂ much dilated, densely clothed with long hairs on inner surface, terminal spurs absent; tarsi $\frac{1}{2}$. Forewings triangular, costa straight to three-fourths, thence arched, apex acute, termen slightly sinuate; white with fuscous dots; a sub-basal dot at one-fourth, and a dot on median beyond this; a discal dot rather beyond middle, sometimes larger and blackish; a series of fine dots on veins from five-sixths costa, at first parallel to termen, then bent inwards, and continued to dorsum slightly beyond middle; a terminal series of interneural blackish dots; cilia white. Hindwings with termen gently rounded, tornus prominent; 6 and 7 connate or separate; white with fuscous dots; a median discal dot, sometimes blackish; a subterminal series of fine dots, strongly outwardly curved in middle, from five-sixths costa to three-fifths dorsum; terminal dots and cilia as forewings.

North Australia: Darwin. North Queensland: Cape York. Also from Tenimber Is., Timor and Java.

Genus 44. OZOLA.

Wlk., *Cat. Brit. Mus.*, xxiv, 1080; Prout, *Gen. Insect.*, Oenochrom., p. 93.

Face smooth. Palpi moderate, porrect, rather slender; second joint rough-scaled above towards apex; terminal joint short, truncate. Antennae about three-fourths; in ♂ ciliated. Thorax slender; not hairy beneath. Femora smooth. Posterior tibiae with a single median and two terminal spurs in both sexes; in ♂ more or less dilated, with internal groove and tuft. Tarsi not spinulose. Forewings with 10 absent (coincident with 9), 7, 8, 9 stalked from well before upper angle of cell, 11 arising from near 7, 8, 9, anastomosing strongly with 12, then with 10. Hindwings with 3 and 4 separate, 5 from middle of cell, 6 and 7 separate, 11 from near base, running into 12, 12 widely separated from cell.

Type, *O. microniaria* Wlk., from India. A moderately large genus ranging from India throughout the Archipelago, with one species in Africa. Many of the species have narrow forewings falcate at the apex.

1. Hindwings with termen strongly angled on vein 6 *basisparsata*. 204
 Hindwings with termen rounded *exigua*. 205

204. OZOLA BASISPARSATA.

Carima basisparsata Wlk., *Cat. Brit. Mus.*, xxvi, 1631.

♂, ♀. 34-36 mm. Head brown-whitish. Palpi $1\frac{1}{4}$; fuscous; bases of first and second joints whitish. Antennae brown-whitish; ciliations in ♂ $1\frac{1}{2}$. Thorax and abdomen brown-whitish with a few fuscous scales. Legs whitish with slight fuscous irroration; posterior tibiae of ♂ dilated, with internal groove and tuft. Forewings narrow-triangular, elongate, costa nearly straight, but strongly arched before apex, apex acute, slightly produced, termen strongly angled on vein 4, slightly concave above and below angle, very oblique; brown-whitish variably suffused with brownish and with very sparse fuscous irroration; sometimes a curved, broadly suffused, antemedian line; postmedian line very slender, pale-grey, from three-fifths costa, outwardly curved beneath costa, thence straight to four-fifths dorsum, sometimes obscured by brownish suffusion; a subterminal line of confluent fuscous dots from costa to vein 5, or continued further, some-

times the area between this and postmedian line is darkly suffused; cilia fuscous-brown, apices brown-whitish, between veins 3 and 4 wholly whitish. Hindwings subquadrate, termen sharply angled on vein 6; as forewings, with the addition of a dark-fuscous discal dot before middle. Underside whitish irrorated with brown; markings as on upper side but more distinct; a discal dot on forewing.

North Queensland: Cairns, Townsville. Also from Borneo and Malay Peninsula.

205. *OZOLA EXIGUA*.

Swin., *Trans. Ent. Soc. Lond.*, 1902, 645.

♂, ♀. 24-32 mm. Head ochreous-whitish; face with a transverse brownish bar. Palpi $1\frac{1}{4}$; fuscous-brown, towards base ochreous-whitish. Antennae ochreous-grey-whitish; ciliations in ♂ $1\frac{1}{2}$. Thorax and abdomen ochreous-whitish, sometimes with a few fuscous scales. Legs ochreous-whitish partly suffused and irrorated with brown; posterior tibiae of ♂ dilated with internal groove and tuft. Forewings narrow-triangular, elongate, costa straight almost to apex, apex acute, slightly produced, termen sinuate, oblique; ochreous-whitish irrorated, and costa strigulated with fuscous-brown; a distinct fuscous-brown, outwardly-curved antemedian line from one-fourth costa to one-fourth dorsum; a median subcostal discal dot; a similar postmedian line from two-thirds costa to three-fourths dorsum, sinuate, sometimes wavy; a small irregular fuscous blotch on termen beneath apex, connected by a distinct line with costa before apex; a lesser terminal blotch above tornus; in ♀ most of the area beyond the postmedian line is darkly suffused; cilia fuscous, between terminal blotches whitish. Hindwings with termen rounded; as forewings, but without tornal blotch, antemedian and postmedian lines meeting on costa. Underside similar.

North Australia: Darwin. North Queensland: Palm Islands. Also from New Guinea.

Species unknown or wrongly referred to this family.

As already mentioned I refer the genus *Diceratucha* Swin., to the Notodontidae and the genera *Dirce* Prout (*Oenone* Meyr., praeocc.) and *Xenomusa* Meyr., to the Boarmiadae.

206. *Aspilates* (Meyr., nec Treit.) *chordota* Meyr., *Proc. Linn. Soc. N.S.W.*, 1899, 1196, belongs to the Boarmiadae. I have examined the type.
207. *Hypographa reftua* Luc., *Proc. Roy. Soc. Qld.*, 1898, 70.
208. *Onychodes fulgurans* Luc., *ibid.*, 70 (misprinted *fulguraus*).
209. *Arhodia orthotoma* Low., *Trans. Roy. Soc. S. Aust.*, 1894, 83, is a synonym of *Orsonota clelia* Cram. (Boarmiadae).
210. *Arhodia porphyropa* Low., *Trans. Roy. Soc. S. Aust.*, 1898, 42, belongs to the Geometridae.
211. *Monoctenia niphosema* Low., *Trans. Roy. Soc. S. Aust.*, 1908, 114, belongs to Noctuidae.
212. *Dichromodes* ? *triglypta* Low., *ibid.*, 114, belongs to the genus *Sterrha*.
213. *Epidesmia unilinea* Swin., *Trans. Ent. Soc. Lond.*, 1902, is a synonym of *Heteralex aspersa* Warr. The type is from China, not Tasmania.

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OBSERVATIONS ON THE DIPTEROUS FAMILY TANYDERIDAE.

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(Communicated by I. M. Mackerras.)

(Plates v-vi; One Text-figure.)

[Read 21st May, 1930.]

In the present paper, I wish to discuss two distinct subjects, first, to give a preliminary description of the immature stages of the family Tanyderidae, and second, to describe a new species of *Radinoderus* from the Dorrigo Plateau of New South Wales.

The recent discovery of the immature stages of the Tanyderidae is a matter of very great interest to students of the Order, since this was the sole remaining family of lower Orthorrhapha whose larva had baffled discovery to the present time. It seems entirely fitting that the first discussion of the early stages of this archaic family should be published in Australia, despite the fact that the species in question is a North American one, *Protoplasa fitchii* (Osten-Sacken). Australasia is the great centre of distribution of the family, more than one-half of the species so far discovered being from this region (Alexander, 1928*b*). Now that the larval habitat is known and we have an idea of the general appearance of the larva, it seems certain that the early stages of some one of the larger and more showy Australian or New Zealand species will be discovered.

The scantiness of larval, and especially of pupal, material has rendered it inadvisable to consider details of structure at this time. The majority of the larvae in my possession, together with the pupae, will be given to Professor J. Speed Rogers of the University of Florida, Gainesville, for more detailed consideration and dissection, especially of the head-capsule which has been but superficially treated in the present account. One additional larva has been deposited in each of the collections of the British Museum and United States National Museum.

THE IMMATURE STAGES OF THE TANYDERIDAE.

Protoplasa fitchii was long considered to be one of the rarest of North American Diptera (Alexander, 1919, 1920). In 1928, Dr. G. C. Crampton (Crampton, 1929), while collecting in the Gaspé Peninsula of Eastern Quebec, Canada, encountered a large swarm of flies and was amazed to find that they pertained to the present very uncommon species. In his opinion, there were thousands of individuals about and nearly two hundred specimens were secured by passing the net through the swarm a few times.

It was due to the influence of the above discovery that Dr. Crampton and I, in June, 1929, undertook a 2,000-mile motor trip to the Gaspé country and, after a detailed search, finally discovered the early stages of the fly. The entire credit for the finding of the larva and rearing through to the adult condition of *Protoplasa*

is due to Dr. Crampton, in the first place to his initial discovery of the species in numbers and later to his kind interest in returning to the place the succeeding year.

In 1920, a most remarkable dipterous larva was described (Alexander, 1920) that was referred with but little question to *Protoplasa*. All the characters of this larva seemed to fit in so well with our presumed knowledge of the genus, that it came as a distinct shock to find that the true larva of *Protoplasa* was an entirely different creature. Paradoxical as it may sound, the erroneous larva referred here in 1920 still seems closer to what might be expected of the larvae of the Tanyderidae, based on a knowledge of the related families Psychodidae and Ptychopteridae, than does the weird creature that is now settled beyond question. The 1920 larva still remains unknown and much discussion has now arisen as to its correct position in the Diptera. One naturally turns to the Anisopodid subfamily, Axymyiinae, the type of which, *Axymyia furcata* McAtee, was described from this identical region, but Mr. Edwards and I both hesitate to place the larva in question in this section of the Orthorrhapha. Mr. Edwards is inclined to believe that it will be found to belong to the Bruchomyiine Psychodidae (Alexander, 1928a), such as *Nemopalpus*, although the members of the group have not yet been discovered nearer than Peru. I myself cannot but feel the possibility that there still exists at Washington a Psychodoid Dipteron different from any yet discovered.

The Washington larva above discussed was found in saturated logs on the banks of the Potomac River, indicating an aquatic or amphibious life. This supposition was substantiated by the associated insects occurring in the same log (Alexander, 1920). When Dr. Crampton and I finally arrived at the River Pabos, Gaspé, on the afternoon of 19th June, 1929, we at once began a critical survey of all saturated logs, stranded and imbedded in the earth at the stream margin, in a search for the particular type of larva we had in mind. After a long search that produced numerous insects and other animals, but nothing that could possibly be considered as being *Protoplasa*, we turned our attention to the water and, after a time, discovered the larva that finally proved to belong to this fly. After some hours of back-breaking sifting of sandy gravel at the water's margin, amid swarms of black flies, *Simulium*, and punkies, *Culicoides*, we finally secured a total of nine larvae, two of which were placed in rearing and eventually yielded one pupa and an emerged adult female, together with her cast pupal skin. The total duration of the pupal stage is not more than 9 days and presumably from two to three days less than this.

The west branch of the River Pabos, three miles west of Chandler, is a shallow, pebbly to stony bottomed stream where the tides from the Bay of Chaleurs are slightly felt, although the water of the stream at this point is strictly fresh. The river here is about 120 feet wide, without evident rapids or riffles, crossed by an ancient wooden bridge (not iron, as stated by Crampton, 1929) with wooden railings. An island in the river supports the central pier of the bridge. A scanty woody vegetation lines the banks of the stream, this being chiefly alder, balsam poplar and spruce. On the eastern bank, the trees are somewhat taller and more dense, including white birch, spruce and balsam fir. The larvae were found on the west bank a few yards north of the bridge. They occurred in the sand under shallow water but, like the associated *Eriocera*, they undoubtedly migrate to drier soil when ready to pupate.

Associated with the larvae of *Protoplasa* were larvae of a large species of the crane-fly genus *Eriocera*; larvae and abundant pupae of a new species of *Eriocera*, *E. gaspensis* Alexander; and a few larvae of a Tipuline crane-fly.

On 21st June, when a short distance east of Matapedia, Gaspé, 140 miles west of Chandler, Dr. Crampton and I again encountered great swarms of adult *Protoplasa* flying at dusk near a small stream and secured some two hundred additional specimens. At this time, the swarms were in close proximity to large swarms of a Tipulid, *Eriocera longicornis* (Walker).

Description of the Stages.

Larva.—Body eucephalous, terete; lateral spiracles on prothorax and abdominal segment eight; no creeping welts on body; caudal end of abdomen with six long filaments, of which one pair are borne near the caudal ends of two elongate anal pseudopods, the latter terminating in a circlet of short outer crotchets and a central group of long slender crotchets; four simple anal gills.

Pupa.—Appearance very much like a Hexatomine Tipulid; head surmounted by a high bispinous crest; pronotal breathing horns relatively small, smooth, equal in size; leg-sheaths lying side by side, the fore pair shortest, the hind pair longest; venation showing clearly on wing-pads; abdominal segments with a tuberculate armature, chiefly near the posterior margins of the segments.

LARVA.—Length to end of longest filaments, 17–18 mm. Filaments alone, 4.5–5 mm. Greatest diameter of body, 1.5 mm. General coloration dirty white, the head-capsule and spiracles blackened.

Body (Plate v, fig. 1) eucephalous; segments terete or nearly so, those of the thoracic segments a little more dilated than those of the abdomen.

Head (Plate v, figs. 2 and 3) a compact, heavily chitinized capsule. Clypeus transverse, the margin with four lobes, the lateral pair each with two pale setae arising from the lower surface; intermediate lobes each with a single seta. Antennae distinct, three-segmented; basal segment widest; second segment longest, cylindrical; terminal segment reduced in size. What appear to be epipharyngeal structures appear as two large pale lobes densely cushioned with yellow setae. Both labial and maxillary palpi reduced in size.

Prothorax longer than the remaining thoracic segments, divided by a constriction into two rings; on posterior ring at mid-height of body with a small spiracle; mesothorax a little longer and thicker than the metathorax, on dorsal surface divided into two rings by a weak constriction that becomes obsolete on the sides, the ventral margin entire. Nine apparent abdominal segments that gradually increase in length and decrease in diameter from the first to the last; abdominal segments with a narrow basal constriction or ring and a much longer posterior portion that is weakly subdivided into annuli.

Penultimate or eighth abdominal segment (Plate v, fig. 4) with a small spiracle on side shortly before caudal margin; immediately caudad of the spiracle arises a long pale filament that is slightly longer than any of those on the terminal segment. Ninth abdominal segment with the ventral lateral angles produced into long slender anal pseudopods (Plate v, fig. 5), each terminating in two sets of crotchet-like structures, including a marginal series of short curved hooks and a central group of about eighteen long slender rods that are slightly curved at their tips. Just before apex of pseudopod on dorsal face arises a long slender filament. Each dorsal lateral portion of the ninth segment with a long filament

that is a little stouter at base but somewhat shorter than the filaments of the penultimate segment. From the disk between these six elongate filaments arise four short simple anal gills.

Chaetotaxy: Prothorax with a group of about five small setae on lateral aspect of basal ring, with an additional seta on posterior ring some distance before the spiracle. A further group of small setae on ventral surface. On the mesothorax and metathorax, a group of three setae, two large and one smaller intermediate one placed in an oblique straight line on anterior ring; on ventral surface, setae about as on prothorax and still small, placed on slightly tumid swellings that cannot be considered as being creeping welts. Very small and weak setae on dorsal aspect of posterior ring of all thoracic segments, these gradually increasing in size on outer segments. On the abdominal segments the arrangement of setae is about the same, the dorsal series remaining small and inconspicuous, lacking on segment eight; the lateral series are arranged, one on basal ring, two on posterior ring; ventral setae of posterior ring becoming large and more conspicuous, arranged more or less definitely in pairs but with no indication of creeping welts.

PUPA.—Male, length, 8.5–9 mm. Greatest width, dextro-sinistral, about 1.5–1.6 mm. Greatest depth, dorso-ventral, 1.6–1.8 mm. General appearance of pupa about as figured (Plate vi, fig. 1), the abdomen of this specimen more or less shrunken.

Head (Plate vi, figs. 3 and 4) surmounted by a high, bispinous crest, the two terminal points directed cephalad and strongly ventrad; dorsal surface of these horns with a basal spinous protuberance, together with a long appressed seta lying further distad. Dorsal region of head behind the cephalic horns with four conspicuous tubercles that bear long setae. Sheath of labrum at base with a large median spine directed ventrad and two slightly smaller lateral spines directed ventrad and caudad (Plate vi, figs. 1 and 3). Sheaths of maxillary palpi very stout, five-segmented, directed laterad and thence cephalad. Labial sheath very large, bilobed. Ventral aspect of head between the antennal sheaths and the labrum and overlying the eyes of the developing adult within a transverse row of four tubercles that bear long delicate setae.

Pronotum (Plate vi, figs. 1 and 4) extensive, finely transversely wrinkled. Pronotal breathing-horns (Plate vi, fig. 2) each appearing as a relatively small, smooth structure, slightly sinuous, gradually narrowed to a terminal point, both horns of equal size and quite symmetrical. Mesonotum nearly smooth, gibbous, with a more or less distinct median depression, best defined at anterior end; a weak callosity above wing-root provided with two small setae. All leg-pads lying side-by-side, the fore (inner) pair shortest, ending shortly before the penultimate segment of the middle legs, which, in turn, end about opposite the termination of the third segment of the hind (outer) pair of legs. Wing-pads showing the essential features of venation of the family, Sc simple; R five-branched, M four-branched; Cu simple; a single anal vein, with a second curved into the axilla. Metanotum narrow, smooth, with a large seta on either side; sheath of halteres chiefly concealed beneath the wing-pad.

Abdominal tergites just before caudal margins with a transverse row of tubercles of various sizes and shapes, these terminating in long to short setae; the rows number between twenty-five and thirty such tubercles on tergites three and four, being somewhat reduced in number on the more basal segments, rapidly decreasing in number on the outer segments, there being only about six on

the seventh tergite, but these all large and powerful. Each cephalic lateral angle of the tergite with two additional tubercles, these more approximated on the basal segments, becoming slightly more separated on the outer segments. Pleurites with a single powerful setiferous tubercle on basal portion, together with a transverse group on posterior ring, consisting of two tubercles with a smaller tripartite or quadripartite tubercle between, the lateral tubercles becoming larger and more powerful on the outer segments. Sternites with a transverse swelling on either side near caudal margin, each bearing a tiny lateral seta and a powerful inner tubercle bearing a long seta (Plate vi, fig. 5); a transverse row of very tiny setae on basal portion of the sternites beyond the termination of the wing-pad, these becoming somewhat larger and more conspicuous on the outer segments. Eighth segment with a lateral finger-like lobe, directed caudad. Genital sheaths of both sexes about as figured (male, Plate vi, fig. 1; female, Plate vi, fig. 5).

Nepionotype (type larva).—River Pabos, Gaspé, Quebec, 19th June, 1929, in collection of Professor Rogers.

Neanotype (type pupa).—Reared from larvae from type locality, transformed at Amherst, killed 30th June, 1929.

Paratype larvae and one pupal skin.

Affinities.

The larva of *Protoplasa* is so distinct from that of all other families of Diptera that a comparison is scarcely needed. On the other hand, the pupa is so exceedingly like a Hexatomine Tipulid, such as *Eriocera*, that no features are available for definition of the family in this stage, other than the venation of the pupal wing-pads and the details of structure of the mouth-parts.

For many years the Tanyderidae were placed with the Ptychopteridae and the relationship admittedly exists, though probably not as close as was believed before the discovery of the early stages. It was formerly believed that the immature stages of the Tanyderidae, when discovered, would conform in their chief essentials with those of the Psychodidae and the Ptychopteridae, such as the possession of an anal breathing-tube, a character of all families of Psychodoid Diptera. The Tanyderidae depart from all these related families in a totally different arrangement of spiracles, these being placed laterally on the prothorax and eighth abdominal segment, and so deviating from the normal arrangement of spiracles in amphipneustic respiration. Similarly the body pseudopods or creeping welts, that might well be pre-supposed from the taxonomic arrangement of the groups, do not occur. The long anal pseudopods are rather like those of the Chironomidae.

I am supplying a tentative arrangement of the larvae of the Orthorrhaphous Diptera to show the position of the Tanyderidae therein:

- | | |
|--|----|
| 1. Body eucephalous; or the posterior portion of the head-capsule with deep longitudinal incisions; mandibles moving horizontally or obliquely; labium usually well-developed (larvae frequently peripneustic). (Orthorrhapha Nematocera) . . . | 2 |
| Body not eucephalous, the head being more or less retractile or lacking (Heteroneuridae); labial plate not developed; mandibles moving vertically; (larvae normally amphipneustic; very rarely metapneustic or peripneustic, i.e., some Dolichopodidae). (Orthorrhapha Brachycera; Cyclorrhapha) | 19 |
| 2. Head-capsule incomplete behind, retractile | 3 |
| Head-capsule complete, immovable, i.e., body eucephalous | 4 |

- 3. Larvae peripneustic; usually with a "breast-bone", a chitinized plate on ventral surface of second thoracic segment (mainly phytophagous, mostly gall-makers; a few in decaying wood, bulbs, fungi; a few zoophagous) CECIDOMYIIDAE (ITONIDIDAE).
 Larvae metapneustic or apneustic, i.e., *Antocha*; no "breast-bone"; never gall-makers (habits very various, mostly in wet earth or decaying wood) TIPULIDAE
- 4. Body cylindrical, with the spiracles small, lateral in position on sides of prothorax and eighth abdominal segment; six long filaments at caudal end of body, one pair borne by long anal pseudopods; (aquatic) TANYDERIDAE
 Characters not as above 5
- 5. Body depressed; abdominal segments one to seven with conspicuous lateral out-growths, at outer end of each with a ventral sucking-disk armed with concentric rows of crochets; antennae long, unequally biramous; (larvae aquatic, in mountain streams, clinging to stones by pseudopods) DEUTEROPHLEBIDAE
 Characters not as above 6
- 6. Body depressed, the head-capsule complete but permanently retracted within thorax; body constricted into six primary divisions, each with a median ventral sucking disk, with a tuft of gill-filaments on either side; (aquatic) BLEPHAROCERIDAE
 Characters not as above 7
- 7. Thoracic segments fused into a complex mass, without pseudopods; in most genera with an anal respiratory funnel; when lacking, as in Anophelinae and some Chaoborinae, the first statement holds; (aquatic) CULICIDAE
 Thoracic segments not so fused; if conspicuously dilated or extended, provided with a median prothoracic pseudopod 8
- 8. Posterior spiracles borne at apex of a breathing-tube that is at least one-half as long as body; two anal gills; (aquatic or semi-aquatic) PTYCHOPTERIDAE
 Posterior spiracles borne at apex of a very short tube or sessile; gills four in number or lacking 9
- 9. Body amphipneustic or with conspicuous anal gills 10
 Body peripneustic, metapneustic or apneustic 13
- 10. No median pseudopod on prothorax 11
 A median ventral pseudopod on prothorax 12
- 11. Body segments simple; in cases, with paired pseudopods on either abdominal segments one and two, or on the former alone; form in life U-shaped; (aquatic or semi-aquatic) DIXIDAE
 Characters not as above; body segments divided by false constrictions; (decaying vegetable matter) ANTISOPODIDAE
- 12. Thorax much distended; labial plate with only four to seven teeth, these capable of being directed caudad; antennae retractile CHIRONOMIDAE (Tanyipinae)
 Thorax not dilated; labial plate, when with distinct teeth, these exceeding seven in number and directed cephalad; antennae non-retractile CHIRONOMIDAE (Chironominae); ORPHNEPHILIDAE
- 13. Body metapneustic or apneustic 14
 Body peripneustic 16
- 14. Body very elongate, slender, tapering toward both ends, terminal segment with about eight setae; (aquatic, movements snake-like, *Palpomyia*, *Culicoides*, etc.) CHIRONOMIDAE (Ceratopogoninae)
 Larva not long and snake-like 15
- 15. Body without pseudopods; segments with transverse constrictions; some or all of the dorsal segments with narrow, chitinized transverse bands or plates; or the terminal segment produced into a very short tube; (habits various, in decaying vegetable matter or aquatic) PSYCHODIDAE
 Body stout, armed with numerous setae, some of which are flattened and lanceolate; segments without secondary constrictions or chitinized plates; (terrestrial, in dung, beneath bark, or in water-soaked logs, *Forcipomyia*, *Ceratopogon*, etc.) CHIRONOMIDAE (Ceratopogoninae)
- 16. Abdominal spiracles rudimentary but evident; body clavate, the caudal end strongly enlarged and bearing a sucking-disk with which larva adheres to habitat; mouth with fans; (aquatic) SIMULIIDAE
 Abdominal spiracles distinct; other characters not as above; (terrestrial) 17

17. Antennae elongate; body with conspicuous setae; arranged in transverse rows .. 18
 Antennae short and inconspicuous; body without conspicuous setae; (generally fungicolous, some in decaying vegetable matter) MYCETOPHLLIDAE
18. Posterior spiracles elevated on long stalk-like processes, the lateral spiracles on shorter stalks; (in dung and other decaying matter) SCATOPSIDAE
 Spiracles sessile, the posterior pair large, on dorsal surface of ninth abdominal segment; prothoracic spiracle larger than others of lateral series; (soil) BIBIONIDAE
19. Maxillae well-developed, the palpi distinct; mandibles normally sickle-shaped, not protruded far beyond the apices of the maxillae, often not extending one-half this distance; antennae well-developed, placed on a chitinized dorsal plate. (*Orthorrhapha Brachycera*) 20
 Maxillae poorly developed, the palpi visible only in a few scattered groups; mandibles short and hook-like, usually capable of protrusion far beyond the tips of the maxillae when the latter are developed; antennae poorly developed or lacking, when present placed upon a membranous surface (*Cyclorrhapha*)
20. Body elongate, elliptical, strongly flattened, with a slight dorso-medial carina, the body with only nine apparent segments, excluding the head; metathorax elongate and apparently including also the first abdominal segment; (amphipneustic; posterior spiracles distant; pupa in last larval skin; six elongate appendages on thorax and two others on last abdominal segment; earth or beneath basal leaves of rosette plants; Lundbeck considers to be *Orthorrhaphous*, de Meijere *Cyclorrhaphous*) LONCHOPTERIDAE
 Characters not as above 21
21. Posterior spiracles approximated, situated within a terminal or subterminal cleft or chamber and usually concealed; body more or less shagreened or longitudinally striated 22
 Posterior spiracles rather widely separated, situated on the apparent apical segment, or upon the penultimate or antepenultimate segment; body not shagreened or striated 23
22. Body depressed, spindle-shaped, the surface finely shagreened; head little, if any, retractile; spiracular fissure transverse; (earth, animal nests, under bark, decaying vegetable or animal matter; pupa in last larval skin) .. STRATIOMYIDAE
 Body cylindrical to pyriform, the abdominal segments with a girdle of pseudopods on each segment; body-integument usually longitudinally striated, sometimes irregularly roughened; head retractile; spiracular fissure vertical; (aquatic or semi-aquatic; pupa free) TABANIDAE
23. Posterior spiracles upon the apparent apical segment 24
 Posterior spiracles upon the penultimate or antepenultimate segment 30
24. Apical abdominal segment heavily chitinized, blackened 25
 Apical abdominal segment not heavily chitinized or blackened 26
25. Thoracic segments not chitinized dorsally; apical plate very large, the spiracles vertically elongated, the lobes surrounding the disk small, widely separated; (earth, rarely under bark) COENOMYIIDAE
 Prothorax and mesothorax chitinized dorsally; apical chitinized plate rather small, spiracles circular, the paired surrounding lobes large, fused basally, each with a number of long setae; (beneath bark) XYLOPHAGIDAE
26. Posterior spiracles not in an apical transverse cleft 27
 Posterior spiracles widely separated, situated in an apical transverse cleft; head very small, retractile; (internal parasites of Coleopterous larvae) NEMESTRINIDAE
27. Apical abdominal segment terminating in two elongate processes that are fringed with delicate elongate setae; abdomen with paired ventral pseudopods and fleshy dorsal and lateral appendages; (aquatic, *Atherix*) LEPTIDAE, in part
 Apical abdominal segment not as above, the pseudopods and other appendages lacking or approximately so 28
28. Apical abdominal segment terminating in four or five short, pointed glabrous lobes or two fleshy lips; head-skeleton with a large arched dorsal plate, the longitudinal rods being articulated upon a horizontal plane; (terrestrial, *Leptis*, *Chrysopila*, etc.) LEPTIDAE, in part
 Apical abdominal segment not as above; or the head-skeleton without an arched dorsal plate, the longitudinal rods articulated with the labial plate at right angles or nearly so, in profile appearing bent 29

29. Larva oval in outline, the smaller cephalic end marked off by a strong constriction; body integument smooth and viscid so particles of dirt adhere; abdomen with seven pairs of pad-like areas on venter of segments two to eight; spiracles not surrounded by lobes; (parasitic on spiders; the newly-hatched larva is more elongate-oval, the body with conspicuous palmate scales and with two conspicuous caudal setae) CYRTIDAE (ACROCERIDAE)
 Body slender, cylindrical; spiracular disk surrounded by small fleshy lobes; abdominal segments with a ventral transverse creeping welt; ventral lobes of spiracular disk larger than dorsal pair; (fleshy lobes lacking in *Neurigona*; body amphipneustic except in *Thrypticus* which is peripneustic; habits various, under bark, in wet earth; aquatic; burrowing in stems of palustral grasses) DOLICHOPODIDAE; EMPIDIDAE
30. Posterior spiracles placed on antepenultimate abdominal segment; six basal abdominal segments subdivided by false constrictions to appear as twelve; body very long and slender 31
 Posterior spiracles placed on the penultimate abdominal segment; abdominal segments all simple, undivided; body not excessively elongate 32
31. Posterior median plate of head-capsule spatulate at apex; (in earth and wood) THEREVIDAE
 Posterior median plate of head-capsule not dilated at apex; (usually in houses, beneath carpets) SCENOPINIDAE
32. Penultimate abdominal segment longer than the ultimate, with a transverse impression near the end to give the superficial appearance of two distinct segments; last segment terminating in a sharp ridge with a median point; (in decaying wood, predaceous on wood-boring Coleoptera) MYDAIDAE
 Penultimate abdominal segment shorter than the ultimate, or, if longer, without a transverse impression as described above; ultimate segment not as described. . . 33
33. Thoracic segments each with two long setae, one on either side on ventro-lateral margin; apical segment with from six to eight long setae; penultimate abdominal segment usually shorter than the ultimate; body in life straight; (in wood or soil, predaceous) ASILIDAE
 Thoracic segments, and apical segment of abdomen, without conspicuous setae; penultimate segment distinctly longer than the ultimate; body in life usually arcuate; (habits various, predaceous, parasitic or inquilinous) ... BOMBYLIDAE

I cannot attempt at this time to give a key to the Orthorrhaphous pupae. The pupa of the Tanyderidae may be separated from the allied groups by the following simple key:

1. One of the pronotal breathing horns enormously elongated, much longer than the body, the other horn very short and abortive PTYCHOPTERIDAE
 Breathing horns short, or, if elongated (in a few Tipulinae), not longer than the body and the disproportion in size not conspicuous 2
2. Tarsal sheaths lying side by side, parallel 3
 Tarsal sheaths overlying one another in pairs TRICHOCERIDAE
3. Wing-sheath showing radius as being five-branched TANYDERIDAE
 Wing-sheath with radius reduced, with not more than four branches reaching the margin TIPULIDAE

A NEW SPECIES OF RADINODERUS FROM THE DORRIGO PLATEAU.

The new species described herewith was included in a large and interesting series of crane-flies received from my friend, Mr. W. Heron, from the Dorrigo Plateau of New South Wales. The type specimen is preserved in my collection through the kind interest of the collector.

RADINODERUS DORRIGENSIS, n. sp.

General coloration dark-brown; antennae 20-segmented, the scape black, the flagellum yellow; femora yellow, with a very broad black ring at near mid-length; tips of femora and bases of tibiae more narrowly blackened; wings whitish

with a dark brown pattern that is arranged in the form of two X-shaped areas that are confluent at the outer ends of cells C and Sc, the more basal one extensively connected with the darkened areas around the arculus in cells R and M.

♀. Length about 25 mm.; wing 18.5 mm.

Rostrum and palpi black. Antennae 20-segmented; scape black, the flagellum yellow, the incisures of the basal segments weakly darkened, the outer segments clearer yellow, the terminal two segments more dusky; first flagellar segment about one-third longer than the second; succeeding segments of nearly equal length, cylindrical, the last segment shorter. Head and cervical sclerites black or brownish-black, discoloured.

Anterior mesonotum light-brown, the disk almost covered by black stripes, the median stripe especially wide; scutellum obscure yellow, margined with dark-brown and including a median line of the same colour; postnotum dark. Pleura dark-brown; variegated with obscure brownish-yellow on the sternopleurite and cephalic portion of the pteropleurite. Halteres dusky at base, the outer half of the stem light-yellow, the knobs dark-brown. Legs with the coxae and trochanters dark; femora yellow, all with a very broad black ring at near mid-length, this including approximately two-fifths of the extent of the segment; tips of femora broadly blackened; tibiae yellow, the bases broadly blackened, the amount a little greater than the femoral tips; remainder of legs pale yellow. Wings (Text-fig. 1) whitish with a heavy dark-brown pattern, this appearing as



Text-fig. 1.—Wing of *Radinoderus dorrigenis*.
n. sp.; holotype ♀.

two X-shaped areas that are joined in the outer end of cells C and Sc; the basal area is further connected with an extensive marking in the prearcular and arcular regions by rays in the radial and medial fields; veins yellow, dark-brown in the patterned areas. Venation: As compared with *terrae-reginae*, the following differences are most evident—R longer; Rs more arcuated at origin; R, less upturned at tip; R₂₊₃ shorter; cell M₄ narrower at margin; cell 2nd A narrower.

Abdomen dark-brown, both sternites and tergites variegated laterally near base with conspicuous yellow areas; genital segment black.

Hab.—New South Wales

Holotype ♀, Brooklana, Eastern Dorrigo, altitude about 2,000 feet, 10th February, 1929 (W. Heron).

Radinoderus dorrigenis is closest to *R. terrae-reginae* (Alexander), differing in the number of antennal segments (20 instead of 24), the conspicuous black medial rings on all femora, and details of the wing-pattern and venation.

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EXPLANATION OF PLATES V-VI.

Plate v.

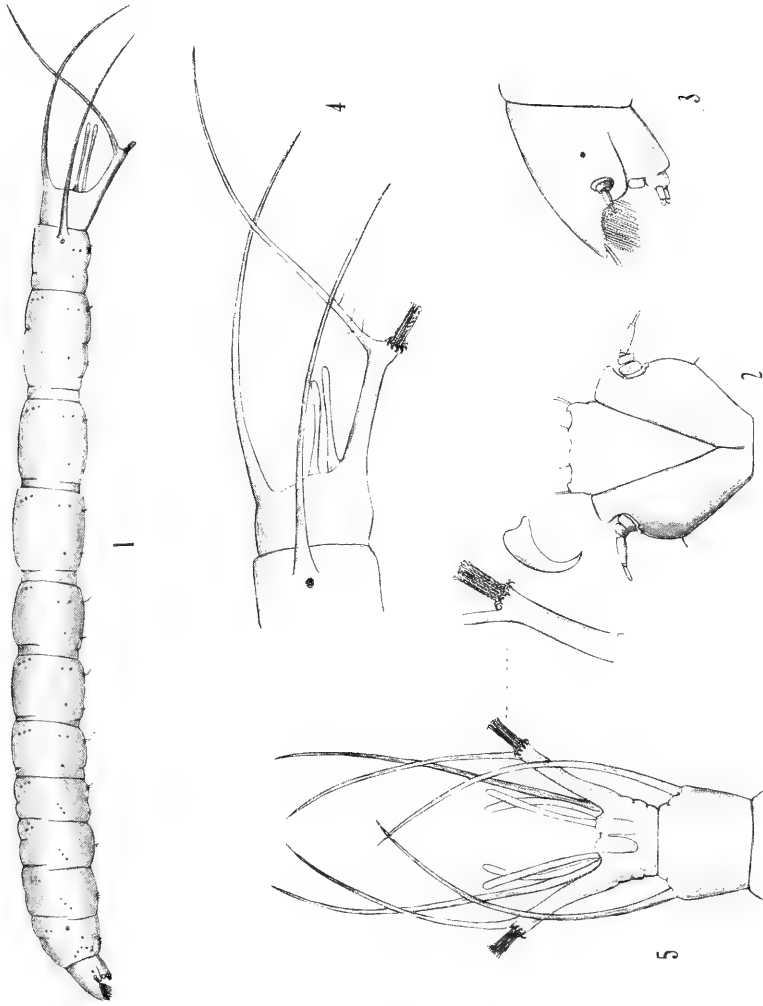
Larva of *Protoplasa fitchii*.

- 1.—Entire larva, lateral aspect.
- 2.—Head-capsule, diagrammatic, dorsal aspect.
- 3.—Head-capsule, diagrammatic, lateral aspect.
- 4.—Caudal end, lateral aspect.
- 5.—Caudal end, ventral aspect, with further enlargements of anal pseudopod and crotchets.

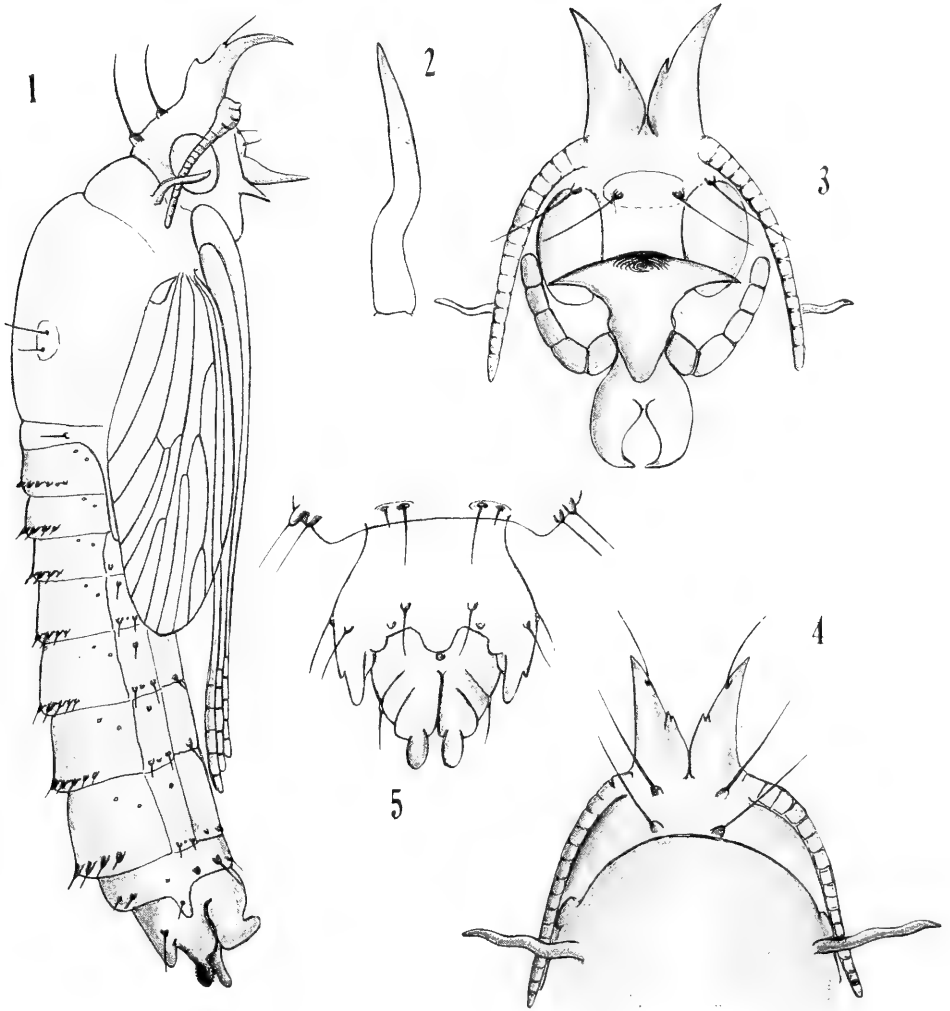
Plate vi.

Pupa of *Protoplasa fitchii*.

- 1.—Entire pupa, male, lateral aspect.
 - 2.—Pronotal breathing horn.
 - 3.—Head, male, ventral aspect.
 - 4.—Head, male, dorsal aspect.
 - 5.—Genital sheaths, female, ventral aspect.
-



Larva of *Protoplasa filchii*.



Pupa of *Protoplasia fitchii*.

THE GENUS *MICROMONOSPORA* ØRSKOV, A LITTLE KNOWN
GROUP OF SOIL MICROORGANISMS.

By H. L. JENSEN.

Macleay Bacteriologist to the Society.

(Plate vii.)

[Read 21st May, 1930.]

The large and somewhat heterogeneous group of microorganisms known as Actinomycetes or ray fungi has presented many troublesome problems to systematic microbiology: firstly, because of the marked variability exhibited by organisms of this group, which renders their separation from other microorganisms rather vague; secondly, because of their quite uncertain phylogenetic position (it is still a matter of dispute whether they should be classed with the Bacteria or with the Eumycetes); thirdly, and not least, because the study of these organisms has been rather one-sided, mostly limited to pathogenous forms and to certain groups of soil forms. The only work, in which they have been studied from a broader biological point of view, is so far the excellent monograph of Lieske (1921). The only rational attempt to classify the group of actinomycetes on a basis of definite morphological characters is represented by the work of Ørskov (1923), who worked mostly with pathogenous species, among which were a fair number of old "laboratory strains". Ørskov suggested the following division of the group of the microorganisms previously known as the genus *Actinomyces*:

i. *Cohnistreptothrix*: The vegetative mycelium consists of branched, unicellular hyphae; from this there arises an aerial mycelium of hyphae that are thicker than those of the vegetative mycelium. The aerial hyphae undergo a process of constriction which gives rise to a formation of chains of regular-sized spores; these are somewhat more thermo-resistant than the vegetative hyphae.

ii. *Actinomyces*: The vegetative mycelium consists of more or less branched hyphae, which may or may not form an aerial mycelium, consisting of hyphae of the same thickness as those of the vegetative mycelium. Both vegetative and aerial hyphae divide by the formation of transverse walls into fragments of irregular size and shape. There is no difference in the thermo-resistance of vegetative and aerial mycelium. Some species of this genus seem to form a transition to the genera *Corynebacterium* and *Mycobacterium*.

iii. *Micromonospora*: A branched, unicellular mycelium is formed, consisting of very delicate hyphae with short lateral branches, each of which bears a single terminal spore. The spores are small, oval and highly refractive. This genus was represented by only a single strain, of which a culture had been obtained from Kral's Mikrobiologische Sammlung, Prague, under the name of *Streptothrix Chalceae*.

Ørskov did not find this organism mentioned anywhere in the literature accessible to him. An organism of this name has, however, been examined by

Musgrave, Clegg and Polk (1908) in their studies on pathogenous actinomycetes. They state that *Streptothrix chalcea* is a non-pathogenous, saprophytic organism, of which a culture has been received by them from Professor A. G. Foulerton, London, who isolated it from the air. Foulerton has apparently not published any description of the organism, and the description given by Musgrave, Clegg and Polk is rather incomplete. Lieske (1921) had a culture of this organism from Kral, but does not say much about it.

Whether any previously described ray fungus is of this morphological type is rather doubtful. The *Thermoactinomyces vulgaris* described by Tsiklinsky (1899) might be of this type, according to the figure of spore formation and to the fact that spore formation is stated to take place on submerged mycelium in liquid cultures. But the organism is also, in opposition to *Micromonospora*, said to form an aerial mycelium. Peklo (1910) gives, in his description of *Actinomyces alni* (which he claims to be the symbiont present in the root nodules of *Alnus*), some figures of a type of spore formation, which is not inconsistent with that of *Micromonospora*. The value of this observation is, however, tempered by the fact that Peklo, as pointed out by Lieske (1921), probably worked with cultures contaminated with spore-forming bacteria, and the occurrence of branching, spore-forming bacilli, which might simulate the appearance of a *Micromonospora*, is not excluded (Löhnis, 1922). Millard and Burr (1926) describe two "species", *Actinomyces salmonicolor* and *Act. maculatus*, which are culturally much like some of the *Micromonospora*-strains described below, but the spores are stated to be formed "in short chains". No microscopical illustration is given, so that an accurate idea of the nature of these organisms cannot be formed.

Actinomyces monosporeus, which has been studied in detail by Schütze (1908), shows a mode of spore formation which is to some extent analogous to that of *Micromonospora*, but since the spores are here formed on a specially differentiated aerial mycelium (as in the *Cohnistreptothrix*-group) which is absent in *Micromonospora*, it is doubtful whether these two organisms are really related to each other.

In 1927 the author observed in a microbiological analysis of a Danish garden soil, an organism apparently belonging to the *Micromonospora*-type, and in November, 1929, when some Australian soils were plated on agar media for observation of the general character of their bacterial flora, a number of colonies of organisms of the same type was observed. Since this suggested that this practically unknown genus might represent a group of common and perhaps important soil organisms, a number of strains were isolated from various soils, and their morphological and biological characters were tested in order to obtain a basis for a further study of this genus.

Ten strains were isolated from the following soils:

1.—No. 125. Alluvial soil, heavy clay, rich in organic matter, pH 6.0. Isolated Strains 125 I, 125 II, 125 IV, and 125 VI.

2.—No. 129. Laterite soil, poor in organic matter, pH 6.7. Isolated Strain 129 V.

3.—No. 163. Laterite soil, poor in organic matter, pH 7.9. Isolated Strain 163 III.

4.—No. 176. Laterite soil, poor in organic matter, pH 6.5. Isolated Strains 176 IV, 176 XII, and 176 XVII.

5.—Soil from a lawn in the University grounds, rich in undecomposed grass roots, pH 6.6: Isolated Strain U IV.

The following medium was used for the isolation: Dextrose 2.0 gm.; Casein, dissolved in 10 c.c. 0.1N NaOH, 0.2 gm.; K_2HPO_4 , 0.5 gm.; $MgSO_4$, 0.2 gm.; Agar, 15.0 gm.; H_2O , 1000 c.c. pH 6.4–6.6.

On plates poured in a dilution of 1:100,000–200,000 and incubated at 30° C., the colonies appear after 6–8 days; they grow very slowly and never attain any very considerable size (maximum about 1 mm. in 12–14 days). They are perfectly round, compact, with myceloid edges like colonies of ordinary actinomycetes and, like these, their structure is firm and cartilaginous, but, owing to their small dimensions, their actinomyces-character is not easily discovered except under the microscope. The colour of the colonies is pink to orange, except the strains 125 IV and 176 IV, which are blue. Surface colonies never show any aerial mycelium, but sometimes a dark, moist crust of spores. Pure cultures can be obtained from the colonies on casein-dextrose-agar without any difficulty.

Several synthetic media, mostly those recommended by Waksman (1919) for the characterization of actinomycetes, were used for the study of cultural characters of the Micromonosporae. Only those which gave the most characteristic growth are mentioned here:

1.—Dextrose-Asparagin-Agar: Dextrose 10.0 gm., Asparagin 0.5 gm., K_2HPO_4 0.5 gm., Agar 15.0 gm., H_2O 1000 c.c. pH 7.0–7.2.

2.—Starch-Casein-Agar: Soluble starch 10.0 gm., Casein dissolved in 1N NaOH 1.0 gm., K_2HPO_4 0.5 gm., $MgSO_4$ 0.5 gm., H_2O 1000 c.c. pH 7.0.

3.—Gelatin: 15 per cent. gold label gelatin in tap water. pH 7.0–7.2.

4.—Milk.

5.—Potato plugs.

6.—Dextrose-Asparagin Solution: Same as No. 1, without agar.

7.—Saccharose-Nitrate Solution: Saccharose 30.0 gm., $NaNO_3$ 2.0 gm., K_2HPO_4 1.0 gm., $MgSO_4$ 0.5 gm., KCl 0.5 gm., $FeSO_4$ trace, Agar 15.0 gm., H_2O 1000 c.c. pH 7.0–7.2.

All the agar media were used as slope cultures. The temperature of incubation was 30° C., unless otherwise stated.

MORPHOLOGY.

All the strains studied here have the following common morphological characters: In nutrient solutions and on agar media they form an extensive mycelium of richly branched hyphae; these are very delicate, varying in thickness between 0.2 and 0.5 μ . In older solution cultures one sometimes sees thicker central hyphae surrounded by more delicate branches, sometimes running out into tips of unmeasurable thinness. Definite cell walls or transverse septa are not visible. In young hyphae the protoplasm usually appears quite homogeneous, both in living and stained condition; in older cultures the thick hyphae are often seen to contain a number of unstainable elements—probably vacuoles or drops of fat—which sometimes gives them a beaded appearance. Old hyphae can be broken into pieces when the material is rubbed between two slides, but a typical spontaneous “fragmentation” of the mycelium does not take place. In nutrient solutions and on the surface of agar media, spores are produced in the manner described by Ørskov: hyphae produce short lateral branches, usually 5–8 μ long and of varying thickness (from about the same as the main hyphae to almost

immeasurable thinness). Each branch bears a single terminal spore, round or oval, 0.8-1.2 μ . The spores resemble bacterial endospores, being highly refractive and surrounded by a distinctly visible cell wall; this is most easily observed by vital staining with aqueous methylene-blue, which seems especially strongly absorbed in the cell wall. The spore formation is, both in solution and on agar, limited to certain parts of the vegetative hyphae which, in ordinarily mounted, vitally stained preparations, appear as *Botrytis*-like clusters (Plate vii, fig. 1). In some instances the spores are seen to sprout directly from the hyphae (Plate vii, fig. 2), so that examples are observed, which bear a striking resemblance to the formation of ectogonia in *Bac. influenzae* as figured by Wade and Manalang (1920). The sporulation is abundant in the Strains 125 VI, 176 XVII, 163 III, 129 V, and U IV, very scanty in 125 I and 125 IV.

The development from spore to spore takes place in the following manner*: When mature spores from the surface of an agar culture are transferred to a suitable agar or solution medium (dextrose asparagin-agar or solution was used in most cases), they swell somewhat and begin to germinate after 20-24 hours at 30° C. One or two, in some cases three germ tubes are produced. These grow rapidly and soon begin to branch monopodially, so that after 2-3 days small, well defined mycelia are formed (Plate vii, fig. 3, *b*), and the short spore-bearing lateral branches begin to appear. On dextrose-asparagin-agar the course of development is soon obscured by the profuse sporulation which takes place, but it can be followed in solution and partly on tap-water-agar as recommended by Ørskov (1923), although the growth here has a tendency to stop before the life cycle is complete. Plate vii, fig. 4 shows a small mycelium with new spores on this medium. In dextrose-asparagin-solution there is, after three days, an abundant formation of hyphae which in certain parts bear numerous short lateral branches (exactly simulating the figure given by Ørskov) with intensely staining terminal swellings developing into new spores (Plate vii, fig. 3, *c*).

STAINING REACTIONS.

The hyphae and spores of the strains studied here stain easily with all the usual bacterial stains (carbol-fuchsin, aqueous fuchsin, Loeffler's methylene-blue, aqueous methylene-blue, gentian violet). Also Delafield's haematoxylin gives, especially when material is fixed with sublimate-alcohol, fine and clear preparations. The spores stain in all cases intensely, the hyphae rather badly. All elements of all strains are, even in three to four weeks' old cultures, gram-positive, but never acid-fast (decolourized, after staining with hot carbol-fuchsin, by a few seconds' treatment with 20 per cent. sulphuric acid). Whether nuclei are present in the spores and mycelium is difficult to decide owing to the minuteness of the objects, and, moreover, the question of the presence of true nuclei in bacteria and related organisms is not yet definitely settled. Preparations stained by the method of Schumacher (1926) for demonstrating bacterial "nuclei"† show the presence of deeply stained, minute granules both in old spores from dextrose-asparagin-agar and in germinating spores, germ tubes and young mycelia in dextrose-asparagin-solution (Plate vii, fig. 5). Whether these granules represent

* Mainly based on the study of Strains 125 II, 125 VI, and 176 XVII.

† The material is dried on a slide and treated for 2-4 hours with 25 per cent. hydrochloric acid, washed first with water, then for 10 seconds with dilute Na₂CO₃ solution, finally stained for 30 seconds with carbol-thionine.

true nuclei remains uncertain, owing to the difficulty of following their development, but it does not appear unlikely. Petersen (1928) did by this method obtain figures much like those obtained by staining with iron haematoxylin or Giemsa-stain, by means of which methods he demonstrated the presence of bodies undoubtedly representing true nuclei in *Bacillus mycoides*.

Similar minute round bodies, staining deeply with Delafield's haematoxylin and imbedded in an amorphous, very badly staining substance, is sometimes observed in 5-6 days' old cultures in dextrose-asparagin-solution. The whole phenomenon does not look unlike a "symplasm"-stage (Löhnis, 1922), although it is not pretended to make any definite statements as to its nature, before it has been studied more fully.

CULTURAL CHARACTERS.

Strain 125 I.

Hyphae in dextrose-asparagin-solution 0.3-0.5 μ thick. Spores very scarce; on filter paper in mineral nutrient solution the inoculum is, after 15-16 days, covered by a crust of spores; these are spherical to oval, 1.0-1.3 μ .

Dextrose-asparagin-agar: Scant growth after 16 days. Vegetative mycelium flat, smooth, with myceloid edges, spreading into medium, colourless with pink shade. After 24-30 days the growth is somewhat better, of unchanged appearance. No sporulation or soluble pigment.

Starch-casein-agar: Growth scant after 16 days, fair after 24-30 days; appearance as on previous medium. On plate culture a diastatic activity is just discernible after 10 days.

Gelatin, 22 days at 22-24° C., stab culture: Scant growth. Small round orange granules in stab; slow saccate liquefaction. No pigment. Liquefied gelatin clear, viscid.

Potato: Scant growth after 16 days; small orange granules surrounded by white haloes. After 24-30 days growth becomes better; vegetative mycelium raised, lichnoid, dark orange. No sporulation or soluble pigment.

Milk: No growth after 30 days.

Dextrose-asparagin-solution, 24 days: Fair growth. Small, firm, round, pale pink granules on bottom of tube.

Strain 176 XII.

Hyphae 0.3-0.5 μ thick. Spores oval, 1.0 \times 1.2 μ .

Dextrose-asparagin-agar: Scant growth after 6 days. Vegetative mycelium flat, growing slightly down into medium, colourless. After 12-18 days the growth becomes better. Vegetative mycelium raised, smooth, heavy, pinkish-orange with greyish shade on surface. No soluble pigment. After 32 days the growth is very good, of unchanged appearance.

Starch-casein-agar: After 4 days a narrow, granulated, orange vegetative mycelium is formed; after 12 days it turns brick-red, with tufts of orange mycelium growing down into the medium. After 18 days small greyish-black spots, due to spore formation, begin to appear on the surface which, after 32 days, becomes nearly black. No soluble pigment.

Gelatin, 21 days 22-24° C., stab culture: Small orange granules in stab. Slow, saccate liquefaction. No soluble pigment.

Potato: Very scant growth after 10 days. Vegetative mycelium forms small brick-red granules surrounded by white haloes. After 18-32 days good growth.

Vegetative mycelium much raised, sharply folded, looking like minute roses. No sporulation or soluble pigment.

Milk: No growth after 35 days.

Saccharose-nitrate-solution, 20 days: Scant growth. Loose, colourless flakes on bottom of tube. No inversion of the saccharose. No reduction of nitrate. No acidity.

Strain 125 VI.

Hyphae 0.2-0.3, up to 0.8 μ thick. Spores oval, 0.9-1.0 \times 1.0-1.2 μ .

Dextrose-asparagin-agar: After 6-14 days fair growth. Vegetative mycelium spreading, granulated, growing into medium, olive-brown with red tinge in lower portion. After 30 days good growth. The mycelium is dark olive-green with orange edges, surface covered by a soft, moist, glistening, greenish-black layer of spores. No soluble pigment.

Starch-casein-agar: Fair growth after 6 days. Vegetative mycelium narrow, granulated, orange with greyish spots. After 14 days the mycelium is olive-brown with orange shade on edges, after 30 days quite equal to previous medium. Plate culture shows a fair diastatic activity after 11 days.

Gelatin, 21 days 22-24° C., stab culture: Small orange granules in stab. Slow, saccate liquefaction. No soluble pigment.

Potato: No growth after 30 days.

Milk: No growth or change after 35 days.

Saccharose-nitrate-solution: After 9 days scant growth. Small colourless flakes on bottom of tube. No inversion of saccharose. Nitrate is reduced to nitrite. No acidity.

Strain 176 XVII.

Hyphae 0.3-0.4 μ thick. Spores oval, 0.8-1.0 \times 1.0-1.2 μ .

Dextrose-asparagin-agar: After 8 days fair growth. Vegetative mycelium raised, granulated, orange with olive-green surface, after 14-30 days all dark olive with orange shade on edges, surface moist, glistening, greenish-black. No soluble pigment.

Starch-casein-agar: After 6 days fair growth. Vegetative mycelium raised, granulated, orange with greyish-black spots on surface. After 14-30 days the mycelium is all greenish-black with orange spots, surface covered by a moist, glistening, smooth, greenish-black layer of spores. In plate culture there is a fair diastatic activity.

Potato: No growth after 30 days.

Milk: No growth or change after 35 days.

Saccharose-nitrate-solution, 9 days: Scant growth. Small round colourless to faint orange granules on bottom of tube. No inversion of saccharose. Nitrate is reduced to nitrite. No acidity.

Strain 163 III.

Hyphae 0.3-0.5 μ thick. Spores spherical, 1.0-1.2 μ .

Dextrose-asparagin-agar: After 8 days fair growth. Vegetative mycelium narrow, raised, granulated, orange with greyish spots, after 16-24 days covered by moist, glistening, greyish-black granules, consisting of spores. No soluble pigment.

Starch-casein-agar: Good growth after 8 days. Vegetative mycelium narrow, superficial, folded, bright orange. After 16 days spore formation begins from upper end of growth and proceeds downwards, until after 24 days both the vegetative mycelium and the layer of spores are all greyish-black with a greenish tinge in reverse. A faint greenish soluble pigment is formed. Fair diastatic activity in plate culture.

Gelatin, 22 days 22-24° C., stab culture: Small orange to dark grey granules in stab. Slow, saccate liquefaction. No pigment.

Potato: Good growth after 8 days. Vegetative mycelium raised, lichnoid, orange. After 16 days assuming a greyish shade; after 24 days small black granules appear.

Milk: After 8 days small orange granules along side of tube; no change. After 12 days the milk is coagulated; the coagulum is gradually softened and after 28 days largely redissolved. The whey is clear, yellowish, of neutral reaction (coagulation due to a rennet-like enzyme).

Strain U IV.

Spores oval, 0.7-0.9 × 1.0-1.2 μ .

Dextrose-asparagin-agar. Good growth after 8 days. Vegetative mycelium spreading, granulated, greenish-black with orange edges (after 4 days all orange). After 18 days the surface is covered by a moist, greenish-black layer of spores. No soluble pigment.

Starch-casein-agar. After 8 days excellent growth, equal to previous medium. Unchanged after 18 days. A faint greenish soluble pigment is formed. Very slight diastatic action in plate culture.

Potato: Excellent growth after 8 days. Vegetative mycelium raised, lichnoid, orange. No sporulation or soluble pigment. Unchanged after 18 days.

Milk: After 18 days numerous small round orange colonies are formed on wall of tube. After 21 days coagulation occurs; about one-third of the coagulum is redissolved after 50 days. Whey is clear, light yellow, with numerous flakes of light-orange mycelium. Reaction faintly acid.

Saccharose-nitrate-solution: Fair growth after 10 days. Small round granules attached to wall of tube; large, loose, pink flakes on bottom. No inversion of saccharose. No reduction of nitrate. No acidity.

Strain 129 V.

Hyphae 0.2-0.4 μ thick. Spores spherical to oval, 0.8-1.0 μ .

Dextrose-asparagin-agar: After 7 days fair growth. Vegetative mycelium superficial, granulated, light-orange with moist, greyish-black granules on surface, after 18 days nearly colourless with dark centre; surface granulated, moist, nearly black. No soluble pigment.

Starch-casein-agar. Good growth after 7 days. Vegetative mycelium superficial, granulated, light-orange. After 12 days the mycelium turns dark-orange, and moist, brownish-black granules begin to spread over the surface. After 18 days the mycelium is all black with orange edges and greenish shade in centre; surface all covered by a moist, dark olive-brown layer.

Potato: No growth after 18 days.

Milk: After 7 days numerous small round colonies, colourless to faint orange, along wall of tube; no change in the milk. After 18 days unchanged.



Saccharose-nitrate-solution: Scant growth after 18 days. Loose flakes of white mycelium with greyish spots on bottom of tube. No inversion of saccharose. No reduction of nitrate. No acidity.

Strain 125 II.

Hypvae 0.3-0.4 μ thick. Spores spherical to slightly oval, 1.0-1.2 μ .

Dextrose-asparagin-agar. Fair growth after 8 days. Vegetative mycelium raised, granulated, red-brown with moist, dark-brown spots. After 14 days the mycelium is mahogany-brown with nearly black, moist granules of spores on surface. A light coffee-brown soluble pigment is formed. After 24-30 days the growth is nearly all black, pigment deeper brown.

Starch-casein-agar: Scant growth after 8 days. Vegetative mycelium flat, developing into medium, red-brown, after 14 days turning nearly black; light-brown soluble pigment. After 21 days growth is all black, surface dry, with metallic lustre; pigment deep-brown. Very slight diastatic activity on plate culture.

Gelatin, 25 days 22-24° C., stab culture: Small granules in stab, first orange, later turning brown. Slow, saccate liquefaction. No pigment in gelatin.

Potato: Scant growth after 14 days. Vegetative mycelium raised, granulated, orange with red-brown spots. After 21-30 days a brownish soluble pigment diffuses through the plug; growth unchanged.

Milk: Very slow growth. After 60 days small greyish-brown granules on side of tube, faint greyish-brown discoloration of milk, but no coagulation or clearing.

Saccharose-nitrate-solution: Scant growth after 9 days. Numerous small loose greyish flakes on bottom of tube. Saccharose is inverted (strong reduction of Fehling's solution). Nitrate is reduced to nitrite. No acidity.

Strain 176 IV.

Hypvae 0.2-0.4 μ thick. Spores nearly spherical, 0.9-1.2 μ .

Dextrose-asparagin-solution: Faint growth after 10 days. Vegetative mycelium forms compact, raised colonies which grow down into the medium, dark greenish-blue with paler edges (after 5 days all colourless). After 25 days the mycelium is nearly black, surface smooth and hard, without the moist masses of spores characteristic of the preceding strains. An extremely thin, greyish veil, resembling an aerial mycelium, is formed on the centre of the colonies.

Starch-casein-agar: Very scant growth after 10 days. Vegetative mycelium forms minute isolated colonies, colourless with deep-blue centre. Unchanged after 25 days. Very slight diastatic activity on plate.

Gelatin, 22 days 22-24° C., stab culture: Small orange granules in gelatin. Slow, saccate liquefaction. No soluble pigment.

Potato: No growth after 30 days.

Milk: No growth after 30 days.

Dextrose-asparagin-solution: Fair growth after 24 days. Small pinkish flakes on bottom of tube. Later bluish surface colonies appear, and a greenish-blue soluble pigment is formed. When the pink mycelium is transferred to a strip of filter paper in mineral nutrient solution, it turns blue in a few days, and sporulation takes place; the formation of the blue pigment seems to depend on perfect aeration.

This strain as well as the following, develops very slowly in all media tested.

Strain 125 IV.

An organism of a type similar to the previous one (176 IV). Not studied in detail because of its very slow growth in all media.

PHYSIOLOGICAL CHARACTERS.

1. *Oxygen requirements.*—The ability to thrive under anaerobic conditions was tested for the following strains: 125 I, 125 II, 125 VI, 163 III, 176 IV, 176 XII, and 176 XVII. They were grown on dextrose-asparagin-agar in small test-tubes placed in a larger wide-necked, rubber-stoppered bottle, in which the oxygen was absorbed by means of pyrogallic acid and potassium hydroxide. No growth of any of the strains took place within 14 days at 30° C. These organisms are thus obligate aerobic, and even strictly aerobic, as was shown by growing the Strains 125 II, 176 IV, 176 XVII, 163 III, and U IV as "distribution cultures" in high layers of dextrose-asparagin-agar in test-tubes. Growth took place only in the upper 2-3 mm. of the medium, except in the case of Strain 176 IV, where small colonies were seen developing at a depth of 7-8 mm. under the surface, where the best growth took place.

2. *Resistance to drying.*—The ray fungi as a whole are known to be exceptionally resistant to drying, especially in the spore state. In order to test this point for the Micromonosporae, spores from dextrose-agar cultures of Strains 125 VI, 125 II, 176 XII, and 176 XVII were transferred to sterile glass splinters in small test tubes, allowed to dry and kept at room temperature. A similar experiment was made with vegetative mycelium from agar and potato cultures of Strains 129 V and U IV. Sterile dextrose-asparagin-solution was added to the tubes with spores after 3 months and to those with vegetative mycelium after 5 weeks.

The vegetative mycelia had survived, but from the spores, growth was obtained only in the case of Strain 176 XII. The spores thus seem less resistant to drying than those of ordinary actinomycetes, which will generally retain their vitality for many months and even years. This is not quite in agreement with Ørskov (1923) who found that the spores retain their vitality for at least eight months.

TEMPERATURE RELATIONSHIPS AND RESISTANCE TO HEAT.

As mentioned before, all strains produced their best growth at 30-32° C. At 22-25° C. the growth is also good, but visibly slower. In order to test their ability to grow at higher temperatures, Strains 125 VI, 176 XVII, 176 XII, 125 I, 163 III, U IV, 125 II, and 176 IV were grown on dextrose-asparagin-agar at 46-47° C. and at 42-43° C. At the former temperature no growth of any of the strains took place. At 42-43° C. Strains 125 VI and 176 XVII produced a fair growth, 125 II, 176 IV, and 176 XII a very scant growth in 12 days, 125 I and U IV no growth at all. The Micromonosporae are thus ordinary mesophilic organisms.

The resistance of spores and mycelium to higher temperatures was tested by heating about 0.5 c.c. of sterile dextrose-asparagin-solution, with either spores from the surface of a dextrose-asparagin-agar culture or small fragments of vegetative mycelium where spore formation had not yet started, for different lengths of time in small thin-walled test-tubes; after cooling, transferring either a loopful of spore suspension or a small fragment of mycelium to slants of

dextrose-asparagin-agar, and incubating at 30° C. The results are seen from Table 1.

TABLE 1.
Thermo-resistance of Spores and Mycelium of *Micromonospora*-Strains.

Temperature and time of heating.	Growth when transferred to dextrose agar.					
	125 II Spores.	125 VI Spores.	129 V		U IV	
			Spores.	Veg. myc.	Spores.	Veg. myc.
65° C. 2 min.	"	"	"	+	"	+
65° C. 5 min.	"	"	"	+	"	+
70° C. 2 min.	+	+	"	+	+	÷
70° C. 5 min.	+	+	+	÷	+	÷
80° C. 1 min.	+	+	+	÷	+	"
80° C. 2 min.	+	+	+	"	÷	"
80° C. 5 min.	(+)*	+	+	"	÷	"
80° C. 10 min.	÷	÷	÷	"	"	"
100° C. 30 sec.	÷	÷	÷	"	÷	"

* Only 1 colony.

This shows that the spores are fairly resistant to heat (although far less so than bacterial endospores), and more resistant than the vegetative mycelium. In this respect they resemble the spores of the *Cohnistreptothrix*-group of ray fungi, as shown by Domec (1892), Foulerton and Jones (1902), Gilbert (1904), Ørskov (1923), and others.

RESISTANCE TO ORGANIC DYES.

Lieske (1921) observed that the actinomycetes studied by him were extraordinarily sensitive to organic dyes, especially methylene-blue and gentian-violet, which prevented growth of the organisms when added to broth cultures in a concentration of 1:500,000. Since these and related compounds have come into use in recent years in bacteriology for diagnostic purposes, it was thought desirable to test the *Micromonosporae* in this respect. Strains were grown on dextrose-asparagin-agar containing methylene-blue and crystal-violet in concentrations from 1:10,000 to 1:200,000, for 15 days at 30° C. For comparison, two ordinary soil actinomycetes of the *Cohnistreptothrix*-group, isolated from soil U, were included in the experiment. The results (two figures indicate incomplete agreement between the duplicate cultures) are found in Table 2.

Methylene-blue is seen to be far less toxic here than in the experiments of Lieske, especially towards *Act. griseus* and *viridochromogenus*, which grow unhindered at a concentration of 1:10,000, whereas the *Micromonosporae* all are checked at 1:20,000. Strain 163 III seems distinctly more sensitive than the other ones, between which the differences are insignificant. Crystal-violet is far more toxic to the *Micromonosporae*, of which only Strain 125 II is comparatively

TABLE 2.
Resistance of Strains of *Micromonospora* and *Actinomyces* to Organic Dyes.

	Strain.	Growth at concentration of dye.				
		1 : 10,000	1 : 20,000	1 : 50,000	1 : 100,000	1 : 200,000
Methylene blue	125 I	0	0	1	2	1-2
	125 II	0	0	1	1-2	2-3
	125 VI	0	0	0	0-1	2
	176 XVII	0	0	0-1	2-3	2-4
	163 III	0	0	0	0-1	0
	<i>Act. griseus</i>	3	2	4	4	4
	<i>Act. viridochromogenus</i>	4	4	5	5	5
Crystal violet	125 I	0	0	0	0	0
	125 II	0	0	1	2	2-3
	125 VI	0	0	0	0-1	0-1
	176 XVII	0	0	0	0	0
	163 III	0	0	0	0	0
	<i>Act. griseus</i>	0	0	0	3	3
	<i>Act. viridochromogenus</i>	3	3	3	4	4

0, no growth; 1, trace of growth; 2, scant; 3, fair; 4, good; 5, excellent.

TABLE 3.

Strain.	Growth.	Final pH.
Control	(a) —	5.7
	(b) —	5.7
125 I	(a) none	5.7
	(b) trace	5.9
125 II	(a) scant	5.8
	(b) scant	5.9
125 VI	(a) none	5.8
	(b) none	5.8
163 III	(a) none	5.7
	(b) scant	5.8
176 IV	(a) none	5.8
	(b) none	5.8
176 XII	(a) none	5.8
	(b) trace	5.9
176 XVII	(a) none	5.7
	(b) none	5.8
U IV	(a) none	5.7
	(b) fair	5.8

resistant, whereas the others are wholly or nearly checked by a concentration of 1:200,000. *Act. griseus* is almost as sensitive, whereas *Act. viridochromogenus* is only little influenced.

RESISTANCE TO ACIDITY.

Eight strains were grown in dextrose-asparagin-solution where K_2HPO_4 was replaced by KH_2PO_4 . The solution, which had an initial reaction of pH 5.7, was used in portions of 4 c.c. in small test-tubes. Duplicate cultures were incubated for 14 days at 30° C. The results obtained are shown in Table 3.

This simple experiment shows that the Micromonosporae are remarkably sensitive to acidity, even more so than the *Cohnistreptothrix*-group, of which even the most sensitive are able to induce growth at pH 4.8-5.2 (Waksman, 1919).

PROTEOLYTIC ACTIVITY.

The slow liquefaction of gelatin shows that the Micromonosporae, like most actinomycetes, are capable of producing a proteolytic enzyme. In order to obtain quantitative expressions for their proteolytic power, three Micromonosporae and *Act. viridochromogenus* were grown in the following solution: Casein dissolved in 1 N NaOH, 10.0 gm., dextrose 10.0 gm., K_2HPO_4 1.0 gm., $MgSO_4$ 0.5 gm., $FeCl_3$ trace, H_2O 1000 c.c. pH 7.0-7.2. The solution was used in portions of 50 c.c. in 100 c.c. Erlenmeyer flasks. Duplicates were inoculated with spores from dextrose-asparagin-agar cultures and incubated at 30° C. for 30 days, after which time the solutions were filtered and the filtrates restored to a volume of 50 c.c. Determinations of amino-N were then carried out by means of the formaldehyde titration method.

TABLE 4.
Proteolytic Activity of *Micromonospora*-Strains in Casein Solutions.

Organism.	Formol-N, mgm. per 50 c.c.
125 II {	2.2 } 2.7
	3.1 }
125 VI {	2.7 } 2.6
	2.4 }
163 III {	13.8 } 13.9
	14.0 }
<i>Act. viridochromogenus</i> .. {	8.1 } 9.3
	10.5 }
Control (Sterile solution) .. {	1.2 } 1.6
	2.0 }

Table 4 shows that the proteolysis caused by Strains 125 II and 125 VI is hardly significant, whereas Strain 163 III exceeds *Act. viridochromogenus*, which is a rather weakly proteolytic organism (Waksman, 1919).

Another series of semi-quantitative experiments was carried out by growing the organisms on milk-agar plates. These were prepared by mixing 6 c.c. of milk and 3 c.c. of melted agar (2% agar in tap water) in a Petri dish; after the mixture had set, the plate was inoculated at the centre with spore material and incubated at 30° C. Perfectly transparent zones, due to hydrolysis of the casein, were produced in all cases. In Strain 163 III, which coagulated the milk, the transparent zone was surrounded by a dense ring of precipitated casein, indicating the formation of a rennet-like enzyme. A measurement of the diameter of the proteolytic zones gave the results recorded in Table 5.

TABLE 5.
Proteolytic Activity on Milk Agar.

Organism.	Proteolytic zone, diam. in mm.
125 I	3-4
176 XII.. .. .	12-13
125 VI	21-22
163 III	21-22
U IV	23-24
125 II	5-6
176 IV	3-4
<i>Act. viridochromogenus</i> ..	20-22
<i>Act. griseus</i>	62-64

The more active Micromonosporae are here seen to be about equal to *Act. viridochromogenus*, but not nearly as active as *Act. griseus*, which is a very strongly proteolytic organism (Waksman, 1919).

Upon the whole the Micromonosporae do not seem to be very active in proteolytic respect.

UTILIZATION OF VARIOUS NITROGEN COMPOUNDS.

Seven strains were tested for their ability to utilize nitrogen in various forms by growing them in dextrose-solution (medium 6, without asparagin) with 0.2% of N-compound. The solutions were used in portions of 5 c.c. in small test-tubes, and duplicate cultures were incubated for 3 weeks at 30° C. Table 6 shows the results.

All strains grew as small whitish to orange flakes or granules on the bottom of the solution, except Strain 163 III, which also formed floating orange surface-colonies. Strain 125 II formed a brown soluble pigment in solutions with asparagin and peptone. Asparagin appears to be decidedly the best source of nitrogen; glycine and peptone are inferior, uric acid and sodium nitrate still more so, and ammonium sulphate is available only to Strain 163 III. Finally, coffein is quite unsuitable. The comparatively good growth of the Strains 125 I and 176 XVII in the nitrogen-free solution might suggest the possibility of a fixation of elementary

TABLE 6.

Utilization of various Nitrogen compounds by *Micromonospora*-Strains.

Strain.	Growth with Source of N :							
	N-free.	Asparagin.	Glycine.	Peptone.	NaNO ₃	(NH ₄) ₂ SO ₄	Uric acid.	Coffein.
125 I	1-2	2-3	2	1	1	0-1	2	0
125 II	0-1	3	1	2	1-2	1	1-2	0
163 III	1	5	2-3	2-3	1-2	3	2	0
125 VI	1	4	2	2-3	1	0	0-1	0
176 XVII	1-2	4	1-2	2-3	1	0	0-1	0
176 XII	1	2	2-3	3	1-2	0	1-2	0
176 IV	0-1	2-3	1	1	1-2	0	2	0

The growth is indicated by the same characters as in Table 2.

nitrogen by these organisms. However, a quantitative experiment (growing the two strains for 6 weeks in nitrogen-free dextrose solution and determining total nitrogen at the end of the experiment) gave negative results.

DECOMPOSITION OF CELLULOSE.

Several strains of *Micromonospora* were grown in test-tubes on strips of filter paper half immersed in the following solution: NaNO₃ 1.0 gm., K₂HPO₄ 0.5 gm., MgSO₄ 0.5 gm., H₂O 1,000 c.c. This experiment gave the following result:

Strain 125 I: No growth after 45 days.

Strain 125 II: Slight growth after 56 days; submerged part of paper shows numerous minute greyish-black spots; some loose fibres of cellulose on bottom of tube; paper appears slightly corroded at level of solution. After 88 days no striking change; paper is broken in two when tube is shaken; microscopically the fibres appear surrounded by spore-bearing hyphae, but not much attacked.

Strain 163 III: After 75 days a small dark-olive spot is formed on the paper at the place of inoculation. No distinct growth or destruction of the paper.

Strain 176 IV: After 65 days there is a small reddish spot on the paper, covered by bluish mycelium. Destruction of paper is visible neither microscopically nor macroscopically.

Strain 176 XII: After 90 days there is at the place of inoculation a small dark spot surrounded by a bright orange halo, 7-8 mm. in diameter. In this zone the paper is loose and softened; microscopically the cellulose fibres appear much destroyed and penetrated by hyphae.

Strain 125 VI: After 56 days strong decomposition of paper; submerged part semi-transparent, softened, falling into a pulp of loose fibres when tube is shaken; the exposed part of the paper is faint reddish with dark olive-green spots, becoming soft and pulpy. Microscopically the fibres are much destroyed and penetrated by spore-bearing hyphae.

Strain 176 XVII: After 56 days strong decomposition; the inoculum on the exposed part of paper spreads out into a large greenish-black spot, in which the paper has practically lost its structure. After 100-110 days the attack has

spread to the submerged part of the paper which is coloured reddish and disintegrates into a pulp when the tube is shaken.

Several strains of *Micromonospora*, especially 125 VI and 176 XVII, are thus capable of decomposing cellulose. This capacity is more pronounced when the nitrate is replaced by a more favourable source of nitrogen. In an experiment, where the above solution with 0.2% asparagin instead of nitrate was used, the following results were obtained after 35 days.

Strain 163 III: Very slight growth. Small olive-grey spots on exposed part of paper. No destruction.

Strain 176 IV: Fair growth. Numerous small round colonies, with dense olive-brown centre and paler periphery, appear on both submerged and exposed part of paper. No destruction.

Strain 176 XVII: Excellent growth. Exposed portion of the paper greyish-orange with an olive-brown zone at level of solution. Paper very soft and pulpy when touched with the needle. No attack of submerged portion.

Strain 125 VI: Appearance as 176 XVII. Destruction of paper very strong, especially just above the level of solution.

Strain U IV: Appearance as 125 VI and 176 XVII, but destruction of paper somewhat less pronounced.

IMPORTANCE IN THE SOIL.

Although the data yet available do not warrant any definite conclusions as to the importance of the *Micromonosporae* in the microbial processes in the soil, a few observations have been made which give an idea of the conditions under which they are active in the soil. Samples of the soil 163 had received 15% water and (1) 0.5% crude lignin prepared from oats straw, and (2) 1.0% cellulose as ground filter paper. The samples were stored in a moist condition at room temperature for five months, after which time plate counts were carried out on the casein agar medium described on page 233. The addition of lignin and cellulose to the soil gave rise to a marked increase in the numbers of *actinomyces*-colonies compared with soil without addition. The colonies were counted after 10 days' incubation at 30° C., and colonies suspected of being *Micromonosporae* were picked out and transferred to slants of dextrose-asparagin-agar, where sporulation usually occurs rapidly and *Micromonosporae* are easily recognized. The following results were noticed:

1. *Soil without addition*: Dilution 1:250,000. Five parallel plates. Total number of *Actinomyces*-colonies (including *Micromonosporae*), 278. Isolated 16 strains, of which 13 proved to be *Micromonosporae*.

2. *Soil + Lignin*: Dilution 1:400,000. Five parallel plates. Total number of *Actinomyces*-colonies, 428. Isolated 33 strains, of which 23 proved to be *Micromonosporae*.

3. *Soil + Cellulose*: Dilution 1:500,000. Five parallel plates. Total number of *Actinomyces*-colonies, 329. Isolated 27 strains, of which 22 proved to be *Micromonosporae*.

These figures show a definite increase in the abundance of *Micromonosporae*, when cellulose or lignin is added to the soil. This phenomenon, together with the fact that several strains of *Micromonospora*, when incubated for a sufficiently long time, are capable of bringing about a marked decomposition of cellulose—stronger than that caused by most other ray fungi—suggests that they may play

an important rôle in the decomposition of cellulosic material in the soil. Whether their increase in soil with lignin is due to an ability to decompose this rather vaguely defined group of very resistant compounds must be left to future studies to decide.

SYSTEMATIC POSITION.

The morphological features of the 10 strains show plainly that these organisms are, as pointed out by Ørskov (1923), entirely different from the rest of the actinomycetes and should be recognized as a separate genus, *Micromonospora*. While the spore formation in the other actinomycetes, if present, is a kind of oidia formation, resembling that of several Hyphomycetes, we are here dealing with an entirely different process, a kind of conidia formation which exactly resembles the formation of ectogonia in several bacteria, such as *Bact. typhi* according to Almquist (1908), *Bac. influenzae* according to Wade and Manalang (1920), and *Spirillum rubrum* according to Petersen (1921). The most striking resemblance is shown by the ectogonia formation in *Mycobact. tuberculosis*, according to Meirowsky (1914), whose figures in certain instances (e.g. Fig. 35,

TABLE 7.
Summary of Cultural Characters of *Micromonospora*-Strains.

Strain.	Colour of veget. mycel.	Colour of spore layer.	Sporulation.	Soluble pigment.	Reduction of NaNO ₃ .	Inv. of saccharose.	Action on milk.	Growth on potato.
125 I	colourless to orange	grey to black	scant	none	none	none	none	fair good
176 XII								
125 VI	colourless to orange	greenish black to brownish black	abundant	none or faint yellow to faint green	+ + none none	none	none none coagulated	none none good none good
176 XVII								
163 III								
129 V U IV								
125 II	red to brown	black	good	brown	+	strong	none	fair
176 IV	colourless or faint orange to deep blue	dark blue	scant	none or faint blue	none	none	none	none
125 IV								

Plate iia and Plate xviii, see Löhnis, 1922, Plate xii, fig. 162, and Plate xiv) look quite like slightly diminished pictures of the spore formation in *Micromonospora*. The formation of ectogonia and of branched and filamentous forms is upon the whole not of uncommon occurrence among the bacteria (for summary of the literature up to 1918, see Löhnis, 1922). There does not, therefore, seem to be any reason to regard the genus *Micromonospora* as anything but a highly developed group of bacteria, the resemblance of which to higher fungi, especially the loose conglomerate known as Hyphomycetes, seems purely external. This is probably true also of the other ray fungi (the genera *Cohnistrepthrix* and *Actinomyces*, if one accepts the system of Ørskov), but whether these and *Micromonospora* are related in phylogenetic respect is quite uncertain.

As to the question whether the strains studied here represent several definite "species", we see from the summary of cultural characters in Table 7, that we are dealing with at least three different groups: (1) Strains 125 I, 176 XII, 125 VI, 176 XVII, 163 III, U IV, and 129 V; (2) Strain 125 II; and (3) Strains 125 IV and 176 IV.

In Group 1 the strains 125 VI and 176 XVII agree almost completely, but otherwise there is rather much heterogeneity—scant to very abundant sporulation (Strains 125 I compared with 125 VI, 176 XVII, U IV), coagulation of milk by some strains, reduction of nitrate by others, absent to very strong power of decomposing cellulose, etc. It is very likely that this imperfectly known group of microorganisms includes a large number of different forms, and the various characters studied here may be as variable as in the case of other actinomycetes (see Lieske, 1921). It would, therefore, probably be premature to establish any of the groups of these organisms as definite "species" until a closer study of a larger number of strains and of the constancy of their various cultural characters has been carried out.

SUMMARY.

Ten strains of actinomycetes-like organisms of the type of *Streptothrix chalcea* (Foulerton) have been isolated from soil and studied. The evidence at hand justifies entirely the establishment of this group of microorganisms as a separate genus *Micromonospora*, as suggested by Ørskov. Their vegetative thallus is composed of long, delicate, branching hyphae. The mode of spore formation resembles the formation of ectogonia in the bacteria: short lateral branches sprout from the main hyphae, each bearing a single terminal spore, oval to spherical, highly refractive, and staining deeply with anilin dyes and haematoxylin. Spores and mycelium are gram-positive, but not acid-fast. The spores show a somewhat higher thermo-resistance than the vegetative hyphae. The organisms are strictly aerobic, mesophilic, and very sensitive to acidity and organic dyes. Their proteolytic and diastatic activities are rather weak. Free nitrogen is not fixed. Some strains reduce nitrate to nitrite. Cellulose is decomposed actively by several strains. They may occur in considerable numbers in the soil, occupying 5-8 per cent. of the total numbers of colonies of *Actinomyces*-type. Their abundance seems increased through addition of cellulose or lignin to the soil.

Addendum (30th June, 1930.)

While this paper was in the press, the author became aware of a paper by Williams (1912) who studied an organism isolated from pericarditic exudate.

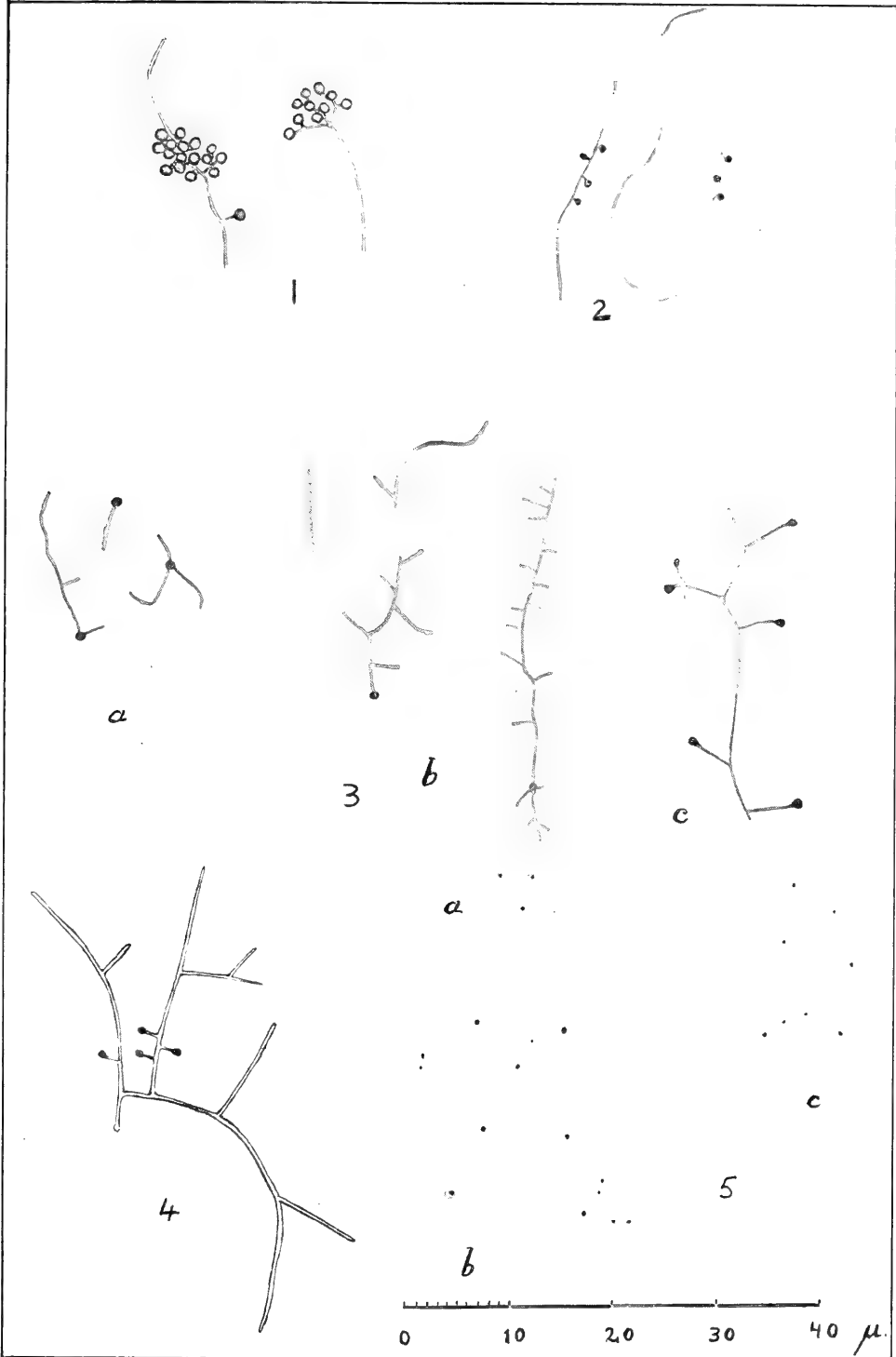
His description and illustrations show plainly that the organism is a *Micromonospora*, although not identical with any of the forms described above.

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EXPLANATION OF PLATE VII.

- Fig. 1.—Strain 125 II. Clusters of spores from the surface of dextrose-asparagin-agar. (Vital staining with aqueous methylene-blue.)
- Fig. 2.—Strain 176 IV. Spore-bearing mycelium from filter paper in asparagin-solution. 18 days 30° C. (Dilute carbol-fuchsin.)
- Fig. 3.—Strain 176 XVII. Development in dextrose-asparagin-solution, 30° C. (Delafield's haematoxylin.) a, 42 hours; b, 3 days; c, 5 days.
- Fig. 4.—Strain 176 XII. Young spore-bearing mycelium on water-agar. 5 days 30° C. (Living material.)
- Fig. 5.—Strain 176 XVII. Development in dextrose-asparagin-solution, 30° C. (2 hours' treatment with 25% HCl, staining with carbol thionin.) a, resting spores; b, germinating spores, 42 hours; c, young mycelium, 5 days.
- (All magnifications are approximately 1500.)



Strains of *Micromonospora*.

FIFTH CONTRIBUTION TOWARDS A NEW CLASSIFICATION OF
AUSTRALIAN ASILIDAE (DIPTERA).

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[Read 25th June, 1930.]

In this and future parts of my studies in Asilidae, I am including notes on certain exotic forms that come within the tribes dealt with; for specimens received I am indebted to the late Prof. M. Bezzi and to Prof. J. Herve-Bazin for European genera, whilst Professor R. Painter and Mr. W. S. Bromley have supplied North American genera.

New characters are being employed in these papers and many of them are fairly well maintained in the various sections, but it must be understood that none of them is necessarily of generic or tribal importance; they are recorded only as they are found on the material before me, and occasionally some misunderstanding of these characters may arise because they are founded chiefly on preserved material. Closer investigation on fresh and supple material may show the possibility of other interpretations so, as far as possible, all such characters are examined on newly killed material. Again, certain terms that have long been in use are now shown to be inapplicable, but more suitable names do not seem to have been substituted in such cases. One such example is the so-called "metapleura", a bulging part just above the metathoracic spiracle. The hairs and bristles thereon seem to have some generic and subgeneric value, varying from an abundance of hairs to a row of bristles, or they may even be absent. Other parts of the pleura may also have hair on them, but these have not been studied and in the tribes here dealt with they are comparatively scarce.

Prothorax.—Already in these papers I have indicated that two types of prothorax are found, one being the form with one complete sclerite covering the whole of the underside, the other having this area divided so that there is a ventral plate surrounded by a membranous area. It would seem the first of these is the primitive form and, as the part became soft and membranous, the plate that was left near the anterior coxae took on its characteristic appearance. Part of it overlapped a membrane, another part forming a continuous surface with the softened portion of the sclerite, and often retaining the pollinose covering on that soft area. In *Ommatius* the sclerite has become only partly broken down in this manner. It appears rather obscure at times, whether this ventral plate has been isolated or not, and I find, contrary to my earlier statement, that it is

formed in the Leptogasterini, at least in Australian material. The sternum here differs from other cases by the apparent failure to develop a section overlapping part of the surrounding membrane, and therefore it looks as if the sternum has a uniform density throughout its more or less uniformly brown area.

Chaetotaxy.—The ocellar tubercle usually contains a group of hairs or bristles which vary from a rather dense group of hairs to a smaller number, some of which are bristly in nature. A small group of bristles only may occur, varying from eight to two pairs, or even to a single pair, and in most of these cases the few hairs left may be inconspicuous. This vestiture may even be entirely absent as on *Chryseutria*. The character varies partly in accordance with the general hirsute nature, or otherwise, of the insect and, in the main, appears to be specific rather than generic in importance.

The hairs are more or less plentiful on *Thereutria* and its allies, but are reduced on *Diogmites* and the Australian form that is very near it in the key. They vary on *Neosaropogon* and allies, are plentiful on *Stenopogon* and allies, and also on *Bathypogon*; the two latter groups contain rather hairy species, whereas *Microstylum*, which contains bare species, has them reduced. Throughout the tribe Stichopogonini they are numerous or fairly so.

The dorsal thoracic bristles are rather disappointing in Australian material; they are not always as consistent as one would expect, but some use may be made of them if one considers the general tendency to have them limited to a certain number rather than the actual numbers on any part.

The bristles on Stichopogonini are more consistent in the material before me and all the genera are included in the table below; in the tribe Saropogonini only Australian material is listed and the exotic species placed in the same genera do not necessarily conform.

Thereutria, *Metaphria*, *Rachipogon*, and the unnamed genus containing *N. froggattii* have the usual row of hairs, bristly hairs or bristles, rarely absent in any genus, on the anterior section of the pronotum and, in addition, one or two lateral bristles occur on the posterior section; in this they contrast with all other Australian material.

Many of the larger species have a few strong bristles on the humeral callus, but these seem to be specific rather than generic in value. Again, the dorso-centrals may be present, often indicated, but frequently absent. Normally there are up to three pairs of notopleural bristles or, on the larger species, the number may be doubled, so that six are evident on each side, arranged in two rows, one of which is much weaker than the other and is ignored in the table. The usual three, when present, are arranged in a line or triangularly.

On *Chryseutria* there is one very strongly developed lateral bristle on the first abdominal segment, whilst none is present on *Aterpogon*, *Questopogon*, *Cyrtopogon* and *Pseudobasipogon*, all of which are rather hairy in this region; on all other genera of the Saropogonini there are, except in rare examples, three or four bristles. In Stichopogonini these bristles are only definitely developed on *Neopogon*; *Cryptopogon* may have one or more hairs black and bristly. Elsewhere on the abdomen, bristles are found only in the genus *Microstylum* and the subgenus *Scleropogon*, in which they are placed laterally on the second segment, on the former anteriorly, on the latter posteriorly, to the row of impressions that mark the interior muscular attachments.

Table of dorsal thoracic bristles.

Genera.	Pairs of bristles.					Scutellar (total number; those in excess of six form a fringe, often with hairs).	Notes.
	Notopleural.	Supra-alar.	Postalar.	Presutural dorsocentrals.	Postsutural dorsocentrals.		
SAROPOGONINI.							
<i>Chryseutria</i> ..	—	—	—	—	—	—	Very bare species.
<i>Aterpogon</i> ..	—	—	—	—	—	10-12	Very hairy species; bristles not apparent.
<i>Questopogon</i> ..	2-3	2	3	—	4	10	
<i>Thereutria</i> ..	2-3	2	2-3	3	4	4-6	
<i>Metaphria</i> ..	2	2	2	3-4	4-5	2-4	On small species reduced in number.
<i>Rachipogon</i> ..	2	2	1-2	—	0-3	2	
Genus unnamed	3	2	3	—	4-5	2	(<i>Neosaropogon froggattii</i> D. & F.
<i>Saropogon</i> ..	2	2	2	—	5	2	<i>S. gamarus</i> is without scutellar bristles.
<i>Neocryptopogon</i> ..	2	2	1	—	—	—	
<i>Neosaropogon</i> ..	2	2	1	—	—	—	<i>N. princeps</i> has 2-4 scutellars, and another species has only notopleurals.
<i>Neodictria</i> ..	2	1	—	—	—	—	
<i>Erythropogon</i> ..	1	1	—	—	—	—	<i>E. maculinevris</i> .
		3	1	—	—	8	<i>E. australis</i> Macq.
<i>Stenopogon</i> ..	2-3	1	1-3	—	—	6-8	
<i>Bathypogon</i> ..	3	1	2	—	3-4	4	Very consistent in genus; <i>Microstylum</i> has 2 supra-alar, and 3 laterals on pronotum, the rest as on <i>Bathypogon</i> .
STICHOPOGONINI.							
<i>Laphystia</i> ..	3	1	3	—	—	—	
<i>Lasiopogon</i> ..	2-3	1-2	1-2	3	3	8	
<i>Neopogon</i> ..	1	—	1	—	—	—	
<i>Clinoopogon</i> ..	1	1	1	—	2	—	Scutellum with fringe of numerous long hairs.
<i>Cryptopogon</i> ..	1	1	1	—	2	—	Scutellum with fringe of scanty short hairs.

Tribe SAROPOGONINI.

The classification of this tribe is fraught with difficulties; it seems to be world-wide and therefore important, and my endeavour to place all genera belonging to it has met with but partial success. Many genera hitherto proposed may not be worthy even of subgeneric status, but I have, as far as possible, maintained each known to me as a separate segregate in the following key.

Key to the genera of the Saropogonini.

1. Anterior tibiae provided with a spur 2
Anterior tibiae without a spur 13
2. Thorax with two stout spines, one above the base of each wing. Prothorax rather long, the posterior section of the dorsal portion being twice the length of the anterior part and divided from it by a broad U-shaped depression. A few scattered hairs above metathoracic spiracle. Antennae with three segments and a spine, the third being twice as long as the two basal ones. Scutellum without bristles, apex of first abdominal segment with only one lateral bristle. Venation simple *Chryseutria* Hardy.
Thorax without such spines 3
3. Antennae with four segments and a spine, scutellum with a fringe of bristles, rarely bare. Venation simple. Face invariably with erect hairs above tubercle 4
Antennae with three or four segments and a spine; face hairy or bare above tubercle; if antennae have four segments the face is bare, at most with a few depressed hairs 6
4. Soft hairs distributed over the whole face which is prominent but without a defined tubercle or moustache. A row of bristles above metathoracic spiracle. Without lateral bristles on first abdominal segment, abdomen widening to apex of second and third segment, thence narrowing on female, and on male more or less parallel sided *Aterpogon*, n. gen.
Face with well defined moustache 5
5. Tubercle of face very large, and the hair abundant. With abundant hair above metathoracic spiracle, the bristles not well defined. With lateral bristles on first abdominal segment; abdomen strongly tapering to its apex *Questopogon* D. & F.
Tubercle of face very small and containing a simple moustache; head at base of antennae also projects tubercle-like. With few weak hairs and bristles above metathoracic spiracle. Without lateral bristles on first abdominal segment; abdomen strongly club-shaped. Scutellum may be bare or may have a fringe of bristles. Hair on face rather sparse *Erythropogon* White.
6. Abdomen strongly tapering from base; scutellum with bristles, rarely without. Antennae with three segments and a spine. One or two outstanding and isolated lateral bristles on pronotum, except on *Diogmites* and perhaps certain other exotic forms 7
Abdomen club-shaped or cylindrical. Scutellum generally without bristles. Antennae usually with four segments and a spine. Without lateral bristles on pronotum, except on certain exotic forms 11
7. Abdomen of normal length or rather short, most or all of its segments being shorter or hardly longer than wide 8
Abdomen very long, the second and subsequent segments being all conspicuously longer than wide. With a row of strong bristles above metathoracic spiracle. Gen. —
8. Numerous long hairs above metathoracic spiracle and amongst them bristles may be fairly well defined. Moustache rather bushy. Third antennal segment about as long as the basal segments combined. Scutellum with two or more marginal bristles. Veins R_1 and R_{2+3} meet before or at the wing-margin *Thereutria* Loew.
Bristles present only above metathoracic spiracle; if hairs are also present they are short and inconspicuous 9
9. Third antennal segment about as long as the two basal segments combined. Veins R_1 and R_{2+3} may meet before the wing margin, or M_3 may meet M_1 . Scutellum with (or ? without) bristles 10

- Third segment of antennae twice the length of the basal segments combined
Rachiopogon Ricardo.
10. Prothorax normal, the depression between the two equal sections of pronotum being V-shaped. Veins R_1 and R_{2+3} meet at or before the wing-margin
Metalphria Ricardo.
- Prothorax very long, the posterior section being twice as long as the anterior one and a broad U-shaped depression divides them. M_3 and M_4 meet at or before the wing margin
Diogmites Loew.
11. Scutellum with a pair of bristles, rarely without them. Antennae with four segments and a minute spine (fourth segment missing on European specimens). Thorax normal (but considerably arched on exotic forms). Abdomen normal, rather parallel sided (but may widen towards apex on exotic forms). With a row of bristles above metathoracic spiracle. Two postalar and some dorso-central bristles on Australian species
Saropogon Loew.
- Scutellum without bristles, or, if present, the abdomen is elongate, very slender and more or less club-shaped. A row of bristles and some hairs almost invariably present above metathoracic spiracle; bristles often weak, with only one postalar and without dorso-centrals 12
12. Face prominent, bulging and bare, moustache scanty and on an almost linear tubercle that is hardly discernible. Antennae with only three segments and a minute spine
Neocyrtopogon Ricardo.
- Face normal, not bulging. Antennae with four segments and a spine, the fourth segment rarely absent
Neosaropogon Ricardo.
13. Face prominent and covered with hairs, but without a definite tubercle or moustache. With abundant hairs above metathoracic spiracle 14
- Face with well formed tubercle and moustache 15
14. Face covered with very dense hair. Non-metallic species, dorsally rather hairy.
Cyrtopogon Loew.
- Face covered with moderately dense hair. Metallic species, dorsally bare
Pseudoholopogon Strobl.
15. Vein M_3 running into M_4 and forming an almost continuous but sinuous line with the median cross-vein 18
- Venation usually simple, but if M_3 meets M_4 , it never forms a continuous line with the median cross-vein, but is at right angles to it, or forms an acute angle with M_4 16
16. Face broad, about the width of one eye; tubercle restricted to a very small area above oral margin. With hairs above metathoracic spiracle
Neodioctria Ricardo.
- Face narrow, at least near antennae where it is only about half the width of an eye; tubercle large, reaching half-way towards antennae or further 17
17. Species with antennae situated so that in profile they are seen to be about one-third the depth of eye. If higher there are no hairs or bristles above metathoracic spiracle
Stenopogon Loew. 19
- Species with antennae situated high up on the head, so that in profile they are seen to be at one-fourth the depth of the eye. Face with very short stiff hairs reaching from tubercle to very near antennae. With a row of bristles and short stiff hairs above metathoracic spiracle
Ospriocerus Loew.
18. Face with a large tubercle covered with bristles. With abundant hairs above metathoracic spiracle. Only one supra-alar bristle present. M_1 and R_3 run to wing border separately. Wings relatively short
Bathypogon Loew.
- Face with a small tubercle and bare; moustache confined to the oral margin. Only a row of bristles above metathoracic spiracle. Two supra-alar bristles present. M_1 and R_3 meet before wing margin
Microstylum Macquart.

Key to subgenera of Stenopogon.

19. Thorax laterally very hairy, the hairs, including those above metathoracic spiracle, very long and fine. Face with a batch of very long hairs below antennae. Pronotum without marked bristles. Hypopygium inverted
Neoscleropogon Malloch.
- Thorax laterally rather bare, only a few hairs present. Face below antennae and above tubercle often bare. Hypopygium normal 20

20. With hairs and strong bristles above metathoracic spiracle. Fourth antennal segment very long, about two-thirds the length of the third. Face bare. Many strong bristles on pronotum, including a group of lateral ones on the posterior portion *Scleropogon* Loew.
- Without hairs or bristles above metathoracic spiracle. Fourth antennal segment normal, about one-fourth the length of the third or less. Face bare or hairy. Hair of prothorax forming many slender bristles including a lateral group on the pronotum *Stenopogon* Loew.

Genus ERYTHROPOGON White.

Two species belong here; they are very dissimilar in many characters, but both conform to those given in the key. The typical form, *E. maculinevris*, was said to bear a resemblance to an ichneumon in the shape of the abdomen and the long antennae, whilst the other has been compared with a vespid wasp in appearance. The relationship of the genus would appear to be nearest to the *Neosaropogon* group, but at present there is little information that supports the view.

ERYTHROPOGON AUSTRALIS Macquart.

Dasypogon australis Macquart, *Dipt. Exot.*, i (2), 1838, 45; Walker, *List Dipt. Brit. Mus.*, vi, suppl. 2, 1854, 482; Ricardo, *Ann. Mag. Nat. Hist.*, (8) ix, 1912, 350.—*Dasypogon limbipennis* Macquart, *Dipt. Exot.*, suppl. 1, 1847, 62; Walker, *List Dipt. Brit. Mus.*, vi, suppl. 2, 1854, 479.—*Brachyrrhopala limbipennis* Ricardo, *Ann. Mag. Nat. Hist.*, (9) i, 1912, 487; White, *Proc. Roy. Soc. Tasmania*, 1916, 157.—*Erythropogon limbipennis* Hardy, *Proc. Linn. Soc. N.S.W.*, ii, 1926, 308.—*Dioctria tasmanica* Walker, *Ins. Saund. Dipt.*, i, 1851, 85.

Ricardo examined the type of *D. australis* Macquart, which is evidently mutilated or in poor condition, and she states that it may be easily recognized by the wings, for which purpose she described the pattern. She also stated that the apex of the abdomen has spines, the scutellum is reddish with long yellow bristles, the fourth posterior cell of the wings is wide open and the legs are yellowish. In all these the present species agrees, whereas the absence of the tibial spur (spine of Ricardo) is the only character given by her that disagrees; probably the spur was present but overlooked. Again a comparison of Macquart's two descriptions, nine years apart in date of publication and differing somewhat, shows that both are equally applicable to this species. Ricardo stated that Walker's species belongs here, and the description leaves no doubt on this point.

Genus ATERPOGON, n. gen.

The species upon which this genus is founded has its nearest relationship with *Questopogon*, and its characters are given in the key. To this genus, *Brachyrrhopala bella* White probably belongs, but the species described below is not the same as White's species, which I have seen on two occasions.

ATERPOGON CYRTOPOGONOIDES, n. sp.

♂. Face greyish and with long yellowish hairs. Proboscis, palpi and antennae black. Head behind whitish, and with ocular cilia and scanty beard white. Thorax black with postalar callus and scutellum brown and a golden patch above scutellum; the pleura is golden, this colour extending on to the coxae; hairs on dorsum long and thin, and above the metathoracic spiracle are similar hairs, amongst which a row of bristly hairs may be detected; long bristly cilia occur

along the apical margin of the scutellum. Abdomen mainly black, with long scattered hairs; the second to sixth segments bordered with reddish-brown, which colour increases in width on the successive segments, and the seventh is entirely brown. Hypopygium black. Legs brown with the apex of metatarsus, the subsequent segments and the coxae black. Wings hyaline, with the basal half smoky.

♀. Similar to the male, the brown border of the abdominal segments less distinct, and the eighth segment black. Anterior femora fuscous at base for about one-third the length on the anterior side.

Length, 6-8 mm.

Hab.—Queensland: Brisbane (1 ♂, 1 ♀); a pair taken by me when sweeping grass at Mt. Coot-tha, 12th December, 1920. New South Wales: Albury (1 ♂, 6.1.29, F. E. Wilson), a much larger specimen but, I believe, the same species.

Genus QUESTOPOGON Dakin & Fordham.

Two females are represented in the South Australian Museum, and another (Denman, N. S. Wales, 26.12.22, A. P. Dodd) in Mr. J. S. Mann's collection, but the antennal characters do not conform to those given for the typical species; most of the specific characters agree, however, and all the principal structures given by Dakin and Fordham equally apply, so I have little doubt concerning the generic relationship.

Genus METALAPHRIA Ricardo.

This genus was based on a single species, and of it I have four species before me. Two are presumably near *M. australis* Ric., the third is *M. aurifacies* White, and the fourth is described below as new. There is some doubt concerning the original species which, possibly, may not belong to the genus as here understood. The small species show reduced thoracic bristles, there being only one pair each of supra-alar and postalar, and also dorsocentral bristles.

METALAPHRIA TESSELLATA, n. sp.

♂. A brownish-yellow species with the whole dorsal area moderately tessellated, so that the pattern changes according to the reflection of the light. Moustache and antennae yellow; proboscis and palpi black with white hairs; beard and bristles behind head yellow. On thorax thin dark stripes evident. The bristles above the metathoracic spiracle distinct, and a few short hairs to be detected near them. The abdomen has dark patches on each segment, chiefly at the sides. Legs yellow throughout, but the intermediate and posterior femora darkened above towards the apex, and also at the apex of the tibiae. Wings hyaline, but yellowish towards the base, and the veins R_1 and R_{2+3} meet at or, usually, before the apex.

♀. Similar to the male, but the seventh and eighth segments of the abdomen darker and without tessellation.

Length, 12-15 mm.

Hab.—Queensland: Brisbane, throughout the summer months, mainly on sandy tracks at Sunnybank, but not common, and their colour makes them very difficult to detect. In the field they are readily mistaken for the genus *Bathypogon*. The type series consists of seven males and three females. South Australia: Two specimens in the South Australian Museum may belong here, one from Angas Plains, the other without further locality.

Genus RACHIOPOGON Ricardo.

This genus was proposed for a single species, *Dasygogon grantii* Newman, and in it I am placing related species that have the third antennal segment twice the length of the two basal ones combined. In addition, on the under side of the anterior tibiae there is but one outstanding long bristle, contrasting with two that occur on *Thereutria* and *Metalaphria*; an exception in the latter genus occurs on small species, where the bristles in general may be much reduced.

Relatively this becomes a complex when compared with *Thereutria* and *Metalaphria*, and the coloration of the species is very diverse. Besides those recorded below, I believe *Dasygogon luctuosus* Macquart may belong here, as I have from Chinchilla, Queensland, a species that agrees very closely with the description.

RACHIOPOGON CARBO Walker.

Dasygogon carbo Walker, *Ins. Saund. Dipt.*, i, 1851, 87; *List Dipt. Brit. Mus.*, vi, suppl. 2, 1854, 478; Ricardo; *Ann. Mag. Nat. Hist.*, x, 1912, 350.—*Rachiopegon carbo* Hardy, *Proc. Linn. Soc. N.S.W.*, li, 1926, 308.—? *Dasygogon limbinervis* Macquart, *Dipt. Exot.*, suppl. 5, 1854, 71.

A black species with black wings; the fourth and fifth abdominal segments are red or mainly so, but this colour seems to vary so that only one of these segments may be red. Macquart's description is very similar but the wings are lighter, and the record is from Sydney.

Hab.—North-west Victoria: Bannerton (A. Nicholson) in collection of Mr. F. E. Wilson; another pair from the same locality, but entirely black, may also belong here. South Australia: 1 ♂, 2 ♀ without further locality in the South Australian Museum. There are further specimens in collections and, as far as yet known, it would seem to be limited to these two States.

RACHIOPOGON NIGRINUS Ricardo.

Neosaropogon nigrinus Ricardo, *Ann. Mag. Nat. Hist.*, (9) i, 1918, 60.—*Rachiopegon nigrinus* Hardy, *Proc. Linn. Soc. N.S.W.*, li, 1926, 308.

In 1926 (these PROCEEDINGS, li, p. 305), I drew attention to two species standing under the name *Neosaropogon nigrinus*, one of them being an *Ommatius*. The identity of the other has now been accepted as correct; Mr. F. H. Taylor has sent me a specimen of the same form, which specimen he informs me is part of the type series, and I have compared it with the description, finding it agrees in every character. In the original description this species is said to be related to *N. claripes* Ric., but this is hardly the case, for on structural grounds it must be placed in *Rachiopegon*.

RACHIOPOGON RUBESCENS White.

Saropogon rubescens White, *Proc. Roy. Soc. Tasmania*, 1913, 271.

The type is before me, and the antennae are broken, but another specimen which I have seen shows that the third antennal segment conforms to *Rachiopegon*, with which other characters agree. The resemblance to *Saropogon* is superficial and White had not recognized *S. sergius* Walker, to which he allied it.

Genus ———.

As pointed out on a previous occasion, a new generic position is wanted for *Neosaropogon claripennis* Ricardo and *Neosaropogon froggattii* Dakin & Fordham.

I have indicated the affinities and characters in the key, leaving the genus blank. The first species is represented in the Australian Museum, Sydney, the second, besides being represented in the South Australian Museum by two specimens, is in Mr. F. E. Wilson's collection and from Mundaring, near Perth, Western Australia (J. Clark). The position of *N. salinator* is open to doubt, but according to Walker's description it could hardly belong here.

Genus *DIOGMITES* Loew.

The genus *Diogmites* has long stood as a synonym of *Deromyia* Phil., but there would seem to be no reliable data available to confirm this, and for Australian material the genus *Deromyia* has been used to harbour a complex. There are four species of *Diogmites* before me from North America, and these are certainly Saropogonini in affinities; there is an undescribed Australian species that conforms in many respects, but it differs in having no scutellar bristles and vein M_3 does not meet M_4 . For *Deromyia australis*, Ricardo gives the character of the ovipositor as "prominent below", which description eminently fits yet another form that I am unable to place in this tribe so, pending further information, I am omitting the generic name *Deromyia* from any segregate, and I think it very likely the genus will be found to be limited to South America.

Genus *SAROPOGON* Loew.

I would retain temporarily one described species, *Saropogon semirufum* Bigot, of which I have seen one specimen, a female. An ally to it is from the Blue Mts., and two further species are from Brisbane. Two European and one North American species are before me, and some differences in characters are noted in the key. The American species is so very large that at first sight it appears distinct; this species, *S. dispar* Coq., superficially resembles a *Diogmites*, but in structure it differs. The American and Australian species have the fourth antennal segment, the European ones seem to be without it. The abdomen of the Australian forms is relatively longer than the others and tends to taper towards the apex, whereas it tends to widen, at least on the males, on the others. Exotic forms have one or two outstanding lateral bristles on the posterior section of the pronotum, a character missing on the Australian species.

A new genus close to this has a superficial appearance of the European species of *Saropogon*, but the moustache is more bushy, and other characters would exclude it. It is readily recognized by the abdomen broadening towards the apex and it contains one of the commonest Brisbane species which was referred to as a *Saropogon* in my earlier papers.

SAROPOGON GAMARUS Walker.

Dasygogon gamarus Walker, *List Dipt. Brit. Mus.*, ii, 1849, 346; *ibid.*, vi, suppl. 2, 1854, 486.—*Lasiopogon gamarus* Kertész, *Cat. Dipt.*, 1909, 73.—*Dasygogon suavis* Walker, *Trans. Ent. Soc. Lond.*, n.s., iv, 1857, 327.—*Saropogon suavis* Ricardo, *Ann. Mag. Nat. Hist.*, (8) ix, 1912, 146.—*Neosaropogon suavis* Hardy, *Proc. Linn. Soc. N.S.W.*, lii, 1927, 397.

Ricardo thinks *Dasygogon analis* Macquart may be this species; the type is said to be without a head and the abdomen is yellow. It is not clear if there are markings on the abdomen of the specimen seen by her, as Ricardo only refers to them in respect to the original description. Macquart's remarks concerning

these markings of the thorax and abdomen suggest the species may not belong to this genus. The remainder of the synonymy was proposed by Ricardo and is accepted with the necessary alteration to conform with priority. The species is not uncommon around Sydney from February to April.

Although this species is without scutellar bristles, the other bristles, and the character of the abdomen, this being much shorter than in *Neosaropogon*, suggest that the affinities are as here given.

Genus NEOCYRTOPOGON Ricardo.

The excavation between the eyes on this genus was said to be "eliminated"; this should have been "almost eliminated", but there seems to be some variation in this respect. I have now seen a long series of specimens and find only one species represented amongst them, but it varies in size and markings.

NEOCYRTOPOGON MACULATA Roder.

Brachyrrhopala maculata Roder, *Wien. Ent. Zeit.*, ii, 1883, 274; Hardy, *Proc. Roy. Soc. Q'land*, xli, 1929, 60.—*Neocyrtopogon bifasciatus* Ricardo, *Ann. Mag. Nat. Hist.*, (8) ix, 1912, 589.

In 1929, when revising species of *Brachyrrhopala*, I excluded *B. maculata* from that genus, and suggested that it might be a species of *Neosaropogon*. When checking characters for its generic position, it became evident that it was a *Neocyrtopogon* and, moreover, the same species as that upon which the genus was founded.

Genus NEOSAROPOGON Ricardo.

This is a large genus in Australia, of which I have eight species before me. Two described forms are recognizable and neither quite conforms to the remainder. The genus would seem to be related to Australian species placed under *Saropogon*, not to the exotic forms placed there, and it is closely akin to *Neocyrtopogon*, under which it may ultimately be placed as a subgenus. The typical form may or may not have the fourth antennal segment present; it occurs in the others.

NEOSAROPOGON PRINCEPS Macquart.

Previously (these PROCEEDINGS, liii, 1928, 472) I drew attention to the fact that there may be a complex standing under this name. Three of Walker's names are placed as synonyms by Ricardo (*Ann. Mag. Nat. Hist.*, (8) ix, 1912, 591) who stated that, amongst characters given on the type, on the abdomen "the third segment is almost wholly dark" as compared with "only dark on the anterior border" for the other forms. These colour characters seem to conform on Queensland and New South Wales specimens respectively, so it is possible the one known to me only from Queensland may be the typical species and the remainder would then come under one of the names proposed by Walker.

NEOSAROPOGON NITIDUS Macquart.

Dasyopogon nitidus Macquart, *Dipt. Exot.*, suppl. 1, 1846, 61; Walker, *List Dipt. Brit. Mus.*, vi, suppl. 2, 1854, 479.—*Brachyrrhopala nitidus* Ricardo, *Ann. Mag. Nat. Hist.*, ix, 1912, 585; White, *Proc. Roy. Soc. Tasmania*, 1916, 156; Hardy, *Proc. Roy. Soc. Tasmania*, 1916, 271.—*Neosaropogon nitidus* Hardy, *PROC. LINN. Soc. N.S.W.*, lii, 1927, 397.—*Dasyopogon sergius* Walker, *List Dipt. Brit. Mus.*,

ii, 1849, 473; *id.*, vi, suppl. 2, 1854, 477.—*Lasiopogon sergius* Kertész, *Cat. Dipt.*, iv, 1909, 73.—*Saropogon sergius* Ricardo, *Ann. Mag. Nat. Hist.*, ix, 1912, 585.—*Dasyopogon festinans* Walker, *Ins. Saund. Dipt.*, i, 1851, 92.—*Brachyrrhopala nitidus* var. *dissimilans*, Hardy, *Proc. Roy. Soc. Tasmania*, 1916, 271.

The above synonymy is not new, but there are one or two discrepancies in it. Ricardo states that *D. festinans*, from unknown locality, is identical with *D. sergius* Walker, from New South Wales; she also added "from the description of *Dasyopogon nitidus* Macquart, from Tasmania, it is possibly the same species as this". Judging from her descriptions and remarks, there would be no doubt concerning the synonymy, but Walker's description of *D. sergius* does not correspond in markings, and if the synonymy is correct, the locality is wrong.

With regard to the variety *dissimilis*, this has not been met with again, but Mr. C. E. Cole took an intermediate form that has the face with normal colouring, otherwise it resembles the variety. In build it resembles that of *N. princeps* to a remarkable extent.

The species has the scutellum with two pairs of bristles, and there are a few depressed hairs on the face above the tubercle; these two characters are unique to the species, which is only known from Tasmania.

Genus NEODIOCTRIA Loew.

The typical form, *N. australis* Ricardo, from the Blue Mts., is before me. In general resemblance it conforms to *Neosaropogon*, but is without the tibial spur and the abdomen does not tend to widen at the apex but is more or less uniformly wide. In the genitalia of the male, being somewhat globular and having a conspicuous ventral plate, it conforms best to the *Stenopogon* group. On many specimens the hypopygium is inverted, in other cases it is turned through 90 degrees or more.

Genus STENOPOGON Loew.

With the possible exception of *Leptogaster*, *Neosaropogon* and other genera with very elongate slender abdomen, the Asilidae have the first sternite of the abdomen divided into two parts, a modification that seems to be responsible for the flexibility of the abdomen at its base. In Therevidae this sclerite may be partly divided, or even partially formed into three sections. Malloch has used the hairy nature or otherwise of this divided sclerite in order to group species of genus *Stenopogon* into divisions, but the character would seem to be too trivial to be used thus. *Neoscleropogon* is coupled by him with that section of *Scleropogon* that has the posterior part of this sclerite bare, but Australian forms of the genus *Stenopogon* form a homogeneous group that may or may not be bare in this region.

There is only one character given by Malloch in his definition of *Neoscleropogon* that appears to me to hold true, namely, the long pleural hairs. I have attempted to give a better interpretation in the key in regard to this and other subgenera already proposed, but it seems inadvisable to maintain subgenera at the present time when the genera are so poorly understood.

In my figure of the genitalia (PROC. LINN. SOC. N.S.W., li, 1926, 310), illustrated as that of *S. elongatus*, but later shown to be that of *S. fraternus* Bigot, one of the forms confused under the former name, the parts labelled should be corrected as follows: for *d.p.* read *v.p.*; for *u.f.* read *l.f.* and for *l.f.* read *u.f.*; this and all other hypopygia on Australian species are inverted, so the dorsal plate

(*d.p.*) there referred to, becomes the ventral plate (*v.p.*), and the names of the forceps, upper and lower, need reversing.

Genus OSPRIOCERUS Loew.

This North American genus belongs to the *Stenopogon* group, but it differs very considerably in the antennae; the third segment is very long, and the fourth very short, and both together are about three times the length of the basal ones united.

Tribe STICHOPOGONINI, n. tribe.

To this tribe, hitherto left unnamed by me, and which contains two Australian genera, *Clinopogon* and *Cryptopogon*, belong also the American genera *Lasiopogon*, *Neopogon* and, I believe, *Stichopogon*; the last of these I have not seen. *Holocephala*, *Laphystia* and *Psilocurus* do not come within the definition of the group.

Key to genera of the tribe Stichopogonini.

1. Tubercle very large, occupying nearly the whole of the face and containing long erect hairs throughout its length. Hypopygium inverted *Lasiopogon* Loew.
Tubercle moderate in size. If long hairs occur on the face above tubercle, they are strongly depressed and lie over the moustache. Hypopygium normal 2
2. Moustache more or less restricted to the oral margin, the hairs above it being short and inconspicuous 3
Moustache not so confined, long dense hairs overlying the bristles on the tubercle *Clinopogon* Bezzi.
3. Species with rather long abdomen. One presutural and one postalar pair of bristles only present *Neopogon* Bezzi.
Species with shorter, normal abdomen. More than two pairs of thoracic bristles present *Cryptopogon* White.

Genus LASIOPOGON Loew.

The American species of this genus comes within this tribe, and although Lundbeck, when describing the European form, does not mention the character of the prothorax, the description he gives fits here too. Lundbeck draws attention to the inverted hypopygium, a character I find also occurring on the American specimen. Melin, recording the habits of copulation, states: "the two sexes sit with their abdomen in a straight line, facing in opposite directions", which is in keeping with the inverted hypopygium, but Melin makes no mention of this fact. Lundbeck refers to *Cyrtopogon* Loew, as being nearly related, but that genus has a superficial resemblance to it and I am unable to maintain the supposed relationship.

Genus NEOPOGON Bezzi.

Of this genus I have seen two American species. It is regarded as being a synonym of *Stichopogon* by many, but I have not seen the latter genus which is the first described of this group and therefore used for the tribal name. There may be some doubt also if *Clinopogon* and *Cryptopogon* are worthy of separate generic status, but *Neopogon* seems to be consistently different in chaetotaxy as well as shape of the abdomen; the two Australian genera are only to be distinguished from each other by the nature of the moustache. The three genera form a natural group having many characters in common with *Lasiopogon*, to which they are undoubtedly allied.

THE MOSSES OF FIJI.

By H. N. DIXON, M.A., F.L.S., and WILLIAM GREENWOOD, F.L.S.

(Plates viii-ix.)

[Read 25th June, 1930.]

In general, the flowering plants of any country are collected more and are consequently known better than the cryptogams, and Fiji is no exception to this.

The main collections of mosses made in Fiji are those collected by the United States Exploring Expedition of 1840, Milne in "the *Herald*" in 1856, Seemann and Graeffe about 1860 and Miss Gibbs in 1907. These collections altogether recorded 100 species from Fiji. In 1917 Greenwood commenced collecting the mosses whilst on week-end trips to the mountains for botanical and entomological material, and the number of known species now stands at 205.

In this paper all species at present known are included, all the previous records being given as far as possible. Of the numbers collected by Greenwood only about half are given, except where these show an extension of range within the islands beyond that previously known, or are records of species not previously recorded or new.

From the point of view of geographical distribution the mosses of a country are of interest, as they are not plants that would be carried about from place to place by natives. The mosses of Fiji show a strong Indo-Malay element, while, of the remainder, some extend east and west to Samoa and the New Hebrides, New Caledonia and Australia. Only some 205 are at present known from Fiji, and this is probably about half the number to be expected. It would be premature to attempt to give the number of species, out of those recorded, that are endemic, since there is a strong probability that several of those that at present appear to be so (especially among the species described by C. Mueller in the Musci Polynesiaci) may be identical with species already described from surrounding groups.

Of the new records of already known species, the following are of special interest. *Calymperes tuberculosum* (Thér. & Dix.) Broth.; *Bryum chrysoeuron* C.M.; *Pseudorhacelopus philippinensis* Broth.; *Euptychium Gunnii* Broth. & Watts; *Papillaria pellucida* Broth. & Watts; *Homalia exigua* (Bry. jav.); *Campyodontium flavescens* (Hook.); *Clastobryella cuculligera* (Bry. jav.) Fleisch.

A word about the localities quoted may not be out of place. Miss Gibbs collected around Nadarivatu, which lies under Mt. Victoria (4,000 feet) and is on the north side of Viti Levu, the largest island in the group. Greenwood collected mostly in the mountains lying about ten miles back from Lautoka, which is on the coast in the centre of the sugar-growing area of the west coast. These mountains form a range parallel to the coast, and the highest peak, Mt. Evans, is about 3,960 feet high. Nagaga is a Fiji village lying under Mt. Evans and about 8 miles from Lautoka, and the Falls are a short distance from Nagaga.

Loloti is the name of a place where there was a Fiji village years ago and lies about midway between Nagaga and Sabeto. Both Mt. Evans and Nadarivatu are on the dry side of the island. On Vanua Levu, the second largest island, the main collecting has been at Labasa and Wainikoro. Labasa is the centre of the sugar-growing area and lies on the north side of the island. Wainikoro is on the same coast, about 30 miles from Labasa. Both places are on the dry side of the island. Levuka is on Ovalau, the third largest island, and is on the wet side of the island. Nausori and Suva are on the wet side of Viti Levu.

On the wet side of the islands the forests extend nearly down to the sea, and when more collecting has been done in this area many more species should be found.

On the dry side, the country near the coast is open rolling hills, with scattered clumps of *Pandanus*, *Guava* and *Dodonaea*, and flat cultivated land. The forests do not extend below about 1,000 feet elevation, except in the gullies and watercourses where the timber may come a little lower.

On the dry side, in the gullies and near the coast one finds little of interest in the mosses except *Fissidens* and *Philonotis*. Once one climbs past the 1,000 feet level, one comes into patches of timber and reed covered hills with rocky gullies, and here can be found *Entodon Hillebrandii*, *Thuidium cymbifolium*, *Ectropothecium*, *Hypopterygium*, *Mnium*, and *Hyophila*. Climbing higher one enters a forest of very tall trees with very little undergrowth, and here the fallen logs are covered with *Syrrhodon mamillatus*, *Fissidens* and *Leucomium*. Climbing higher the forest thins out, and near the top of Mt. Evans (3,960 feet) the trees are only about 30 feet high, and stunted by the wind. Here the fallen logs and branches are covered with a thick growth of *Papillaria*, *Leucoloma* and *Mniodendron*.

In the following pages a key is given to the genera, and to some of the species, and it is hoped that these will prove useful.

As more collecting is done, and more species become known from Fiji, it is hoped to issue a supplementary article bringing the knowledge of the mosses up to date.

Key to Genera of Mosses Found in Fiji.

[Note.—This key is only applicable to the species (of the included genera) which are actually found in Fiji.]

1. Leaves equitant, conduplicate, distichous 2
Leaves often complanate, but not equitant or truly distichous 3
2. Leaf sheath basal only, formed by an additional lamina (vaginant lamina) arising from the nerve *Fissidens*
The whole leaf doubled on itself and sheathing the stem, leaves nerveless *Orthorrhynchium*
3. Acrocarpous, *i.e.*, the stems are more or less erect (in *Syrrhodon* (*Thyridium*) and *Macromitrium* they may be more or less creeping, but the fruit is terminal on erect branches); fruit terminal except in *Anoectangium* 4
Pleurocarpous, *i.e.*, the stems are creeping or erect from a creeping rhizomatous stem; fruit lateral, the perichaetia produced on the side of the stem or main branches 33
4. Branches fasciculate, dimorphous, some spreading, some pendent and appressed to stem; leaf cells dimorphous, chlorophyllose, very narrow and inconspicuous, hyaline, large, empty, with spiral fibres. Marsh plants *Sphagnum*
Branches not fasciculate; cells all chlorophyllose, or if large and empty, without spiral fibres 5

5. Leaf nearly all composed of nerve—hence apparently nerveless—nerve composed of at least three layers of cells, minute chlorophyllose cells (chlorocysts) and large, empty cells (leucocysts) (Leucobryaceae) 6
 Lamina of leaf mostly composed of chlorophyllose cells; nerve narrow (rarely half width of leaf) 9
6. Chlorocysts superficial (as well as internal), on dorsal and ventral surface of nerve, papillose, so that the leaf is rough *Evodictyon*
 Chlorocysts in a single median layer (seen only in a transverse section of leaf) .. 7
7. Nerve with a dorsal median bundle of stereid cells (appearing as a narrow midrib); capsule erect, symmetric *Leucophanes*
 Nerve without median stereid bundle 8
8. Chlorocysts in transverse section of leaf always quadrangular, capsule curved, dicranoid *Leucobryum*
 Chlorocysts in upper part of leaf in section triangular; capsule erect, symmetric *Octoblepharum*
9. Median basal cells large, empty, very clearly differentiated from the minute chlorophyllose lamina cells (Calymperaceae) 10
 Median basal cells not strikingly differentiated 11
10. Calyptra mitriform, plicate; peristome 0; abnormal leaves often present (with apex narrowed to a more or less prolonged, proboscis extension, then expanded at tip and bearing a tuft of gemmae). Teniole frequently present in lamina (a very narrow intramarginal band of 2-3 rows of paler cells, best seen at shoulder of leaf base, but often continued both upwards and downwards) .. *Calymperes*
 Calyptra cucullate, smooth. Peristome usually present. Abnormal leaves and teniole wanting (but the upper part of the lamina frequently with a narrow, hyaline border or with a thickened intramarginal band) *Syrrophodon*
11. Stems erect. Calyptra large, covered with a dense felt of whitish hairs, pointing downwards (Polytrichaceae) 12
 Calyptra naked, or if hairy, with erect hairs 13
12. Seta rough, leaves without lamellae *Pseudorhacelopus*
 Seta smooth. Upper surface of nerve with numerous longitudinal lamellae *Pogonatum*
13. Calyptra rather large, campanulate, smooth or hairy; stems creeping, with erect branches *Macromitrium*
 Calyptra cucullate, mostly small; stems usually erect 14
14. Leaves large (4-10 mm. long) in rosulate tufts (or in *Mnium* along prostrate shoots); cells large 15
 Leaves smaller, mostly narrow; cells much smaller 16
15. Leaves rotund-spathulate, obtuse and apiculate, cells 20-30 μ in diameter, isodiametric; border of thickened cells *Mnium*
 Leaves spathulate, shortly acuminate, cells rhomboid, border narrow, of non-thickened cells *Rhodobryum*
16. Plants small, capsules almost sessile and immersed 17
 Seta usually long, always longer than the capsule 18
17. Comal leaves larger, lanceolate-subulate, rigid, entire *Garckea*
 Leaves few, broadly ligulate, twisted when dry, subdenticulate *Diphyscium*
18. Leaves narrowly linear or subulate, with thickened border, and bigeminate, spinose teeth; nerve toothed at back *Rhizogonium*
 Border not thickened, teeth when present not bigeminate 19
19. Capsule subspherical, plicate; leaf cells usually unipapillate or with prominent cell ends *Philonotis*
 Capsule more or less elongate, cells either smooth or with numerous fine papillae 20
20. Capsule erect or suberect, peristome 0 or single 23
 Capsule more or less inclined or pendulous (except *Brachymenium*), peristome double; cells more or less rhomboid, smooth 21
21. Leaves all reddish *Mniobryum*
 Leaves not red, except at base 22
22. Capsule almost erect, endostome very imperfect *Brachymenium*
 Capsule inclined or pendulous, endostome well developed *Bryum*
23. Nerve very broad, $\frac{1}{4}$ - $\frac{1}{3}$ width of leaf base; leaves rigid, little altered when dry *Campylopus*
 Nerve narrow 24

24. Capsule with a very long, tapering neck or apophysis, leaves narrow-linear	<i>Trematodon</i>
Capsule without a clearly marked neck	25
25. Alar cells clearly defined, large, often orange	26
Alar cells not or little differentiated	27
26. Leaves broad, concave, piliferous; perichaetial leaves very long, reaching to capsule	<i>Eucamptodon</i>
Leaves narrow, gradually finely acuminate	<i>Leucoloma</i>
27. Perichaetia lateral; leaves oblong-ovate, shortly pointed; cells dense and opaque with papillae	<i>Anoetangium</i>
Perichaetia and fruit terminal	28
28. Peristome dicranoid (teeth broader at base, usually more or less deeply bifurcate, transversely barred), leaves narrow and acuminate, cells more or less elongate, smooth	29
Peristome barbuloïd (teeth filiform, often in pairs, usually papillose, not broader at base or conspicuously barred, sometimes very long and spirally twisted); leaves often broad above; upper cells mostly isodiametric, often papillose	30
29. Seta flexuose and curved when moist, capsule plicate	<i>Campylopodium</i>
Seta erect	<i>Dicranella</i>
30. Leaves rigid; upper cells ovoid-rectangular, smooth; lid obliquely subulate, peristome papillose, long, not twisted	<i>Rhamphidium</i>
Leaves twisted or flexuose when dry, upper cells isodiametric, mostly papillose ..	31
31. Leaves small, margins involute above	<i>Hymenostomum</i>
Leaves with plane or revolute margins	32
32. Peristome 0; leaves rather wide, often denticulate at apex	<i>Hyophila</i>
Peristome long, twisted, leaves rather short and wide	<i>Barbula</i>
Peristome teeth very short, erect, leaves long and narrow, margin plane	<i>Trichostomum</i>
33. Stems with differentiated dorsal or ventral leaves (amphigastria) much smaller than the normal leaves	34
Stems without amphigastria	35
34. Amphigastria on under side of frond, rounded, with short points, leaves bordered	<i>Hypopterygium</i>
Amphigastria on upper side, cordate-acuminate with long points, leaves not bordered	<i>Rhacopilum</i>
35. Leaves with a well defined, often thickened border	36
Leaves without thickened border (slightly thickened in <i>Pterobryella</i>)	38
36. Very robust plants, with very long, rigid, lanceolate leaves	<i>Spridens</i>
Smaller plants, with rounded leaves and lax cells	37
37. Nerve single	<i>Distichophyllum</i>
Nerve with two long branches	<i>Cyclodictyon</i>
38. Nerve with two branches reaching nearly to apex	<i>Callicostella</i>
Nerve single, or double and very short, or 0	39
39. Nerve single	40
Nerve double or 0	62
40. Nerve strong, reaching to near apex, and there markedly sinuous; leaves coarsely toothed above	<i>Herpetineuron</i>
Nerve not markedly sinuous	41
41. Stems pendulous, julaceous, leaves very concave, plicate when dry, cells usually unipapillate	<i>Meteorium</i>
Leaves not markedly concave and plicate	42
42. Cells papillose	43
Cells smooth	49
43. Stems prostrate, bi-tri-pinnate, stem- and branch-leaves markedly dimorphous ..	44
Stems pinnate only, or irregularly branched, leaves not markedly dimorphous ..	45
44. Calyptra cucullate, naked, smooth	<i>Thuidium</i>
Calyptra mitriform, hairy, plicate, fringed at base	<i>Pelekium</i>
45. Plants very delicate, on rocks, with minute leaves	<i>Claopodium</i>
Larger, mostly pendulous, leaves mostly 2 mm. long	46
46. Leaves more or less complanate	47
Leaves not complanate	48

47. Nerve long, distinct, cells unipapillate, margin of leaf undulate	<i>Aërobryopsis</i>
Nerve indistinct, cells obscure with numerous small papillae, margin not undulate	<i>Floribundaria</i>
48. Stems slender, pendulous, flexuose	<i>Papillaria</i>
Stems and leaves rigid	<i>Trachypus</i>
49. Nerve more or less toothed at back above	50
Nerve quite smooth at back	53
50. Upper cells rounded or elliptic	<i>Bescherellea</i>
Upper cells elongate, prosenchymatous; stem dendroid	51
51. Leaf margin entire or slightly denticulate	<i>Pterobryella</i>
Leaf margin spinosely toothed	52
52. Stem tomentose	<i>Mniodendron</i>
Stem not tomentose	<i>Hypnodendron</i>
53. Branching irregular, rarely subpinnate, leaves not complanate	54
Branching more or less pinnate; branches or leaves (often both) complanate	57
54. Upper cells rounded, capsules immersed in the conspicuous perichaetia	<i>Cryphaea</i>
Upper cells elongate, capsules exerted	55
55. Alar cells well defined, numerous, plant very slender	<i>Stereophyllum</i>
Alar cells little differentiated; lid long-beaked	56
56. Plants very slender; leaves minute, narrow	<i>Rhynchostegiella</i>
Plants larger, leaves 1 mm. long or more, broader	<i>Rhynchostegium</i>
57. Secondary stems dendroid, very complanate, bi-tri-pinnate, leaves coarsely dentate above	<i>Homaliodendron</i>
Stems pinnate only, or leaves not coarsely dentate	58
58. Leaves strongly auricled	<i>Calyptothecium</i>
Leaves not clearly auricled	59
59. Leaves very complanate, sub-distichous, stems not densely branched	60
Leaves little or not complanate, biplicate when dry, stems densely branched	61
60. Slender, leaves orbicular, not undulate when dry	<i>Homalia</i>
Larger, leaves lingulate, transversely undulate when dry	<i>Himantocladium</i>
61. Leaves subentire, stems often bipinnate	<i>Pinnatella</i>
Leaves toothed above; stems irregularly pinnate	<i>Thamnum</i>
62. Leaves transversely undulate, obtuse, very complanate	<i>Neckeropsis</i>
Leaves not (or irregularly) transversely undulate	63
63. Alar cells few, large, inflated orange or hyaline (in <i>Meiothecium</i> less marked)	(<i>Sematophyllaceae</i>) 64
Alar cells not inflated or hyaline	71
64. Leaves strongly plicate	<i>Piloecium</i>
Leaves not plicate	65
65. Very slender; crowded brood-filaments near the tips of some branches; leaves sharply denticulate	<i>Clastobryella</i>
Brood filaments wanting; plants usually robust	66
66. Cells papillose	67
Cells smooth	68
67. Capsule suberect or inclined	<i>Trichosteleum</i>
Capsule pendulous, leaves concave, abruptly loriform	<i>Rhaphidostichum</i>
68. Leaves sharply toothed	<i>Trismegistia</i>
Leaves entire or finely denticulate	69
69. Upper cells short, elliptic or rhomboid-elliptic	<i>Meiothecium</i>
Upper cells elongate	70
70. Tall plants, leaves large, broad, shortly pointed	<i>Acroporium</i>
Slender, creeping plants, leaves small, lanceolate, subpiliferous	<i>Rhaphidostegium</i>
71. Cells papillose, small plants	72
Cells smooth	73
72. Cell ends sharply protruding, seta hispid or papillose	<i>Chaetomitrium</i>
Papillae distinctly on lumen, often seriate	<i>Taxithelium</i>
73. Alar cells numerous, markedly differentiated; capsule erect, cylindric	74
Alar cells few and not markedly distinct	75
74. Leaves plicate	<i>Campylodontium</i>
Leaves not plicate	<i>Entodon</i>
75. Stems more or less dendroid, often rigid	76
Stems not dendroid	78

76. Robust; leaves seriate, cochleariform, abruptly cuspidate *Symphysodon*
More slender, leaves not seriate, more gradually pointed 77
77. Rigid, pinnate, not flagelliform *Symphysodontella*
Less rigid, branches more or less curved, often flagelliform at tips .. *Camptochaete*
78. Stems more or less erect, simple or slightly branched, mostly densely foliate, with
large leaves; capsules immersed or shortly exserted 79
Stems more or less prostrate, irregularly branched; leaves smaller, setae long .. 81
79. Leaves not plicate *Garovaglia*
Leaves longitudinally plicate 80
80. Peristome teeth papillose, processes filiform; capsule shortly exserted
..... *Endotrichella*
Peristome teeth striolate, processes broad; capsule immersed in the large peri-
chaetium *Euptychium*
81. Cells lax 82
Cells very narrow 83
82. Usually whitish, cells large, 20 μ wide, acutely rhomboid *Leucomium*
Cells shorter, 15 μ wide or less, branch leaves usually dimorphous, some wider and
with wider cells, some more acuminate with narrower cells *Vesicularia*
83. Capsule suberect, asymmetric, leaves mostly complanate, little curved
..... *Isopterygium*
Capsule pendulous, short and turgid, symmetric, leaves often falcate
..... *Ectropothecium*

DICRANACEAE.

TREMATODON Michx.

TREMATODON SP.

On dry, stony bank, Lautoka, near sea-level, 6.8.17; Greenwood (28).

A very slender plant with much twisted leaves when dry, acute or subacute, and with the apex entire or slightly denticulate, the upper cells very small, not incrassate. Seta short, apophysis about twice the length of the sporangium, clearly strumose. The fruit is very imperfect, and the species scarcely determinable; it is quite probably new, but in its present condition it is not possible to find any characters to separate it from *T. suberectus* Mitt.

GARCKEA C. Muell.

GARCKEA PHASCOIDES (Hook.) C.M.

New to Fiji. On wet bank, Mts., Lautoka, Viti Levu, c. 600 feet, 10.5.19; Greenwood (158). On wet clay bank, Mts., interior of Vanua Levu, c. 2,000 ft., 25.12.22; Greenwood (465).

The capitula are rather more densely and shortly foliate than in the common Indian forms; but other Indian plants agree quite well. The recorded distribution has hitherto been southern Asia and Queensland. It is, however, very doubtful whether the four African species are really distinct.

DICRANELLA Schimp.

DICRANELLA FLACCIDULA Mitt.

Viti; Seemann.

On clay banks, Suva, Viti Levu, near sea-level, 16.3.18; Greenwood (110). Labasa, Vanua Levu, near sea-level, Aug., 1922; Greenwood (443). Clay bank, Macuata Coast, Vanua Levu, 29.2.24; Greenwood (519).

DICRANELLA PYCNOGLOSSA (Broth.) Broth.

New to Fiji. On clay bank, Mts., Lautoka, Viti Levu, c. 1,000 ft., 11.4.20; Greenwood (331).

The Queensland plant (F. M. Bailey, 1889, No. 663) agrees perfectly. Not known hitherto except from Eastern Australia.

CAMPYLOPODIUM Besch.

CAMPYLOPODIUM INTEGRUM (C.M.) Par.

Syn. *Dicranella trichophylla* Mitt.

Viti, Seemann; 862 pp. Ovalau, Milne in herb. Hook., 356a. Labasa, Vanua Levu, near sea-level, Aug., 1922; Greenwood (444). On wet bank, Mts., Labasa, Vanua Levu, c. 300 ft., 2.9.23; Greenwood (513).

LEUCOLOMA Brid.

LEUCOLOMA TENUIFOLIUM Mitt.

Syn. *Dicranum oceanicum* C.M.

Ovalau, Graeffe. On rocks, Mt. Evans, Lautoka, Viti Levu, c. 3,000 ft., 4.1.20; Greenwood (276). On trees, *ibidem*, c. 3,600 ft., 18.6.22; Greenwood (426). Mt. Evans, Lautoka, Viti Levu, c. 3,600 ft., 16.4.22; Greenwood (414). Rotten wood, Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (259).

CAMPYLOPUS Brid.

CAMPYLOPUS RICHARDII (Schwaegr.) Brid.

Syn. *Thysanomitrium Richardii* Schwaegr.; *T. umbellatum* W.-Arn.; *T. hawaiiicum* C.M.; *T. Powellianum* C.M., *nomen nudum*.

Wet ground and wet rocks in open swampy places, Mts., Lautoka, Viti Levu, c. 1,500 ft., 3.1.20; Greenwood (186, 192). Wet ground, Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (226).

For a discussion on the relationship of the Oceanic plant to the South American one, cf. Dixon (*Journ. Bot.*, ix, 1922, 287).

Thériot (*Rev. Chilena Hist. Nat.*, xxix, 1925, 289-290) has given what seem to me entirely cogent reasons for considering *Thysanomitrium* as a subgenus only of *Campylopus*.

DICNEMOS Schwaegr.

DICNEMOS RUGOSUS (Hook.) Schwaegr.

Paris cites this from Fiji, but there appears to be no evidence for its occurrence.

EUCAMPTODON Mont.

EUCAMPTODON PILIFERUS Mitt.

(Cf. C.M., *Gen. Musc. Frond.*, p. 251, sub *Solmsia inflata* Hampe MS., and Salmon, *Journ. Bot.*, xl, 1902, p. 3.)

Fiji, Graeffe (Herb. Schimper et Herb. Hampe).

LEUCOBRYACEAE.

LEUCOBRYUM Hampe.

LEUCOBRYUM SANCTUM Hampe.

Viti; Milne. Ovalau, in montibus, Graeffe.

LEUCOBRYUM LAMINATUM Mitt.

Viti, Ovalau, Seemann, 844. On tree trunks, and on ground, Nadarivatu, Viti Levu, c. 2,700 ft., Sept., 1907; Gibbs (772).

LEUCOBRYUM TAHITENSE Aongstr.

New to Fiji. On trees, Mts., Lautoka, Viti Levu, c. 1,500 ft., 1.9.17; Greenwood (72). Nadarivatu, Viti Levu, c. 2,700 ft., 20.6.19; A. Aspinall, Herb. Greenwood (114).

LEUCOBRYUM PUNGENS C.M.

Ovalau, regio montosa et in cacumine montis Tana-lailai, 2,000 ped. alt., Dec., 1864; Graeffe. On dead wood, Mts., Labasa, Vanua Levu, c. 1,000 ft., 12.6.23; Greenwood (491). *Ibidem*, 13.3.24; Greenwood (524).

These two appear to agree with the description of *L. pungens*; the nerve is strongly heterostrosic; the chlorophyllose cells are hypercentric at the base, centric in mid-leaf and at apex.

LEUCOBRYUM SAMOANUM Fleisch. ined.

(M. Fr. Arch. Ind. et Polynes., No. 404; Ins. Upolu, leg. Fleisch.) On dead wood, Mt. Evans, Lautoka, Viti Levu, c. 3,000 ft., 4.1.20; Greenwood (213).

LEUCOBRYUM TEYSMANNIANUM Bry. jav.

Ovalau, in sylvis montosis, Graeffe.

LEUCOBRYUM PENTASTICHUM Bry. jav.

Ovalau, regio montosa, Graeffe. In open forest, Wainikoro, Macuata Coast, Vanua Levu, c. 100 ft., Feb., 1925; Greenwood (552).

LEUCOPHANES Hampe.

LEUCOPHANES VITIANUM C.M.

Ovalau, ad basin *Rhizogonium setosi* in cacumine montis Tana-lailai, 2,000 ped. alt., Graeffe.

LEUCOPHANES DENSIFOLIUM (Mitt.).

Syn. *Octoblepharum densifolium* Mitt.

Viti, Seemann, inter 862. Milne in herb. Hooker.

LEUCOPHANES SMARAGDINUM (Mitt.) Par.

Syn. *Octoblepharum smaragdinum* Mitt.

Viti, Seeman, inter n. 863.

LEUCOPHANES PUNGENS Fleisch. ined.

(M. Fr. Arch. Ind. et Polynes., No. 405; Samoa, Ins. Savaii, detex. Fleischer.) Samoa, Powell, Herb. Mitt., det. H. N. Dixon. New to Fiji. On rotten logs, 3,500 ft., Mt. Evans, Lautoka, Viti Levu, 4.1.20; Greenwood (199, 277). On tree ferns, Mts., Lautoka, Viti Levu, c. 1,000 ft., 2.1.20, Greenwood (210, 263).

I expressed the opinion (*Journ. Bot.*, 1927, p. 255) that *Leucophanes pungens* Fleisch. was identical with *L. smaragdinum* (Mitt.). This was incorrect. Well grown plants of the latter agree closely in habit and leaf-form, though with rather more acute and acutely spiculose apex, but the nerve structure is entirely different, that of *L. pungens* being homostrosic, while that of *L. smaragdinum* is heterostrosic; in consequence of this the leaf-base of *L. pungens* is much thinner and more transparent.

OCTOBLEPHARUM Hedw.

OCTOBLEPHARUM ALBIDUM (L.) Hedw.

New to Fiji. On trunks of coconut palms, Sigatoka, Viti Levu, sea-level, 10.6.21; Greenwood (391). Levuka, Ovalau, sea-level, 23.4.20; Greenwood (339). Mts., Lautoka, Viti Levu, c. 1,000 ft., 11.4.20; Greenwood (333).

EXODICTYON Card.

EXODICTYON SCABRUM (Mitt.) Card.

New to Fiji. On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,600 ft., 18.6.22; Greenwood (431).

It must be confessed that it is difficult to see how this species differs from *E. Blumii* (Nees) Fleisch. The papillae of the nerve do not appear to be any shorter than in that species.

EXODICTYON DENTATUM (Mitt.) Card.

Syn. *Octoblepharum dentatum* Mitt.; *Arthrocormus dentatus* C.M. New to Fiji. Vanua Balavu, Aug., 1927, leg. B. Tothill; Herb. Greenwood (572).

EXODICTYON SCOLOPENDRIUM (Mitt.) Card.

Syn. *Syrrophodon scolopendrium* Mitt.; *Octoblepharum scolopendrium* Mitt. Viti, Seemann, N.843.

FISSIDENTACEAE.

FISSIDENS Hedw.

§ RETICULARIA.

FISSIDENS DALTONIAEFOLIUS C.M.

New to Fiji. On ground, Mts., Lautoka, Viti Levu, c. 1,000 ft., 4.1.20; Greenwood (224). *Ibidem*, c. 800 ft., 4.4.20; Greenwood (306). On ground, Mts., interior Vanua Levu, c. 2,000 ft., 25.12.22; Greenwood (470, 471). On ground, Levuka, Ovalau, c. 300 ft., 13.1.27; Greenwood (565).

§ BRYOIDIUM.

FISSIDENS PUNGENS Hampe & C.M.

New to Fiji. Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (32). Agrees exactly with the Australian plant.

FISSIDENS ZOLLINGERI Mont.

New to Fiji. On ground, Lautoka, Viti Levu, sea-level, 23.3.20; Greenwood (303). *Ibidem*, Mts., c. 2,000 ft., 4.4.20; Greenwood (317). *Ibidem*, c. 600 ft., 16.1.21; Greenwood (380). On ground, Labasa, Vanua Levu, near sea-level, 8.12.22; Greenwood (455), 24.8.23; Greenwood (510). On ground, Wainikoro, Macuata Coast, Vanua Levu, c. 500 ft., Feb., 1925; Greenwood (550). On wet bank, Levuka, Ovalau, c. 200 ft., 13.1.27; Greenwood (564), with *F. diversiretis* Dix.

FISSIDENS GLOSSO-BRYOIDES Dix., n. sp. Plate viii, fig. 1.

§ Bryoidium. Caules gregarii, usque ad 1 cm. fere alti, pallide virides, laxifolii. Folia sicca contracta, flexuosula, lingulata vel rarius oblongo-lingulata, acuta (raro subobtusa); lamina vaginans circa dimidiam partem longitudinis aequans vel paulo ultra; lamina dorsalis ad basin costae enata ibidemque angusta, vix decurrens. Costa perpallida, angusta, percurrens, vix excurrrens. Lamina

ubique limbo latiusculo albo subaequali circumdata. Cellulae minutissimae, 4-6 μ irregulares, perobscurae, humillime, perindistincte papillosae, basilares paullo majores, distinctiores.

Planta sterilis sola nota.

Hab.—Mountains, Lautoka, Viti Levu, on clay banks, Dec., 1917; Greenwood (130, type; 120; 307).

The Section Bryoidium is poorly represented in Oceania, and indeed the only species hitherto recorded of the group is the Tahitian *F. nano-bryoides* Besch., which is a smaller plant with large cells. The pallid colour, very pale nerve, leaves shrinking when dry, and very small cells make this a quite distinct species.

FISSIDENS DIVERSIRETIS Dix., n. sp. Plate viii, fig. 2.

§ Bryoidium. Subcaespitosus, pallidus, circa 5 mm. altus, densiuscule foliosus. Folia sicca contracta, perangusta, ligulato-lanceolata seu lingulata, supra sensim angustata, acuta vel peracuta; lamina dorsalis infra angustissima, longe ad costam decurrens, saepe basin haud attingens. Limbus ubique (nisi laminae vaginantis) perangustus, apicem folii vix attingens, ibique saepe minute denticulatus. Costa perangusta, sinuosula, subconcolor vel superne pallida. Cellulae superiores minutae, 6-9 μ , hexagonae, obscurae, quaeque papilla singula alta coronata. Cellulae basilares laxissimae, hyalinae, saepe 50 μ longae atque 12-15 μ latae.

Synoicus. Fructus terminalis. Seta circa 3 mm. longa, theca parva, elliptica, erecta; operculum rostratum. Peristomii dentes rubri, inferne lati, intus alte cristati.

Hab.—Mountains, Lautoka, Viti Levu; Greenwood (202, type; 172, 319*d*, 305). In deep shade on bank, close to water, Lautoka (144). Levuka, Ovalau (344, 564*b*). On damp ground in forest in mountains, Labasa (514).

A very distinct species in the narrow leaves and extreme diversity between the upper cells and those of the vaginant lamina near base. It appears to be frequent, and is often associated with *F. daltoniaefolius*.

§ SEMILIMBIDIUM.

FISSIDENS LAUTOKENSIS Dix., n. sp. Plate viii, fig. 4.

§ Semilimbidium. Caespitosus. Caulis longiusculus, usque ad 1 cm., simplex vel hic illic divisus. Folia pluriyuga, conferta, plumose disposita, sicca decurvata, falcata, anguste lanceolata, acute acuminata, apex plerumque asymmetricus. Lamina dorsalis ad basin costae enata, ibique plerumque rotundata. Costa angusta, pallida, in vel cum apice soluta. Margines vel ubique elimbati, vel paucorum foliorum supremorum (praecipue caulibus fructiferis) angustissime inconspicue limbati, ceterum ubique conferte regulariter minutissime, superne rotundate inferne argute, crenulati. Cellulae omnes subaequales, 6-7 μ , hexagono-rotundatae, perindistinctae, parietibus hyalinis, alte mammosae, basilares minime mutatae. Seta saepe geniculata, 2 mm. alta; theca minuta, erecta; peristomii dentes angustissimi, inter se remoti, inaequales, irregulariter, saepe ad basin fissi, pallidi.

Hab.—On bark, Mt. Evans, Lautoka, Viti Levu, Jan., 1920; Greenwood (184, type). Hills near Lautoka (4, 133, 134, 147-149, 150). Loloti (363). Labasa (458, 495).

A member of the characteristic plumose-leaved species, often entirely destitute of border, and usually with slight traces only; but very distinct in the areolation

which, instead of being obscure and minutely papillose as is usually the case, consists of very distinctly separated cells, having the walls highly pellucid, and the lumen dark, though rather by the refraction of light due to the high, conical mamillae than by the cell contents; this is particularly noticeable in the lower cells. The lower margin of the dorsal lamina is spiculose with the projecting cell ends.

It varies much in the form of leaf and the development of the border, but the structural characters seem constant.

F. abbreviatus Mitt. is a much shorter plant, with few, not plumose leaves, and obscure, very finely papillose cells.

F. philonotulus Besch. differs, *e descr.*, in the leaf margin entire ("integerrima"), the much longer vaginant lamina (reaching to two-thirds of the length of the leaf), habit resembling a *Philonotis*, *et cetera*.

FISSIDENS CUSPIDIFERUS Dix., n. sp. Plate viii, fig. 3.

§ Semilimbidium. Plantae gregariae, minutae, humillimae, virides, paucifoliae. Folia oblongo-lanceolata, mollia, haud acuminata, plerumque in cuspidem brevem acutum obliquum raptim angustata; costa tenuissima, concolor, percurrens; lamina vaginans anguste viridi-limbata, ceterum margines tenerrime crenulati. Cellulae superiores parvae, circa 8 μ latae, irregulares, chlorophyllosae, parietibus tenuibus, omnes papilla alta singula arguta praeditae; basillares in lamina vaginante laxiores, subquadratae. Seta tenuis, pallida, caule longior, theca minuta, erecta, sicca urceolata, operculo longirostro.

Hab.—Mountains, Lautoka, Viti Levu, Apr., 1920; Greenwood (319a).

Apparently rare; very minute, with rather wide, soft, chlorophyllose leaves, very variable in the point, but usually ending in an oblique, acute, abrupt point, mostly formed by the nerve.

§ ALOMA.

FISSIDENS FISSICAULIS C.M.

Ovalau, inter *Mniadelphum* specimina perpauca; Graeffe.

FISSIDENS ALTISETUS Dix., n. sp. Plate viii, fig. 6.

§ Aloma. Plantae gregariae, humillimae, brevissimae, subacaules; folia 4-6, infima minuta, 2-4 suprema multo majora, circa 0.8 mm. longa, lanceolata, peracuta, perpellucida, immarginata, integra; lamina vaginans minusquam dimidiam partem folii aequans, aperta; costa validiuscula, opaca, in vel cum apice soluta. Cellulae laxae, superiores elongatae hexagonae, inanes, parietibus tenuibus, firmis; 18-24 μ longae, 8-10 μ latae, inferne sensim laxiores. Seta tenuis, flavida, flexuosa, longa, 6-7 mm. alta; theca perminuta, turgide ovata, deoperculata circa 0.5 mm. longa; operculum longirostre.

Hab.—On track in dense shade; mountains, Lautoka, Viti Levu, Jan., 1920; Greenwood (211, type). Loloti, 18.9.20; Greenwood (360, 364).

Very distinct in the narrow, very pellucid leaves, and lax, elongate areolation. *F. fissicaulis* has a distinct, plurijugous stem, crenulate leaves, and excurrent nerve. The length of the seta is a conspicuous feature here, being six or seven times the height of the whole gametophyte.

FISSIDENS VITIENSIS Dix., n. sp. Plate viii, fig. 5.

§ Aloma. Caules aggregati, ad 3 mm. alti, rigidi; folia laxa, carnosa, complanata, 6-7 juga, sicca vix mutata, stricta, oblonga, acuta; lamina dorsalis ad basin folii enata; lamina vaginans brevis, apice rotundato; costa valida, bene delimitata, fusca, in vel sub apice soluta; margines crenulatae; cellulae hexagonae, irregulares, majusculae, 10-14 μ latae, incrassatae, inferne parum majores.

Cetera ignota.

Hab.—On ground, mountains, interior Vanua Levu, c. 2,000 ft., 25.12.22: Greenwood (476, type). On ground in forest, Wainikoro, Macuata Coast, Vanua Levu, c. 500 ft., 27.3.24, Greenwood (542).

Entirely distinct from the last-mentioned species, and nearer to some Asiatic species.

§ CRENULARIA.

FISSIDENS LAGENARIUS Mitt.

Ovalau, reg. montana, Graeffe.

FISSIDENS PEROBTUSUS Dix., n. sp. Plate viii, fig. 7.

§ Crenularia. Caulis brevis, plurijuga, angustus, polymorphus, folia nunc dissita, patentia, nunc densissime conferta, sicca decurvo-falcata; e basi latiore (saepe aperta) late brevissime lingulata, obtusissima. Lamina vaginans plerumque aperta, longissima; ad apicem folii fere attingens. Costa perpellucida, infra apicem desinens. Lamina dorsalis parva, angusta, infra raptim angustata, longe ante basin folii desinens. Laminae omnes elimbatae, crenulatae. Cellulae minutae, perobscurae, chlorophyllosae, dorso inaequaliter, saepe altiuscule papillosae, inferne saepe transverse elongatae, ad margines, praecipue ad apicem, saepe una serie paullo majores, pallidiores, valde crenulatae.

(Fructus in specimine typico nullus; in 518 seta geniculata 1.5-2 mm. longa, theca erecta, minuta, angusta.)

Hab.—On damp ground, Lautoka, Viti Levu, c. 100 feet, Aug., 1917; Greenwood (34, type). Damp bank, Macuata Coast, Vanua Levu; Greenwood (518).

A most distinct little species in the opaque and chlorophyllose, very obtuse leaves, and the vaginant lamina reaching almost to the apex.

§ AMBLYOTHALLIA.

FISSIDENS MANGAREVENSIS Mont.

Syn. F. samoanus C.M.

New to Fiji. On ground and rocks, Mts., Lautoka, Viti Levu, 800-3,000 ft.; Greenwood (201, 146, 154, 346, 350, 351, 370). On rocks in spray of falls, Lautoka, Viti Levu, c. 1,000 ft., 9.12.17; Greenwood (45). Rock and clay bank, Loloti, Viti Levu; Greenwood (208, 212, 361). On wet bank, and on dead wood, Labasa, Vanua Levu, 300 and 500 ft.; Greenwood (486, 499).

FISSIDENS MANGAREVENSIS var. PERACUTUS Dix., n. var.

Gracilis. Folia perangusta, angustissime acuminata.

Hab.—On calcareous rocks, mountains, Lautoka, Viti Levu, Sept., 1917; Greenwood (20, type). *Ibidem*, edge of creek; Greenwood (215).

In its extreme form a very marked variety, but intermediate forms occur.

I have examined authentic specimens of *F. samoanus* C.M. (Upolu, Samoa, leg. Graeffe), and find them identical with *F. mangarevensis* Mont. The cells show a good deal of variation in their degree of obscurity, and the leaf point in acuteness, while the basal termination of the dorsal lamina also varies a good deal; in some stems it is distinctly auriculate in the upper leaves, narrowly decurrent in the lower. The only character by which *F. samoanus*, as described by C. Mueller, should differ from *F. mangarevensis* (he does not compare it with that) is that he describes the vaginant lamina as ending very acutely above, while it is described by Bescherelle as ending obtusely. It is, however, an inconstant character in the species; I have seen it moderately obtuse on the lower, broader leaves of a stem, and very acute on the narrower, upper leaves.

The var. *taitensis* Besch. does not seem of importance. It is only a small form.

C. Mueller does not include Fiji in the "Musci Polynesiaci" for *F. samoanus*; Paris gives Fiji in the distribution, but apparently without foundation.

FISSIDENS PERACUMINATUS Dix., n. sp. Plate viii, fig. 8.

§ Amblyothallia. Habitus *F. mangarevensis* Mont., praecipue var. *peracutae* Dix. Differt cellulis multo majoribus, 10–12 μ (in *F. mangarevensis* 5–7 μ , perobscurae), haud obscuris, subincrassatis, altiuscule mammosis, marginalibus prominentibus, unde folia distincte obtuse crenulata; costa concolore, haud pellucida, valde sinuosa; lamina dorsalis infra angustissime desinente, saepius longe supra costae basin dissoluta. Theca perbrevis, turgida, inaequalis, subcurvata.

Hab.—In thick bush, Macuata Coast, Vanua Levu, Mar., 1924; Greenwood (535, type; 532).

In habit and leaf-form almost exactly similar to the shorter, narrow-leaved forms of *F. mangarevensis*; but differing at once in the far larger, clearly defined cells, the green, very sinuose nerve, strongly crenulate margins, and the dorsal lamina narrowing downwards and ceasing often far above the base; in *F. mangarevensis* it ends abruptly at the leaf base, usually in a rounded auricle. I have seen no fruit of *F. mangarevensis*; Bescherelle describes it as urceolate-cylindric; it is here very short and turgid, and more or less gibbous.

CALYMPERACEAE.

SYRRHOPODON Schwaegr.

SYRRHOPODON ALBO-VAGINATUS Schwaegr.

Viti, Milne, in herb. Hook.

SYRRHOPODON LAEVIGATUS Mitt.

Ovalau, Milne, in herb. Hook.

SYRRHOPODON GRAEFFEANUS C.M.

Ovalau, regio montosa, Graeffe. Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (249).

SYRRHOPODON MAMILLATUS C.M.

Ovalau, inter *Mniadelphum vitianum*, Graeffe. On dead wood in forest, near Nadarivatu, Viti Levu, c. 2,300 ft., Sept., 1907; Gibbs (760). On rotten log, Mt. Evans, Viti Levu, c. 2,000 ft., 10.5.19; Greenwood (161); 4.1.20; Greenwood (270).

On rotten log, Labasa, Vanua Levu; Greenwood (496, 504). On rotten log, Wainikoro, Macuata Coast, Vanua Levu, c. 300 ft., 29.2.24; Greenwood (517).

SYRRHOPODON (THYRIDIMUM) FASCICULATUS Doz. & Molk.

Ovalau, reg. montosa, Graeffe.

SYRRHOPODON (THYRIDIMUM) LUTEUS Mitt.

Ovalau, Milne, on stones in the mountains. Ovalau, in reg. montosa, Graeffe.

SYRRHOPODON CROCEUS Mitt.

Ovalau, reg. montosa, quoque in cacumine montis Tana-lailai, Graeffe.

CALYMPERES SW.

CALYMPERES TENERUM C.M.

New to Fiji. Levuka, Ovalau, near sea-level, 23.4.20; Greenwood (340). Sigatoka, Viti Levu, near sea-level, 11.6.22; Greenwood (417). Vanua Balavu, July, 1927, leg. B. Tothill; Herb. Greenwood (568).

CALYMPERES MOLLUCCENSE Schwaegr.

New to Fiji. On dead wood, Suva, Viti Levu, sea-level, 25.1.23; Greenwood (477). On trees in forest, Wainikoro, Macuata Coast, Vanua Levu, c. 300 ft., Feb., 1925; Greenwood (553).

CALYMPERES SAMOANUM Besch.

New to Fiji. Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (17).

Distinguished, by Bescherele, from *C. Dozyanum* by the presence of a teniole in the basal part, by the cancelline cells markedly scalariform, and the normal leaves rounded at the summit.

C. LINEARIFOLIUM C.M., and *C. OBLIQUATUM* C.M.

Paris gives both these for Fiji, but I can find no evidence for their occurrence. The references in *Engl. Bot. Jahrb.* do not apply to Fiji.

CALYMPERES CHAMAELEONTUM C.M.

New to Fiji. On dead wood, Mts., Labasa, Vanua Levu, c. 300 ft., 3.6.23; Greenwood (484). On tree in forest, Wainikoro, Macuata Coast, Vanua Levu, c. 500 ft., 27.3.24; Greenwood (541).

This agrees perfectly with a specimen from New Caledonia, leg. Franc, det. Thériot.

CALYMPERES ALBO-LIMBATUM Dix., n. sp. Plate viii, fig. 9.

C. marginato Dix. et *C. molluccensi* affine. Differt ab illo foliis angustioribus, anguste lingulatis; cellulis majoribus, 7-9 μ , altius papillatis, cancellina distincte scalariformi, seriebus margines versus parum angustatis.

A *C. molluccensi* cancellina scalariformi, vagina haud vel vix dilatata, costa angustiore, seriebus cancellinis multo paucioribus, margines versus minime angustioribus. Margines basilares minute argute denticulati, teniola perangusta, in lamina ad apicem fere producta, limbum perangustum distinctum albescentem irregulariter eroso-denticulatum instruens.

Hab.—On rotten wood, in mountains, Labasa, Vanua Levu, June, 1923; Greenwood (483).

A delicate little plant which, although by the scalariform cancellina it would be placed under *Olimacina* in Bescherelle's arrangement, is certainly nearly allied to the following species, *C. marginatum*, which belongs to the Eurycycla Group. It differs from that markedly in some characters, especially the large cells, narrower marginal (not intramarginal) border, cancelline cells scarcely narrowed towards margin, narrower nerve, etc. The teniole separates it at once from *C. tenerum*.

CALYMPERES MARGINATUM Dix., n. sp. Plate viii, fig. 10.

Subgenus Hyophilina. *C. molluccensi* Schwaegr. (sensu Fleischer) affine; differt foliorum basi vel paullo vel haud latiore, hyalocystis multo paucioribus, 8-9 (in *C. molluccensi* 12-16 seriatis); marginibus basilaribus et ventralibus integris vel subintegris; teniola perdistincta, ad apicem producta, limbum angustum hyalinum bene notatum instruens, aut marginalem aut serie unica cellularum quadratarum circumductum. Cellulae superiores minutae, 4-6 μ latae, papillosae.

Hab.—Tree trunk, circa 3,000 ft., interior of Vanua Levu, Dec., 1922; Greenwood (474).

C. molluccense Schwaegr. is a much misunderstood species; either it is a highly variable and widely spread plant, or else many of the plants in herbaria are incorrectly determined. As described by Fleischer from the original plant (Rauwak, Mollucas), it varies within certain limits, including the development of the teniole; but the widened base of the leaf, with a much larger number of rows of cells in the cancellina region, seems to preclude the present plant from being placed there. The same characters exclude *C. Geppii* Besch., which (recorded from New Caledonia) is the only species of this alliance at present reported from anywhere in the Oceanic region. It is, therefore, rather remarkable that the present list should include the true *C. molluccense*, together with two other species which, while nearly allied, are certainly distinct from it and from one another.

CALYMPERES TAHITENSE (Sull.) Mitt.

Syn. *C. denticulatum* C.M.; *C. orientale* Mitt.

Viti, damp places on high ground, Milne, 352 in herb. Hook. On rocks, Mts., Lautoka, Viti Levu, c. 1,500 ft., 4.1.20; Greenwood (220). Mts., Labasa, Vanua Levu, c. 500 ft., 8.7.23; Greenwood (503). Labasa, near sea-level, 7.10.22; Greenwood (453). On trees, Lautoka, Viti Levu, Mt. Evans, c. 2,000 ft., 4.1.20; Greenwood (183). On rock, Levuka, Ovalau, near sea-level, 17.5.23; Greenwood (480).

CALYMPERES TAHITENSE var. TRUNCATUM Thér. & Dix., n. var. Plate viii, fig. 11.

Apex foliorum truncatus, saepe retusus. Laminae margines saepe bigeminate dentati.

Hab.—Faisi, Solomon Is., 1912; leg. Lee, herb. G. Webster (804), type. Mt. Evans, Lautoka, Viti Levu, c. 1,500 ft., 9.12.17; Greenwood (44).

This was at first considered to be a new species, but the leaf apex, though very marked at times, varies considerably.

Fleischer has reduced *C. denticulatum* C.M. to *C. orientale* Mitt. But I have examined the original plant of *C. tahitense* Sull., coll. Wilkes, and find it identical in every respect with *C. orientale* and *C. denticulatum*. Brotherus indeed puts *C. tahitense* in a group with "Scheidenteil gesagt", but it is quite entire in Wilkes' plant, and is so figured by Sullivan.

CALYMPERES SERRATUM A. Br.

New to Fiji. Mt. Evans, Lautoka, Viti Levu, c. 2,000 ft., 3.10.20; Greenwood (367).

CALYMPERES LONGIFOLIUM Mitt.

New to Fiji. Mts., Wainikoro, Macuata Coast, Vanua Levu, c. 500 ft., 27.3.24; Greenwood (538, 558).

CALYMPERES LORIFOLIUM Mitt.

Viti, Milne. Ovalau, Graeffe.

CALYMPERES TUBERCULOSUM (Thér. & Dix.) Broth.

Syn. *Syrrhopodon tuberculatus* Thér. & Dix.

New to Fiji. On rock, Mts., Labasa, Vanua Levu, c. 500 ft.; Greenwood (506). On ground in forest, Wainikoro, Macuata Coast, Vanua Levu, c. 300 ft.; Greenwood (533).

Brotherus is without doubt correct in placing this very distinct species in *Calymperes*. Its distribution is rather remarkable; it has only been found elsewhere in Borneo.

POTTIACEAE.

HYMENOSTOMUM R. Br.

HYMENOSTOMUM EDENTULUM (Mitt.) Besch.

New to Fiji. On ground, Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (225, 229).

RHAMPHIDIUM Mitt.

RHAMPHIDIUM VEITCHII Dix., n. sp. Plate viii, fig. 12.

Habitu *R. purpurati* Mitt., sed elatius, strictius, foliis siccis erectis, appressis, comalibus tantum paullo patentibus. Caules 2 cm. alti. Folia inferiora e basi vaginante breviter lingulata, concava, rotundato-obtusa, superiora sensim longiora, magis acuminata, suprema subula longa angusta tenui, sed apice plerumque obtuse truncato ibique conferte denticulato. Costa valida, fusca, subpercurrans. Margines superiores anguste recurvati. Cellulae basilares inanes, anguste lineares, superiores subquadratae, pellucidae. Seta 1 cm. vel supra; theca erecta, elliptica, deoperculata 2 mm. longa, castanea; operculum subaequilongum, oblique tenuirostratum. Peristomii dentes longi, stricti, sicci conniventes, madidi erectopatuli, supra filiformes, infra latiores sed angusti, linea media pallida exarati, ibique hic illic fissi, ubique densissime papilloso. Spori circa 14 μ , tenerrime punctulati.

Hab.—On wet ground, Nausori Mill, Viti Levu, c. 100 ft., May, 1921: leg. R. Veitch, herb. Greenwood (440).

Named in honour of the collector, Chief Entomologist to the Colonial Sugar Refining Co. of Sydney, N.S.W., from 1914 to 1925.

A quite distinct species of a small genus with a very discontinuous geographical distribution.

HYOPHILA Brid.

HYOPHILA VITIANA (C.M.) Jaeg.

Ovalau, Graeffe.

HYOPHILA MICHOLITZII Broth.

New to Fiji. On rocks at falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 27.10.17; Greenwood (18, 103). On wet rocks, Lautoka, Viti Levu, near sea-level, 25.11.19; Greenwood (142). *Ibidem*, c. 800 ft., 2.1.20; Greenwood (262).

HYOPHILA MICHOLITZII, var. STERILIS Fleisch.

Nagaga, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1912; McRoberts.

On rocks in spray of falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 19.9.17; Greenwood (1, 135); *ibidem*, 27.10.17; Greenwood (15); *ibidem*, 10.5.19; Greenwood (156).

This appears to agree exactly with the Javan plant. The specimen of McRoberts was distributed as *H. elata* Broth. & Watts ined., but I think it certainly belongs to this variety; the fact that the type occurs in the Islands confirms the determination.

HYOPHILA SAMOANA Mitt.

New to Fiji. Fiji, 1909, leg. Jas. Murray; herb. W. Ingham (4).

This agrees well with an authentic specimen of Graeffe's; but I doubt very much whether it differs from *H. Micholitzii*.

TRICHOSTOMUM Hedw.

TRICHOSTOMUM MAUIENSE (C.M.) Broth.

(*nec T. mauiense* Broth., *Bull. Bern. P. Bishop Mus.*, 40, p. 12.)

Syn. *Barbula mauiensis* C.M.

New to Fiji. Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 27.10.17; Greenwood (13). Mt. Evans, Lautoka, Viti Levu, c. 2,000 ft., 3.10.20; Greenwood (372).

TRICHOSTOMUM INSULARE (Besch.) Broth.

New to Fiji. Mts., Lautoka, Viti Levu, c. 1,500 ft., 4.4.20; Greenwood (335).

This agrees quite well with the New Caledonian plant.

BARBULA Hedw.

BARBULA LOUISIADUM Broth.?

On side of wet rock cutting, Sigatoka, Viti Levu, near sea-level, 12.9.20; Greenwood (358); *ibidem*, 20.5.21; Greenwood (389).

An undeveloped plant. It scarcely differs from *B. louisiadum*, except in the leaves obtuse or very shortly mucronate.

BARBULA LEUCOBASIS Dix., n. sp. Plate viii, fig. 13.

§ Hydropogon. Pallide viridis, gracilis, humilis. *B. javanicae* Doz. & Molk. affinis, sed foliis multo mollioribus, latioribus, late oblonga, 1.5 mm. longa, 0.5-0.6 mm. lata, acutiora, cellulis basilaribus laxis, unde folii basis in situ albida,

conspicua. Cellulae superiores subquadratae, 8-10 μ latae, alte mamillosae. Margines plani vel hic illic angustissime revoluti. Costa percurrens vel in apiculum minutum excurrens, dorso laevi vel papillosa. Folia perichaetialia vix distincta. Seta tenuis, flexuosa. Peristomii dentes intense rubri.

Hab.—On wet rock, Mts., Lautoka, Viti Levu, Jan., 1920; Greenwood (206, type). On wet bank, Mts., Lautoka, Viti Levu, c. 700 ft., 1.5.21; Greenwood (386).

Near to *B. javanica*, but of softer texture, with broader leaves, their bases conspicuous by their pale colour, due to the lax basal cells. *B. inflexa* has longer leaves, plane margins and different areolation. The basal cells here are lax and hyaline, but they do not extend high in the leaf, and pass very quickly into the small upper cells.

ORTHOTRICHACEAE.

ANOECTANGIUM Bry. eur.

ANOECTANGIUM TAPES Besch.

New to Fiji. Rocks, falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (21); *ibidem*, 9.12.17 (63); *ibidem*, 3.1.20 (285).

MACROMITRIUM Brid.

MACROMITRIUM ANGULATUM Mitt.

New to Fiji. On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,000 ft., 18.6.22; Greenwood (436). *Ibidem*, 4.1.20; Greenwood (198, 207).

MACROMITRIUM INVOLUTIFOLIUM (Hook. & Grev.) Schwaegr.

New to Fiji. On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,600 ft., 23.10.21; Greenwood (406). On rocks, *ibidem*, c. 3,000 ft., 18.6.22; Greenwood (433, 434).

Distr.—East Australia. The reference to New Zealand in Brotherus, Musci, is incorrect.

MACROMITRIUM INCURVIFOLIUM Schwaegr.

On tree trunks in forest, Nadarivatu, Viti Levu, c. 2,700 ft., Sept., 1907; Gibbs (755). On trees, Mt. Evans, Lautoka, Viti Levu, c. 2,000 ft., 3.10.20; Greenwood (368, 373, 374). *Ibidem*, c. 3,600 ft., 23.10.21; Greenwood (405).

MACROMITRIUM BEECHEYANUM Mitt.

New to Fiji. On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,600 ft., 23.10.21; Greenwood (409). *Ibidem*, c. 3,000 ft., 18.6.22; Greenwood (435).

MACROMITRIUM TONGENSE Sull.

On wood in forest, Nadarivatu, Viti Levu, c. 2,700 ft., Sept., 1907; Gibbs (857). On trees, Wainikoro, Macuata Coast, Vanua Levu, c. 300 ft., Feb., 1925; Greenwood (549).

Key to the Fiji Species of Macromitrium.

1. Erect branches very short, less than 3 mm. high, leaves closely spirally twisted when dry *M. tongense*
- Erect branches long, 4 mm. or more high 2
2. Branches very slender, rigid; leaves very small, scarcely 1 mm. long, appressed and rigidly curved to one side when dry; calyptra densely hairy; seta papillose
..... *M. angulatum*
- Branches stouter; leaves longer, more or less contorted when dry; seta smooth .. 3

3. Capsule subcylindric; robust plant *M. involutifolium*
 Capsule elliptic-ovoid 4
 4. Leaves narrowly ligulate, long *M. Beecheyanum*
 Leaves much shorter, acuminate *M. incurvifolium*

BRYACEAE.

BRACHYMENIUM Hook.

BRACHYMENIUM INDICUM (Doz. & Mol.) Bry. jav.

New to Fiji. On rocks, Levuka, Ovalau, c. 100 ft., 17.5.23; Greenwood (479); *ibidem*, 23.4.20; Greenwood (338, 341).

BRACHYMENIUM INDICUM, var. CORRUGATUM Besch.

On coral rocks in shade, Sigatoka, Viti Levu, near sea-level, 10.6.21; Greenwood (121, 393).

MNIQBRYUM Schimp.

MNIQBRYUM RUBRUM Dix., n. sp. Plate viii, fig. 14.

Densissime coespitosum, humillimum, rubrum. Habitu et colore *M. tasmanici* Broth. simile; atque foliorum forma, sed costa in cuspidem brevem integrum excurrens; foliorum margines integerrimi; cellulae marginales in seriebus 1-2 lineares, limbum angustissimum bene notatum instruentes.

Hab.—Fiji; leg. Jas. Murray, 1909 (1).

The generic position of this moss is not quite certain; but the leaf form, colour, etc., are so similar to *M. tasmanicum* that it seems likely to belong here rather than to *Webera*. The very narrow, pellucid leaves, with a very narrow but well defined border, quite entire margin, and the red, excurrent nerve, are strong characters.

BRYUM L.

§ DOLIOLIDIUM.

BRYUM PACHYTHECA C.M.

New to Fiji. Damp ground in open, Mts., Lautoka, Viti Levu, c. 400 ft., 29.5.21; Greenwood (385). Wet places, Mts., Lautoka, Viti Levu, c. 900 ft., 3.1.20; Greenwood (187).

§ ERYTHROCARPA.

BRYUM CHRYSONEURON C.M.

Syn. B. erythrocarpoides Hampe & C.M.

New to Fiji. Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (30); *ibidem*, 22.2.19; Greenwood (152). Levuka, Ovalau, c. 100 ft., 23.4.20; Greenwood (343).

This is certainly identical with the Australasian plant, which has gone under more names than one. It appears very doubtful whether *B. gedeanum* Doz. & Mol. is not the same thing.

§ ALPINIFORMIA.

BRYUM VITIANUM Dix., n. sp. Plate viii, fig. 15.

Dense caespitosum; caespites superne pallide virides, subnitidi, inferne rubri. Caules 1-2 cm. alti, conferte foliosi. Folia sicca suberecta, leniter curvata, convoluta, 2 mm. longa velpaullo ultra, 1 mm. lata, valde concava, mollia, cymbi-

formia, oblongo-ovata, obtusa vel obtuso-apiculata vel acuta, breviter apiculata, plus minusve cucullato-incurva, apiculo saepe leniter recurvo; margines omnino erecti; costa sat valida, rubra, superne angustata, cum apice soluta vel indistincte brevissime excurrens. Rete laxum, cellulae superiores $40-50 \mu \times 10-14 \mu$, elongate rhomboideae, parietibus tenuiusculis, firmis; marginales angustati, sed limbum notatum haud formantes; apud apicem breviores; basiliares laxae, rubrae, saepe late rectangulares vel quadratae.

Fructus ignotus.

Hab.—Rocks in stream, Lautoka, Viti Levu, c. 1,000 ft., 10.5.19; Greenwood (159, type). *Ibidem*, 22.9.17; Greenwood (12), and 9.12.17 (75).

No. 12 is a more rigid form, with strict stems and closely imbricated, rigid leaves.

The only species of the Section, I believe, yet recorded from the Pacific region, Australasia excepted. *B. Sullivani* C.M. from Australia is very near it, but has stouter nerve, narrower leaves and much smaller cells.

§ ROSULATA.

BRYUM GREENWOODII Dix., n. sp. Plate viii, fig. 16.

Robustum, caules 2-4 cm. alti vel supra, plerumque haud comati (interdum subcomati); folia conferta, paullo decurrentia, e basi angustiore latissime spatulato-ovata, apice subrotundato, nullo modo acuminato, subobtusa vel subacuta; margine inferne revoluta; costa validiuscula, superne multo angustior, in apiculum validum vel cuspidem brevissimum excurrens. Seta 2-2.5 cm. longa. Theca angustiuscula, curvata, brevicolla.

Hab.—Flat, damp rocks in open place, Mt. Evans, Lautoka, Apr., 1922; Greenwood (410, type; 162, 228). Mountains, near Lautoka (71). All sterile except the type.

Near to *B. truncorum*, *B. Decaisnei*, etc., but I think sufficiently distinct in the widely-rounded leaf-apex, scarcely at all pointed, the very shortly excurrent nerve, and curved, narrow capsule with very short neck.

The type gathering shows the stems slightly comose, but the sterile plants have the stems equally foliose throughout their length.

RHODOBRYUM (Schimp.) Hampe.

RHODOBRYUM GRAEFFEANUM (C.M.) Par.

Ovalau, ad arbores, Graeffe. On rocks in stream, foot of Mt. Victoria, Viti Levu, c. 2,500 ft., Sept., 1907; Gibbs (798). On rock in open, Mts., Lautoka, Viti Levu, c. 900 ft., 3.1.20; Greenwood (182, 200). On ground, Mt. Evans, Lautoka, c. 3,960 ft., 4.1.20; Greenwood (239). In crevices, flat rock, Mts., Lautoka, c. 2,000 ft., 3.10.20; Greenwood (375).

MNIACEAE.

MNIUM Linn. emend.

MNIUM ROSTRATUM Schrad.

On wet bank, falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 27.10.17; Greenwood (5). Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (235). Mts., Lautoka, Viti Levu, c. 2,000 ft., 18.6.22; Greenwood (430).

RHIZOGONIACEAE.

RHIZOGONIUM Brid.

RHIZOGONIUM SETOSUM Mitt.

Ovalau, in cacumine montis Tana-lailai, 2,000 ft., Graeffe.

RHIZOGONIUM SPINIFORME (L.) Bruch, f. SAMOANA Mitt.

Trees, Nadarivatu, Viti Levu, 2,700 ft., Sept., 1907; Gibbs (856). *Ibidem*. dead wood in forest, c. 2,300 ft.; Gibbs (714). On rotten log, Mts., Lautoka, Viti Levu, c. 2,000 ft., 9.12.17; Greenwood (47). Mts., Lautoka, Viti Levu, c. 2,000 ft., 4.4.20; Greenwood (323); 4.1.20; Greenwood (189, 194). Mts., Wainikoro, Macuata Coast, Vanua Levu, c. 500 ft., 27.3.24; Greenwood (537).

All these plants belong to Mitten's form, which is a slender one, with smaller, shorter leaves; it occurs in other Pacific groups as well.

BARTRAMIACEAE.

PHILONOTIS Brid.

PHILONOTIS ASPERIFOLIA Mitt.

Ovalau, Graeffe. Covering rocks, Mt. Victoria, Viti Levu, c. 3,000 ft., Sept., 1907; Gibbs (789). Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (26). An unsatisfactory plant. The capsules are smooth. No specimens of Mitten's are at Kew; he describes the capsules as plicate; but Brotherus puts it in a group with capsules smooth or only lightly plicate, and I assume that Mitten's statement is incorrect. Otherwise—apart from the comparison with *P. tenella*—the description agrees well.

PHILONOTIS OBTUSIFOLIA Mitt.

Ysabel (Veitch, in herb. Hooker; Mitt. in Fl. Vitiensis). On wet rocks, Lautoka, Viti Levu, near sea-level, 25.11.19; Greenwood (138, 141).

PHILONOTIS REVOLUTA Bry. jav.

New to Fiji. On damp banks, Lautoka, Viti Levu, c. 600 ft., 1.9.17; Greenwood (67). Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (11, 24, 33).

A sterile plant which appears to belong here, but without fruit or ♂ flowers its position must remain somewhat uncertain.

PHILONOTIS IMBRICATULA Mitt.

New to Fiji. Nausori, Viti Levu, c. 100 ft., Feb., 1920; A. F. Smith; herb. Greenwood (294).

PHILONOTIS ETESSEI Broth. & Par.

New to Fiji. Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 4.1.20; Greenwood (167).

CRYPHAEACEAE.

CRYPHAEA Mohr.

CRYPHAEA GRACILIS Mitt.

Viti, Seemann; Milne.

CRYPHAEA SCHLEINITZIANA C.M.

Insulae Vitienses, Viti Levu, Rewa superior, ad arbores, 30.11.75; Naumann.

CYRTOPODACEAE.

BESCHERELLEA DUBY.

BESCHERELLEA CRYPHAEOIDES (C.M.) FLEISCH.

Syn. ? *Cyrtopus cryphaeoides* C.M.

Ovalau, in reg. montana corticolus, Graeffe.

Fleischer in Hedwig., lxi, 403, refers this to *Bescherellea*, differing from *Cyrtopus* mainly in having no endostome. Graeffe's plant, however, was sterile, so that the reference to *Bescherellea* can only be made on vegetative grounds. Its position is in any case rather doubtful.

SPIRIDENTACEAE.

SPIRIDENS NEES.

SPIRIDENS ARISTIFOLIUS MITT.

Viti, Milne. On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (231).

SPIRIDENS FLAGELLOSUS SCHIMP.

Viti, Seemann, 1865, n. 840. Wilkes, 1842. Thwaites, 1854. Milne. Ovalau, in cacumine montis Tana-lailai, 2,000 ped., Graeffe.

SPIRIDENS BALFOURIANUS GREV.

Viti, Milne. On trees, Nadarivatu, Viti Levu, 3,200 ft., Sept., 1907; Gibbs (602).

It is very doubtful whether these are anything more than forms of one and the same species.

PTEROBRYACEAE.

ENDOTRICHELLA C.M.

ENDOTRICHELLA GRAEFFEANA C.M.

Ovalau, reg. montosa in sylvis, Graeffe.

GAROVAGLIA ENDL.

GAROVAGLIA WEBERI BROTH.

On tree trunks, Taviuni, 1,000 ft., C. Weber in herb. Berol., No. 8.

EUPTYCHIUM SCHIMP.

EUPTYCHIUM SETIGERUM (SULL.) BROTH.

Syn. *Garovaglia setigera* Mitt.

Viti, Amer. Expl. Exped. Ovalau, Milne; Seemann No. 846. Tree stems in forest, Nadarivatu, Viti Levu, 2,300 ft., Sept., 1907; Gibbs (756). On trees, Mts., Lautoka, Viti Levu, c. 800 ft., 3.12.20; Greenwood (377); *ibidem*, 16.1.21 (382).

EUPTYCHIUM GUNNII BROTH. & WATTS.

Syn. *E. assimile* Broth. & Watts.

New to Fiji. Mts., interior of Vanua Levu, c. 2,000 ft., Apr., 1924, leg. Dan Petersen; herb. Greenwood (545). Trees, Mt. Evans, Lautoka, 16.4.22; Greenwood (416).

E. assimile was described as very similar to *E. Gunnii*, but smaller, with the leaf-apex more sharply serrate, upper cells shorter and wider. Greenwood's No. 545 agrees in habit and size with *E. assimile*, while No. 416 has the robust habit

of *E. Gunnii*, with the wider cells of *E. assimile*, and the denticulation of both, on different leaves of the same plant. I think there is no question that both are forms of the same species.

I received an unnamed plant (No. 2, Garovaglia, Fiji Is., Wm. G. Milne, 1859, Herb. Mitten) from the New York Botanic Garden, which also is *E. Gunnii*.

EUPTYCHIMUM VITIENSE Dix., n. sp. Plate ix, fig. 17.

Habitu et foliorum forma inter *E. robustum* Hampe et *E. cuspidatum* (Mitt.); folia breviora quam in illo, quam hujus multo longiora, minus seriata, magis patentia; 3.5-4 mm. longa, oblongo-lanceolata, raptim breviter acutata, apice lato, nunquam tenui-acuminato, marginibus distanter tenuiter denticulatis. Fructus omnino immersus in foliis caulinis, foliis perichaetialibus vix vel parum fructum superantibus. Peristomium magnum; dentes externi fragiles, endostomii membrana praealta, aurantiaca.

Hab.—On trees, alt. 3,600 ft., near summit of Mt. Evans, Lautoka, Oct., 1921; Greenwood (408).

A distinct species of this small and interesting genus, smaller than *E. robustum*, with much shorter, less finely acuminate, denticulate leaves, and much shorter perichaetial bracts. *E. cuspidatum* has very short, closely appressed, very regularly seriate leaves, and much emergent fruit. *E. pungens* Broth. & Par., from New Caledonia, has somewhat similar, but finely pointed leaves, and few alar cells.

PTEROBRYELLA C.M.

PTEROBRYELLA SPECIOSISSIMA (Sull.) C.M.

Viti, Amer. Expl. Exped.

SYMPHYSODON Doz. & Molk.

SYMPHYSODON RUGICALYX (C.M.) Broth.

Syn. *Pilotrichum rugicalyx* C.M.

Ovalau, reg. montosa, inter muscos, Graeffe.

SYMPHYSODON VITIANUS (Sull.) Broth.

Syn. *Pterobryum vitianum* (Sull.) Mitt.

Viti, Seemann, No. 842. On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,600 ft., 18.6.22; Greenwood (422).

This is the plant referred erroneously to *Hypnodendron Junghuhnianum* in Bonplandia.

SYMPHYSODONTELLA Fleisch.

SYMPHYSODONTELLA CYLINDRACEA (Mont.) Fleisch.

Syn. *Symphysodon cylindraceus* (Mont.) Broth.

New to Fiji. Mts., interior of Vanua Levu, c. 2,000 ft., Apr., 1924; leg. Dan Petersen; herb. Greenwood (546).

METEORACEAE.

PAPILLARIA C.M.

PAPILLARIA CROCEA (Hampe) Jaeg.

Syn. *P. cuspidifera* (Tayl.) Jaeg.

Trees, summit of Mt. Evans, Lautoka, Viti Levu, c. 3,000 ft., 23.10.21; Greenwood (403).

P. Aongstroemiana C.M., from Tahiti, is, as Fleischer says, at most a subspecies of this.

PAPILLARIA INTRICATA (Mitt.) Jaeg.

Syn. *Meteorium intricatum* Mitt.

Viti, Seemann. Ovalau, ad arbores reg. montanae, Graeffe. On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 3.10.20; Greenwood (366), with *P. pellucida*. On dead branches, *ibidem*, 18.6.22; Greenwood (428). *Ibidem*, 23.10.21; Greenwood (402, 407), forma tenella.

P. intricata (Mitt.) and *P. helictophylla* (Mont.) Broth. are apparently inseparable except by fruiting characters, and for geographical reasons, therefore, it seems best to place these plants here. No. 402 is a very delicate form, which would have seemed well worthy of varietal rank; but 428 shows the more robust, typical form, in some cases running out into the slender form or state. A form from Samoa, also, is intermediate between the type and the slender plant.

PAPILLARIA PELLUCIDA Broth. & Watts.

New to Fiji. On trees, Mt. Evans, Lautoka, Viti Levu, 4.1.20; Greenwood (279); *ibidem*, c. 3,960 ft., 3.10.20; Greenwood (366); *ibidem*, June, 1921; Greenwood (390); *ibidem*, 16.4.22; Greenwood (415).

Papillaria pellucida was described by Brotherus and Watts (*Journ. Roy. Soc. N.S.W.*, xlix, 141) and the record from Fiji is a very interesting extension of its range. It is otherwise only known from the New Hebrides. No. 415 is the male plant; 366 is in fruit, though with one or two capsules only; the fruit has not been described. The capsule is similar to that of *P. crocea*, but smaller; the calyptra is long and covered with dense, more or less spreading hairs. Peristome teeth connivent when dry, erect and somewhat spreading when moist, reddish, long and gradually tapering, very opaque. Processes filiform, less than half the length of the teeth. These fruiting characters confirm the specific difference of the plant from *P. crocea*, of slender forms of which it has the habit.

METEORIUM Doz. & Molk., emend. Fleisch.

METEORIUM MIQUELIANUM (C.M.) Fleisch.

New to Fiji. On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,600 ft., 23.10.21; Greenwood (400).

FLORIBUNDARIA Fleisch.

FLORIBUNDARIA FLORIBUNDA (Doz. & Molk.) Fleisch.

On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,000 ft., 4.1.20; Greenwood (175, 287).

FLORIBUNDARIA AERUGINOSA (Mitt.) Fleisch.

Syn. *Meteorium aeruginosum* Mitt.

Ovalau, reg. montana, et in cacumine montis Tana-lailai, 2,000 ped., Graeffe. On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,600 ft., 18.6.22; Greenwood (418); *ibidem*, c. 2,000 ft., 9.12.17 (61); *ibidem*, 4.4.20 (309, 314). On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,000 ft., 4.1.20; Greenwood (168).

This is not a very satisfactory species. In 168 the leaf-base is broad and cordate, the leaves very variable in the degree of acumination, the papillae somewhat seriate, but few. It has therefore some characters of *F. pseudo-floribunda*

Fleisch. In 309 the papillae are distinctly few and not seriate, but the leaf-base is narrow. If, therefore, there are any good characters to distinguish *F. pseudo-floribunda* from *F. aeruginosa* they must reside in the peristome and, since all the Fiji plants are sterile, it is safest to refer them to *F. aeruginosa*.

AEROBRYOPSIS Fleisch.

AEROBRYOPSIS VITIANA (Sull.) Fleisch.

Syn. *Meteorium vitianum* Sull.

Viti, on trees; Amer. Expl. Exped. On trees, Mt. Evans, Lautoka, Viti Levu, c. 3,000 ft., 4.1.20; Greenwood (282).

AEROBRYOPSIS LONGISSIMA (Doz. & Molk.) Fleisch.

New to Fiji. On soil on rocks in open, Mt. Evans, Lautoka, Viti Levu, c. 2,000 ft., 4.1.20; Greenwood (271, 275). *Ibidem*, c. 3,600 ft., 18.6.22; Greenwood (419). On dead wood, Mts., Labasa, Vanua Levu, c. 300 ft., 8.6.23; Greenwood (488).

TRACHYPUS Reinw. & Hornsch.

TRACHYPUS BICOLOR Reinw. & Hornsch.

New to Fiji. On wet sloping rocks, Mt. Evans, Lautoka, Viti Levu, c. 2,000 ft., 3.10.20; Greenwood (376); *ibidem*, 16.4.22; Greenwood (411).

NECKERACEAE.

ORTHORRHYNCHIUM Reichdt.

ORTHORRHYNCHIUM CYLINDRICUM (Lindb.) Broth.

Viti; Milne (as *Phyllogonium angustifolium* Schimp. in herb. Mitten). Ovalau, reg. montana, ad arbores; Graeffe. On branches, Mts., Lautoka, Viti Levu, c. 1,000 ft., 28.10.17; Greenwood (19). Vanua Balavu, Aug., 1927; leg. B. Tothill; herb. Greenwood (571).

CALYPTOTHECIUM Mitt.

CALYPTOTHECIUM URVILLEANUM (C.M.) Broth.

Syn. *Neckera Eugeniae* Lindb.

Ovalau, ad arbores reg. montosae; Graeffe. Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (27, 112). Mts., Lautoka, Viti Levu, c. 2,000 ft., 4.4.20; Greenwood (311).

NECKEROPSIS Fleisch.

NECKEROPSIS LEPINEANA (Mont.) Fleisch.

Syn. *Neckera Lepineana* Mont.

Viti Levu; Milne, 337; Seemann, 863. Ovalau, reg. montana; Graeffe. On trees, Mt. Evans, Lautoka, Viti Levu, c. 2,000 ft., 4.1.20; Greenwood (219). Mts., Lautoka, Viti Levu, c. 1,500 ft., 4.4.20; Greenwood (312). Vanua Balavu, Aug., 1927; leg. B. Tothill; herb. Greenwood (573).

No. 573 is a slender form, with somewhat the habit of *N. gracilentia*, but does not differ structurally from *N. Lepineana*.

HIMANTOCLADIUM Fleisch.

HIMANTOCLADIUM LORIFORME (Bry. jav.) Fleisch.

Syn. *Neckera loriformis* Bry. jav.

Gau, Milne; Viti Levu, Seemann, 836.

HIMANTOCLADIUM IMPLANUM (Mitt.) Fleisch.

Syn. *Neckera Graeffeana* C.M.

Ovalau, in sylvis montosis, Graeffe. On trees and rocks, Mts., Lautoka, Viti Levu, c. 1,500 ft., 9.12.17; Greenwood (62). Mts., Lautoka, Viti Levu, c. 2,000 ft., 14.2.20; Greenwood (297); 4.4.20; Greenwood (334).

Much confusion has arisen in this genus owing to Mitten having described his *Neckera implana* as dioicous, whereas it is actually synoicous. *N. Graeffeana* is quite identical with Mitten's plant.

HOMALIA (Brid.) Bry. eur.

HOMALIA EXIGUA Bry. jav.

New to Fiji. On trunks of trees, Mts., Labasa, Vanua Levu, c. 300 ft., 1.7.23; Greenwood (492).

HOMALIODENDRON Fleisch.

HOMALIODENDRON FLABELLATUM (Dicks.) Fleisch.

Syn. *Hookeria flabellata* Sm., *Trans. Linn. Soc.*, ix, 1808, 280.—*Neckera dendroides* Hook., *Musc. exot.*, 1818, t. 69.—*Porotrichum dendroides* Mitt., *Fl. Vit.*, p. 397.—*Homaliodendron dendroides* Fleisch.—*Neckera australasica* C.M., *Syn.* ii, 42.

Ovalau, ad arbores reg. montanae, quoque in cacumine montis Tana-lallai, 2,000 ped. alt., Graeffe. Viti, Seemann. Trees, Mt. Evans, Lautoka, Viti Levu, c. 2,000 ft., 9.12.17; Greenwood (46); 4.1.20 (264); interior Vanua Levu, c. 2,000 ft., Apr., 1924, leg. Dan Petersen; herb. Greenwood (548).

There seems no reason whatever for separating *H. flabellatum* and *H. dendroides*. Wilson has a MS. note in herb. Hooker, on "*Hookeria flabellata* Smith, St. Vincent's, Mr. Dickson", as "scarcely different if at all from *Neckera dendroides* Hook. M. Exot. t. 69". Wilson, however, seems to have failed to note that Smith's species was published in 1808, ten years earlier than *N. dendroides* Hook. and it is Smith's specific name that must be retained.

There seems no difference whatever between them. It may be doubted whether all, or most, of the *Incisifolia* group are not slight forms of one species; but such as they are, *H. flabellatum* and *H. dendroides* have been thought separable by the densely bi-tri-pinnate, flabellate fronds and the ramuline leaves shorter and wider than in the other species, widely obovate-elliptic, with the nerve, perhaps, rather weaker. Whatever may be the value of these characters, they are shared by the Indo-Malayan *H. flabellatum* equally with the usual forms of the Oceanic *H. dendroides* (though in Hooker's type the branch leaves are narrow, and hardly differ from those of *H. javanicum*, etc.).

H. flabellata was described as from St. Vincent's, in the West Indies. But, while it is common in Indo-Malaya, no other specimen has, I believe, been found in the West Indies (*H. grandidens* (C.M.) has more the *H. javanicum* form of leaf). In this connection it may be mentioned that Dickson's specimen at Kew is labelled "St. Vincent's?", as though there might be some doubt of its origin. Its range, therefore, does not seem to include America.

THAMNIUM Bry. eur.

THAMNIUM SUBLATIFOLIUM Dix., n. sp. Plate ix, fig. 18.

T. aneitensi Mitt., et *T. latifolio* (Bry. jav.) peraffine. Ab hoc differt foliis stipitis perangustis, rigide divaricatis, interdum recurvis; foliis caulinis et rameis angustioribus, oblongis (2.5-3 × 1), acutioribus, siccis distinctius longitudinaliter plicatis, saepius minus fortiter denticulatis.

T. aneitense Mitt. (cujus folia stipitis similia sunt) folia latiora, eis *T. latifolii* subsimilia habet.

Hab.—Rocks, alt. 3,000 ft., Mt. Evans, Lautoka, Viti Levu, Dec., 1917; Greenwood (49, type). Astrolabe Range, East of Port Moresby, New Guinea, 1923; Rev. J. B. Clark (102).

In the New Guinea plant the stipe leaves are broader and less divaricate, thus bringing the plant nearer to *T. latifolium*, but the leaf characters are similar, and fairly distinct.

PINNATELLA Fleisch.

PINNATELLA KÜHLIANA (Bry. jav.) Fleisch.

Syn. *Porotrichum elegantissimum* Mitt.

Ovalau, inter alios muscos, Graeffe. On dead wood, Loloti, Mts., Lautoka, Viti Levu, c. 800 ft., 2.1.20; Greenwood (218).

LEMBOPHYLLACEAE.

CAMPTOCHAETE Reichdt.

CAMPTOCHAETE POROTRICHOIDES (Besch.) Broth.

On stones in stream in forest, Nadarivatu, Viti Levu, 2,800 ft., Sept., 1907; Gibbs (737). On rocks, Mts., Lautoka, Viti Levu, c. 1,000 ft., 9.12.17; Greenwood (42). On rocks, Mt. Evans, Lautoka, Viti Levu, 18.6.22; Greenwood (423).

ENTODONTACEAE.

ENTODON C.M.

ENTODON HILLEBRANDII C.M.

New to Fiji. On rocks and wood, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (22). Loloti, Mts., Lautoka, Viti Levu, c. 800 ft., 29.5.21; Greenwood (384). On rocks, Mts., Levuka, Ovalau, c. 200 ft., 13.1.27; Greenwood (562).

Stems flattened, not turgid and subjulaceous, and capsule elongate, cylindric, slightly curved, by which characters it may be known from *E. pallidus* Mitt. Does it differ from *E. Solanderi* (Aongstr.) Jaeg.?

CAMPYLODONTIUM Schwaegr.

CAMPYLODONTIUM FLAVESCENS (Hook.) Bry. jav.

New to Fiji. On dead wood, Mts., Lautoka, Viti Levu, c. 1,000 ft., 9.12.17; Greenwood (118). On trees, Mts., Lautoka, Viti Levu, c. 600 ft., 16.1.21; Greenwood (379).

STEREOPHYLLUM Mitt.

STEREOPHYLLUM VITIENSE Dix., n. sp. Plate ix, fig. 19.

E gracillimis generis, habitu Isopterygii alicujus brevifolii. Corticicola, arcte appressum, nitidum, pallescens. Folia madida complanata, sicca convoluta, ovata, acuta vel subacuta, circa 0.8 mm. longa, 0.3 mm. lata, vix concava, integra,



pallida, pellucida; costa tenuis, vix dimidiam partem folii attingens. Folia dorsalia multo minora, appressa. Cellulae rhomboideo-lineares, perangustae, 4-5 μ latae, parietibus tenuissimis; alares sat numerosae, subquadratae, hyalinae, majusculae, ad costam fere attingentes.

Autoicum. Flores masculi et feminei plures, immaturi. Fructus ignotus.

Hab.—On trees in mountains, Lautoka, Viti Levu, Apr., 1920; Greenwood (316).

An interesting extension of the range of this genus. A single species is known from New Caledonia, otherwise none is recorded from Oceania.

HOOKERIACEAE.

DISTICHOPHYLLUM Doz. & Molk.

DISTICHOPHYLLUM FLAVESCENS (Mitt.) Par.

Syn. *Discophyllum flavescens* Mitt.

Ovalau, Graeffe.

DISTICHOPHYLLUM GRAEFFEANUM (C.M.).

Syn. *Mniadelphus Graeffeanus* C.M.

Viti Levu, ad litus australe in sylvis humidis, Graeffe.

DISTICHOPHYLLUM VITIANUM (Sull.) Besch.

Ovalau, trees in the mountains, Milne. At edge of creek in shade, Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (3). On soil, Mt. Evans, Lautoka, Viti Levu, c. 2,500 ft., 4.1.20; Greenwood (179, 292). *Ibidem*, c. 3,960 ft., 4.1.20; Greenwood (247).

DISTICHOPHYLLUM LIMBATULUM (C.M.) Par.

Syn. *Mniadelphus limbatulus* C.M.

Ovalau, reg. montosa sylvestri, Graeffe.

DISTICHOPHYLLUM TORQUATIFOLIUM Dix., n. sp. Plate ix, fig. 20.

§ *Mniadelphus*. Robustiusculum. Caules 3 cm. alti vel paullo ultra, simplices vel parce ramosi, madida 4-5 mm. lati. Folia sicca spiraliter semitorta, difficillime emollita, etiam madefacta subtorquata, oblongo-ovata, vix spatulata, superne angustata, breviter cuspidata. Costa sat debilis, longa infra apicem desinens. Limbus folii validus, superne e 3-4 seriebus cellularum compositis, integer, apice in cuspidem validam confluens. Cellulae superiores inanes, magnae, medianae circa 22-28 μ latae, versus margines paullo minores, omnes parietibus crassiusculis, collenchymaticis. Cellulae basiliares rectangulares, nec valde laxae, partem minimam folii implentes.

Fructus ignotus.

Hab.—On dripping rocks, Mt. Evans, Lautoka, Viti Levu, Jan., 1920; Greenwood (177). Associated with *D. vitianum*.

A very distinct plant in the leaves twisted when dry, cuspidate, strongly bordered, and the lax cells. *D. vitianum* has the leaves not twisted, larger cells and weaker border. It is nearest to *D. tortile*, but that has considerably larger cells, and the rectangular basal cells reach high in the leaf; here they only occupy a small part.

CYCLODICTYON Mitt.

CYCLODICTYON BLUMEANUM (Mont.) Fleisch.

Syn. *Hookeria Graeffeana* C.M.—*Hookeria vescoana* Besch.

Ovalau, with *Hypnum complanatum*, specimen unicum, Graeffe. On dead wood in forest, Nadarivatu, Viti Levu, 2,800 ft., Sept., 1907; Gibbs (738). On damp ground, Mt. Evans, Lautoka, Viti Levu, c. 2,000 ft., 9.12.17; Greenwood (58).

CALLICOSTELLA C.M.

CALLICOSTELLA PAPILLATA (Mont.) Jaeg.

Syn. *Hookeria oblongifolia* Sull.

Ovalau, ubi copiosa videtur, Graeffe. On dead wood, summit of Mt. Victoria, Viti Levu, 3,800 ft., Sept., 1907; Gibbs (803). Nadarivatu, Viti Levu, 2,700 ft., Sept., 1907; Gibbs (717). On rotten wood, Mt. Evans, Lautoka, Viti Levu, c. 3,000 ft., 18.6.22; Greenwood (424).

CALLICOSTELLA VESICULATA C.M.

New to Fiji. Mts., Labasa, Vanua Levu, c. 300 ft., Aug., 1922; Greenwood (448).

Fleischer's descriptive notes on *C. oblongifolia* (Musci. . . von Buitenzorg, iii, 1027), refer, I believe, to this species, not to *C. oblongifolia*, which has denser areolation and high papillae. *C. vesiculata* has larger cells than *C. papillata*, almost smooth, and less toothed leaves.

CHAETOMITRIUM Doz. & Molk.

CHAETOMITRIUM RUGIFOLIUM Sull.

Viti, on trees, Amer. Expl. Exped. Ovalau, in the mountains, Milne, 364.

CHAETOMITRIUM DEPRESSUM Mitt.

New to Fiji. On trees in forest, Wainikoro, Macuata Coast, Vanua Levu, c. 200 ft., Feb., 1925; Greenwood (554).

Distr.—Samoa.

HYPOPTERYGIACEAE.

HYPOPTERYGIUM Brid.

HYPOPTERYGIUM STRUTHIOPTERIS Brid.

Viti, Seemann.

HYPOPTERYGIUM SEMI-MARGINATUM C.M.

Ovalau, inter alios muscos, Graeffe.

HYPOPTERYGIUM OCEANICUM Mitt.

Dead wood in forest and on stones, Nadarivatu, Viti Levu, near Nadala, 2,300 ft., Sept., 1907; Gibbs (719).

HYPOPTERYGIUM DEBILE Reichdt.

On rocks in spray, falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 28.10.17; Greenwood (8). Mts., Lautoka, Viti Levu, c. 2,000 ft., 4.4.20; Greenwood (318).

Distr.—Tahiti, Samoa.



RHACOPILACEAE.

RHACOPILUM P. Beauv.

It is exceedingly doubtful whether four species exist in Fiji. There is, probably, no question about *R. spectabile*; which is known by its robust habit, very coarsely denticulate leaves and amphigastria, with the basal juxta-costal cells very lax and pellucid.

The remaining species are very perplexing. The distinguishing characters as given by Bescherelle differ very considerably from those given by Fleischer, and the most probable conclusion to be drawn is that the supposed specific characters do not hold, and that we have to deal with a widespread and rather variable species.

As Fleischer treats them, the species are separable thus:

R. cuspidigerum.—Cells minutely papillose, rounded-hexagonal; lateral leaves when moist concave and not widely flattened out.

R. pacificum.—Lateral leaves when moist widely flattened out, not concave.

R. convolutaceum.—Cells distinctly papillose.

Bescherelle separates them as follows:

R. cuspidigerum.—Leaves slightly denticulate only at apex, cells rounded, not dorsally papillate.

R. pacificum.—Leaves slightly denticulate only at apex, cells not dorsally papillose, hexagonal, not rounded.

R. convolutaceum.—Leaves toothed almost from base, and more strongly at apex; all cells rounded and dorsally very prominent.

Now the cells in *R. cuspidigerum*, Fleisch., M. Fr. Arch. Ind. et Polyn., No. 477, from West Java, are quite distinctly elongate-hexagonal, and therefore do not comply with Bescherelle's requirements.

The most reasonable explanation is that *R. convolutaceum* is fairly well marked by the more toothed leaves and more papillose cells, but that *R. pacificum* is probably not specifically distinct from *R. cuspidigerum*.

Greenwood's 115 has the cells distinctly elongate-hexagonal, and therefore would be referable to Bescherelle's *R. pacificum*; on the other hand, they are more or less conspicuously papillose.

RHACOPILUM SPECTABILE Reinw.

Viti, Seemann.

RHACOPILUM CUSPIDIGERUM Schwaegr.

Viti, Milne.

RHACOPILUM PACIFICUM Besch.

New to Fiji. On wet rocks, falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (115).

RHACOPILUM CONVOLUTACEUM C.M.

On volcanic red rock in stream in forest, Nadarivatu, Viti Levu, 2,700 ft., Sept., 1907; Gibbs (739).

THUIDIACEAE.

HERPETINEURON Card.

HERPETINEURON TOCCOAE (Sull. & Lesq.) Card.

New to Fiji. On rock, falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (131).

An interesting new link in the chain connecting the Asiatic and American localities.

CLAOPODIUM Ren. & Card.

CLAOPODIUM AMBLYSTEGIOIDES Dix., n. sp. Plate ix, fig. 21.

Gracile. Habitu fere *Amblystegii serpentis*, sed foliis siccis crispulo-contortis. Caulis et rami laeves, haud papilloși. A *C. leuconeuron* cellulis unipapilloșis differt, ramisque haud complanatis. A *C. assurgens* (Sull. & Lesq.) et *C. hawaiiense* Williams marginibus planis, cellulis marginalibus valde notatis, inanibus, pellucidis; a *C. nervosum* (*C. prionophyllum*) cellulis multo minus obscuris, papillis humilioribus.

Hab.—Rocks, 3,000 ft., Mt. Evans, Lautoka, Viti Levu, Dec., 1917; Greenwood (57).

This may be only a race of *C. nervosum*, from which it scarcely differs but in the less obscure areolation with lower papillae. That species, however, has not been recorded from the Pacific region. *C. hawaiiense* has recurved margins.

PELEKIUM Mitt.

PELEKIUM VELATUM Mitt.

New to Fiji. On dead wood, Mts., Lautoka, Viti Levu, c. 600 ft., 22.9.17; Greenwood (10). *Ibidem*, c. 2,000 ft., 4.1.20; Greenwood (301). Nausori, Viti Levu, May, 1921; leg. R. Veitch, herb. Greenwood (439). Mts., Labasa, Vanua Levu, c. 300 ft., Aug., 1922; Greenwood (447).

THUIDIUM Bry. eur.

THUIDIUM TAHITENSE Broth.

Syn. Amblystegium byssoideum Besch.

New to Fiji. Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 22.9.17; Greenwood (165). Mt. Evans, c. 3,960 ft., 4.1.20; Greenwood (252).

An interesting discovery. It is a somewhat overlooked plant, hitherto known from Tahiti only. Paris omits it altogether. It is curious that Bescherelle did not recognize it to be a Thuidium, especially as he compares it with *T. byssoideum* Besch. It is an exceedingly delicate, minute-leaved plant.

THUIDIUM MEYENIANUM (Hampe) Bry. jav.

Syn. T. trachypodium (Mitt.) Lac.—*T. erosulum* Mitt.

I. of Wakaya, Milne. Mts., Lautoka, Viti Levu, c. 2,000 ft., 4.1.20; Greenwood (195). Sigatoka, Viti Levu, sea-level, 10.6.21; Greenwood (392). Trees, Wainikoro, Macuata Coast, Vanua Levu, 13.3.24; Greenwood (527). Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (260). On dead wood, Mts., interior of Vanua Levu, c. 2,000 ft., 25.12.22; Greenwood (473).

THUIDIUM BIPARIUM (Doz. & Mol.) Bry. jav.

New to Fiji. On ground, Mts., Lautoka, Viti Levu, c. 800 ft., 2.1.20; Greenwood (169). Mts., Labasa, Vanua Levu, c. 300 ft., Aug., 1922; Greenwood (449); 1.7.23; Greenwood (498).

THUIDIUM PLUMULOSUM (Doz. & Molk.) Bry. jav.

Ovalau, Wilkes, in herb. Kew.

THUIDIUM GLAUCINOIDES Broth. and T. SAMOANUM Mitt.

The relation between these two plants is very obscure. According to Mitten's description the differences would lie entirely, or almost so, in the cells very lowly and indistinctly papillose in *T. samoanum*, and the perichaetial bracts ciliate. These characters would seem marked enough, since *T. glaucinoides* has high, spiculose papillae, and the perichaetial bracts without cilia. An examination of the Fijian and Samoan plants, however, leads to much perplexity. Thus plants from "Tutuila, 1867, coll. Veitch" and "Fiji, Horne", both determined by Mitten as *T. samoanum*, have well developed papillae, and the latter has ciliate bracts. "Tutuila, coll. Powell. No. 105" has the cells usually smooth at back, but here and there more markedly papillose. Another plant, determined by Mitten, "Ysabel, Veitch", has the inner perichaetial leaves (in an unfertilized perichaetium) somewhat ciliate, but the cells are quite highly papillose.

Another specimen "360, Ovalau, Oct./54, only specimen found in fruit, Milne, H.M.S. *Herald*, 1855" determined by Mitten as *Leskea glaucina* M. (Mitten, of course, did not distinguish between *T. glaucinum* and *T. glaucinoides*) has the single, high, curved papillae of *T. glaucinoides*, but the perichaetia are too old for examination.

Miss Gibbs' plant, recorded as *T. samoanum*, has the ciliate perichaetial bracts, but the cells highly papillose.

A male plant, "Fiji, Horne" determined by Mitten as *T. samoanum*, has well marked papillae; and another "*T. samoanum* Mitt., Fidschi-Insel, Ovalau, Graeffe, Dr. C. Mueller misit", fairly bristles with papillae!

All the Indo-Malayan plants of *T. glaucinoides* seen in the fertile state, have the bracts without cilia. The stem leaves of *T. glaucinoides*, moreover, have the margin recurved, while in the type of *T. samoanum* (Powell, 105) the margin is distinctly plane (as in *T. glaucinum*).

It would seem, on the whole, safest to conclude that the Fiji-Samoan plant differs substantially from the Indo-Malayan *T. glaucinoides* in having the perichaetial bracts ciliate, and the leaf-margin plane, and that the normal form has the high papillae of *T. glaucinoides*, while rarely the papillae are low and the leaves almost smooth, and the latter form may be made a new variety, *LAEVUS* Dix., based on No. 105, Powell. It may be objected that Mitten makes this his type, and the low papillae a specific character of *T. samoanum*; but Powell's plant cannot be looked upon as strictly the type of the species, since it is sterile, and Mitten not only describes the fruit, but makes the ciliate bracts equally a specific character. The description was evidently drawn up from more than one plant.

Sterile plants may be determined by the margin of the stem leaves, but it is perhaps a not very satisfactory distinction.

THUIDIUM GLAUCINOIDES Broth.

Seemann, inter 847 (as *Leskea glaucina* Mitt., in *Bonplandia*, ix, 366). Mts. near Lautoka, Viti Levu, 1.9.17; Greenwood (9). Mt. Evans, Lautoka, 9.12.17; Greenwood (64).

THUIDIUM SAMOANUM Mitt.

Viti, Seemann. Ovalau, Milne. Fiji, Horne. Ovalau, ad arbores, Graeffe. On stones, Mt. Victoria, Viti Levu, 3,000 ft., Sept., 1907; Gibbs (802). On rock, Mt. Evans, Lautoka, Viti Levu, c. 2,000 ft., 10.5.19; Greenwood (116).

THUIDIUM CYMBIFOLIUM (Doz. & Molk.) Bry. jav.

Syn. *T. ramentosum* Mitt.

Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (105). Mt. Evans, Lautoka, c. 3,960 ft., 4.1.20; Greenwood (246). *Ibidem*, c. 2,000 ft., 4.1.20; Greenwood (191), and 4.4.20; (310).

There is no difference at all between *T. ramentosum* Mitt. and *T. cymbifolium*; Mitten, in describing the Samoan plant, says: "Very like the *T. cymbifolium* Dozy et Molk., Bry. javan. t. 221, from Java and India, but more slender". The Pacific plants are often quite as robust as the Indian plant, however.

HYPNACEAE.

ECTROPOTHECIUM Mitt.

ECTROPOTHECIUM SODALE (Sull.) Mitt.

New to Fiji. Mts., Lautoka, Viti Levu, c. 2,000 ft., 18.6.22; Greenwood (421).

ECTROPOTHECIUM PERCOMPLANATUM Broth.

New to Fiji. On wet rocks, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (126, 128). Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (255).

ECTROPOTHECIUM PERCOMPLANATUM, var. FALCATUM Dix., n. var.

Plus minusve dense, regulariter pinnatum, folia fortiter falcato-decurva.

Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (256, type; 261). Mts., Lautoka, Viti Levu, 9.12.17; (129).

In the typical plant this is a very distinct variety, but No. 129 has laxer branching, and connects it with the type form. The falcate leaves are, however, a marked feature for the species, but in structure and in fruit there is no difference from *E. percomplanatum*.

ECTROPOTHECIUM INCUBANS (Reinw. & Hornsch.) Jaeg. var. SCABERULUM

(Broth. MS.) Fleisch.

New to Fiji. Fiji; Steel (Herb. Dixon).

Fleischer refers *E. scaberulum* Broth. in sched. to a form of *E. incubans*; it is perhaps worth distinguishing as a variety.

ECTROPOTHECIUM PACIFICUM Mitt.

Ovalau, in sylvis montosis, Graeffe. On dead wood in forest, Nadarivatu, Viti Levu, 2,700 ft., Sept., 1907; Gibbs (715).

ECTROPOTHECIUM TUTUILUM (Sull.) Mitt.

Viti, Milne. Labasa, Vanua Levu, c. 300 ft., 22.7.23; Greenwood (507); 16.9.23, (516).

ECTROPOTHECIUM ADNATUM Broth.

New to Fiji. On rotten log, Mts., Lautoka, Viti Levu, c. 2,000 ft., 10.5.19; Greenwood (157). On wet bank, Mts., Levuka, Ovalau, c. 200 ft., 13.1.27; Greenwood (563, 566).

ECTROPOTHECIUM CYATHOTHECIUM (C.M.) Jaeg.

Ovalau, inter *Hookerium oblongifolium* dense intricatum, Graeffe. Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (237, 240, 251). Mts., interior of Vanua Levu, c. 2,000 ft., 25.12.22; Greenwood (466, 475). Trees, Wainikoro, Macuata Coast, Vanua Levu, c. 200 ft., 13.3.24; Greenwood (531).

ECTROPOTHECIUM MALACOBLASTUM (C.M.) Par.

New to Fiji. On edge of stream, Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (16). On wet rock, Lautoka, Viti Levu, near sea-level, 25.11.19; Greenwood (145), with *Vesicularia inflectens*.

ECTROPOTHECIUM MOLLE Dix., n. sp. Plate ix, fig. 22.

Dioicum videtur. Pallide aureum, nitescens, robustum, mollissimum; caules ad 9 cm. longi, plus minusve regulariter densissime pinnati, ramis inaequalibus, 4-8 mm. longis, haud complanatis. Folia fortiter falcata, dense conferta, circa 2 mm. longa, e basi concava, oblonga, breviter sed tenuiter acuminata, apice denticulato; costis binis, bene notatis, longiusculis praedita. Cellulae superiores angustissimae, longae, laevissimae, inferne parum latiores, breviores, ad angulos paucissimae, minutae, unica magna, vesiculosa, hyalina. Folia ramea brevius, latius acuminata, argutius dentata, saepe ad basin fere tenuiter denticulata.

Hab.—Trees, near summit of Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., Oct., 1921; Greenwood (404).

A rather robust, golden plant, with something the habit of *E. intorquatum*, but with the leaves finely acuminate, more or less sharply denticulate, and with a rather long and well marked double nerve. The leaves at the extremities of the stem and branches are often distant, straight and not falcate, only flexuose.

E. sandwichense has shorter basal cells and wider upper ones, but is otherwise very near.

VESICULARIA C.M.

VESICULARIA INFLECTENS (Brid.) C.M.

Rocks in pool, Mts., Lautoka, Viti Levu, c. 600 ft., 2.9.17; Greenwood (14); *ibidem*, 4.1.20; (203).

This appears to be unrecorded from Fiji. Paris includes the group in the distribution, but I have been unable to trace the origin of the record.

VESICULARIA CALODICTYON (C.M.) Broth.

Syn. *Ectropothecium calodictyon* (C.M.) Jaeg.

On dead wood, Mt. Victoria, Viti Levu, 4,000 ft., Sept., 1907; Gibbs (891). On dead wood, Nadarivatu, Viti Levu, 2,700 ft., Sept., 1907; Gibbs (892). Trees, Nausori, near sea-level, R. Veitch, May, 1921; herb. Greenwood (442).

VESICULARIA VITIANA (Mitt.) Dix., n. sp.

(*Ectropothecium vitianum* Mitt. MS. in herb.)

Prostrata, vix nitida, caules sat regulariter pinnati, ramis 3-4 mm. longis. Folia forma structuraque eis *V. reticulatae* similia. Seta brevis, 1 cm. longa.

Hab.—Viti Levu, Fiji Is., 1855; Milne, 338; herb. Mitten. comm. New York Bot. Garden; type. On dead tree-fern, Mts., Lautoka, Viti Levu, c. 600 ft., 22.9.17; Greenwood (36). On damp ground and wood, Wainikoro, Macuata Coast, Vanua Levu, c. 300 ft., 13.3.24; Greenwood (529); *ibidem*, Feb., 1925 (551).

This is so exactly similar to *V. reticulata*, except in the constantly short seta, that it would not be surprising if it turned out to be a race of that species. The distribution of *V. reticulata*, however, is so far entirely Indo-Malayan, so that it is perhaps best to keep the Fiji plant distinct.

ISOPTERYGIUM Mitt.

ISOPTERYGIUM TAXIRAMEUM (Mitt.) Jaeg.

New to Fiji. On damp ground near creek in open, Lautoka, Viti Levu, c. 100 ft., 18.8.17; Greenwood (6).

ISOPTERYGIUM BYSSICAULE (C.M.) Jaeg.

On dead wood in forest, Nadarivatu, Viti Levu, 2,300 ft., Sept., 1907; Gibbs (758).

ISOPTERYGIUM MINUTIRAMEUM (C.M.) Jaeg., var. VITIENSE Dix., n. var.

Minutum. Statura var. *austrpusillo* (C.M.) Fleisch. simillimum, sed foliis laxioribus, tenuius acuminatis, seta brevior, 5 mm. longa, raro 6 mm.

Hab.—On dead tree-fern; Mts. near Lautoka, Viti Levu, c. 1,000 ft., Sept., 1917; Greenwood (36c, type; 337). On dead wood, Cuvu, Sigatoka, Viti Levu; Greenwood (353, 354, 355). On dead wood, Labasa, Vanua Levu; Greenwood (457). Also on earth, 7,500 ft., Bias Valley, Kulu, N. W. Himalayas, Sept., 1928; R. L. Badhwar (1162).

This at first appeared to have all the appearance of a new species, but it cannot be separated from the minute forms of *I. minutirameum*, and scarcely differs from the Javan plant referred (as a var. of *I. minutirameum*) by Fleischer to *I. austrpusillum* (C.M.); the leaves, however, are a little laxer, and the seta seems constantly shorter.

It is remarkable that, to all intents and purposes, the same plant should occur at a considerable altitude in the Himalayas, but there seem no characters whatever to separate it.

ISOPTERYGIUM ALBESCENS (Schwaegr.) Jaeg.

Syn. *I. Ionchopelma* (C.M.) Jaeg.—*I. molliculum* (Sull.) Mitt.

Viti, Milne. Ovalau, Graeffe. On bark, Mts., Lautoka, Viti Levu, c. 1,000 ft., 2.1.20; Greenwood (190). Rotten wood, Sigatoka, Viti Levu, near sea-level, 10.10.19; Greenwood (125). On dead wood, Loloti, Mts., Lautoka, c. 800 ft., 2.1.20; Greenwood (209). On ground, Levuka, Ovalau, c. 100 ft., 23.4.20; Greenwood (342). On dead wood, Mts., Labasa, Vanua Levu, c. 300 ft., 16.9.23; Greenwood (515).

Examination of *Hypnum molliculum* Sull. shows that it is identical with *I. albescens*. The type gathering (Mauna Kea, Hawaii, Wilkes, herb. Kew) has more distant and narrower leaves than in the usual forms of *I. albescens*; the leaf acumen is fine and quite entire; exactly similar forms, however, occur in Borneo and elsewhere in Indo-Malaya. The Sunday I. plant, leg. Milne, has the leaves rather broader and more closely set, and is in every way the same plant as the commoner forms of *I. albescens*, where the branch leaves are often slightly

denticulate at apex. The description does not suggest any difference from *I. albescens*. The distribution of *I. albescens* in Indo-Malaya is very wide, but it has not been recorded from the Pacific; naturally so, since all the plants have been referred to *I. molliculum*.

There can be little doubt that *I. lonchopelma* (C.M.) belongs here also. The occasionally sub-margined leaves, of which C. Mueller makes a point, are frequently found in the Indo-Malayan plant, and Fleischer describes them so. As to the seta, C. Mueller gives no measurements, but simply "longissimo". The seta is given in the Bry. jav. as 1.5 cm. in length. Fleischer gives it as 1.5 to almost 2 cm. In Greenwood's 190 it varies from 1.25 to practically 2 cm. C. Mueller's plant is no doubt simply *I. albescens* with (possibly) unusually long setae.

The sporophyte characters are identical in the Indo-Malayan and Pacific plants.

TAXITHELIUM Spruce.

TAXITHELIUM PAPILLATUM (Harv.) Broth.

Syn. *T. stigmatosum* (Mitt.) Broth.

Ovalau, on stumps of trees in high ground, frequent; Milne. Ovalau, in reg. montana, Graeffe. On wood in shade, Mts., Wainikoro, Macuata Coast, Vanua Levu, c. 300 ft., 27.3.24; Greenwood (536).

Mitten says of his *Trichosteleum stigmatosum* "nearly resembling *T. papillatum* (Hornsch.), but more slender". There is, however, hardly any limit to which *T. papillatum* may not go in this and many other directions. As a matter of fact Mitten has determined Samoan specimens as *T. papillatum* (herb. Kew), though in his "Samoan Mosses" he does not mention its occurrence in Samoa; and it is quite probable that these, or some of them—there are more forms than one included—are the plants he originally referred to his *T. stigmatosum*, but afterwards altered his opinion as to their specific value; at any rate, there are no specimens there referred by him to *T. stigmatosum*.

TAXITHELIUM HERPETIUM (C.M.) Broth.

Dead wood in forest, Nadarivatu, Viti Levu, 2,800 ft., Sept., 1907; Gibbs (716).

TAXITHELIUM VENTRIFOLIUM (C.M.) Broth.

Ovalau, Graeffe.

TAXITHELIUM SAMOANUM (Mitt.) Broth.

Syn. *Trichosteleum samoanum* Jaeg.—*Sigmatella Powelliana* C.M.

Ovalau, Graeffe. Dead wood, Mt. Victoria, Viti Levu, 4,000 ft., Sept., 1907; Gibbs (801). Dead wood in Mts., Wainikoro, Macuata Coast, Vanua Levu, c. 300 ft., 13.3.24; Greenwood (530).

TAXITHELIUM POLYANDRUM Dix., n. sp. Plate ix, fig. 23.

§ Anastigma. Prostratum, diffusum, subrobustum, percomplanatum, pallide virens, nitidum; caules irregulariter ramosi; folia stricte complanata, circa 1 mm. longa, lingulata, sensim paullo attenuata, subobtusa, uno latere prope basin inflexo, ceterum marginibus planis, inferne minute, ad apicem conferte argutius denticulata; ecostata; cellulae superiores breviter lineares, valde sigmatoideae, ad basin paullo tantum longiores; alares 2-3 majusculae, subvesiculosae, inanes; omnes laeves.

Autoicum. Flores ♂ ad caulem et ramos numerosi, magni.

Seta 1-1.25 cm. longa, laevis. Folia perichaetalia numerosa, e basi convoluta erecta in subulam loriformem, robustam argute denticulatam hic illic sublacinatam, saepe fortiter hamatam attenuata. Theca minuta, turgide elliptica, gibbosa, curvata, collo brevissimo, turgido. Peristomii dentes aequae ac endostomii processus supra valde papilloso. Rete exothecii perlaxum, e cellulis isodiametricis, majusculis, parietibus valde flexuosis instructum.

Hab.—Clinging very closely to rocks in mountains, Lautoka, Viti Levu, c. 1,000 ft., 3.1.20; Greenwood (217, type). On rock, Loloti, Viti Levu, c. 800 ft., 29.5.21; Greenwood (388, 394).

In habit much like *T. Binsteadii* Dix., from Ceylon, but with the cells quite smooth. Most species of the group (*Glossadelphus*, § *Anastigma* Fleisch.) have the leaves rounded above and not or scarcely attenuated, and the alar cells less differentiated.

TAXITHELIUM PROTENSUM Dix., n. sp. Plate ix, fig. 24.

Polystigma. Aureo-viride. Sat robustum. Caulis usque ad 7 cm. longus, sat regulariter pinnatus, ramis divergentibus, 5-6 mm. longis, percomplanatis. Folia laxe disposita, complanata, divergentia, substricta, parva, vix 1 mm. longa, perconcava, oblongo-lanceolata, e basi contracta dilatata, inde ad apicem sensim acuminata in acumen breve, peracutum, subintegrum angustata; ecostata. Cellulae omnes elongatae, lineares, perangustae, parietibus tenuibus, distincte, sat valide pluripapillatae. Cellulae basilares vix mutatae; infimae tantum ad insertionem una serie breviores, latiores, pellucidae, parietibus sinuoso-incrassatis; alares 1-2 parum latiores, haud notatae.

Cetera ignota.

Hab.—Fiji Is., coll. Steel; herb. Dixon (4).

A marked species in the pinnate stems, with divergent, complanate, rigid leaves, something of the form of *T. isocladum*, but more longly and finely acuminate, and more concave. The habit is not at all, however, that of *T. isocladum*. The papillae are strong, very regular and very distinct.

LEUCOMIACEAE.

LEUCOMIUM Mitt.

LEUCOMIUM DEBILE (Sull.) Mitt.

Gau, on decayed trees, Milne, 22. Ovalau, inter alios muscos, Graeffe. On dead wood in forest, Nadarivatu, Viti Levu, 2,800 ft., Sept., 1907; Gibbs (718). Mt. Evans, Lautoka, Viti Levu, c. 2,000 ft., 3.10.20; Greenwood (369). On wet rock, Nausori, Viti Levu, near sea-level, May, 1921; leg. R. Veitch; herb. Greenwood (441). Mts., interior Vanua Levu, c. 2,000 ft., 25.12.22; Greenwood (464).

SEMATOPHYLLACEAE.

CLASTOBRYELLA Fleisch.

CLASTOBRYELLA CUCULLIGERA (Bry. jav.) Fleisch.

Syn. *Sematophyllum cuculligerum* Jaeg.

New to Fiji. On bank, Mt. Evans, Lautoka, Viti Levu, c. 2,500 ft., 4.1.20; Greenwood (207b); with *Macromitrium involutifolium*.

TRISMEGISTIA (C.M.) Broth.

TRISMEGISTIA RIGIDA (Hornsch. & Reinw.) Broth.

Viti Levu, Milne.

TRISMEGISTIA COMPLANATULA (C.M.) Broth.

Ovalau, reg. montosa, Graeffe.

Very doubtfully distinct from *T. rigida*.

MEIOTHECIUM Mitt.

MEIOTHECIUM MICROCARPUM (Harv.) Mitt.

New to Fiji. Rocks, Mts., Lautoka, Viti Levu, c. 2,500 ft., 3.10.20; Greenwood (365). Nausori, Viti Levu, near sea-level, leg. A. F. Smith, Feb., 1920; herb. Greenwood (296). Dead wood, Suva, sea-level, 25.1.23; Greenwood (478).

MEIOTHECIUM SERRULATUM Dix., n. sp. Plate ix, fig. 25.

Habitu *M. microcarpi* sed robustius, aureo-viride vel brunnescens. Folia paullo majora, 1.25-1.75 mm. longa, minus profunde carinata, apud apicem plerumque marginibus anguste recurvis; ibidem, plus minusve distincte, nonnunquam argute denticulatis. Cellulae superiores paullo majores, anguste ellipticae, subsinuosae, parietibus perincrassatis.

Fructus ignotus.

Hab.—On dead wood on mountains, Labasa, Vanua Levu, June, 1923; Greenwood (489, *type*; 497).

The larger size, and the apical margins recurved and more or less distinctly denticulate, make this a fairly well defined species. Only small quantities were collected, in both cases sterile.

ACROPORIUM Mitt.

ACROPORIUM BREVICUSPIDATUM (Mitt.) Fleisch.

On rocks, foot of Mt. Victoria, Viti Levu, 2,500 ft., Sept., 1907; Gibbs (789).

RHAPHIDOSTICHUM Fleisch.

RHAPHIDOSTICHUM THELIPORUM (C.M.) Broth.

Syn. *Sematophyllum theliporum* Jaeg.

Ovalau, Graeffe.

RHAPHIDOSTICHUM PALLIDIFOLIUM Dix., n. sp. Plate ix, fig. 26.

Corticolum; prostratum, dense appressum, caulibus parallelibus, robustiusculis, complanatis, circa 2 mm. latis, albescentibus, vel pallide viridibus, subnitidis. Folia dense conferta, arcte appressa, nullo modo patentia, plana vel apice lenissime decurvo, subflexuosa, 1.5-2 mm. longa, e basi contracta oblonga, concava, plus minusve abrupte in subulam robustam latam, saepe semitortam, loriformem, obtusiusculam integram contracta. Costa nulla. Cellulae medianae anguste fusiformes, perincrassatae, supra magis breviores latiores, in subula elliptico-rhomboidaeae, infra sensim longiores angustiores, basilares lineares; omnes incrassatae, perdistinctae; superiores ad angulos apicales saepe humiliter grosse prominentes. Cellulae alares quoque latere 3-4 magnae, vesiculosae, hyalinae.

Dioicum. Flores feminei solum visi.

Hab.—On damp logs in forest, Wainikoro, Macuata Coast, Vanua Levu, c. 300 ft., Feb., 1925; Greenwood (555).

Although without fruit, this moss is fairly certain to belong to *Rhaphidostichum* in the neighbourhood of *R. bunodicarpum* (C.M.) Fleisch. The leaves are much like those of *R. luxurians* as figured in the Bry. javanica, but with broader, less pointed subula, entire or almost so, and very incrassate cells. In habit and colour it is very distinct.

I have not seen *R. theliporum* (C.M.), but it is described as having the leaves laxly set, and "setaceo-loriformi-acuminata".

RHAPHIDOSTEGIUM De Not.

RHAPHIDOSTEGIUM CONTIGUUM (Hook. f. & Wils.) Par.

Syn. *Sematophyllum contiguum* Mitt.

On rocks, Mts., Lautoka, Viti Levu, c. 700 ft., 16.1.21; Greenwood (381). *Ibidem*, on rotten wood, c. 2,000 ft., 18.6.22; Greenwood (420).

TRICHOSTELEUM Mitt.

TRICHOSTELEUM HAMATUM (Doz. & Molk.) Jaeg.

Syn. *T. Pickeringii* (Sull.) Jaeg.—*T. rhinophyllum* (C.M.) Jaeg.

Ovalau, Graeffe. Dead wood in forest, Nadarivatu, Viti Levu, Sept., 1907; Gibbs (759). *Ibidem*, 3,000 ft.; Gibbs (740). On rotten wood, Loloti, Viti Levu, c. 800 ft., 2.1.20; Greenwood (171, 178). Rotten wood, Mts., Lautoka, c. 3,000 ft., 18.6.22; Greenwood (425). Rotten wood, Mts., interior Vanua Levu, c. 2,000 ft., 25.12.22; Greenwood (463).

I can see nothing in *T. Pickeringii* (Sull.) and *T. rhinophyllum* (C.M.), but slight forms, differing from the type form only in minute variations of the length of the leaf point and the degree of roughness of the seta.

TRICHOSTELEUM TRACHYAMPHORUM (C.M.) Par. is recorded from Fiji in Paris, Index, but I can find no authority for its occurrence.

TRICHOSTELEUM BOSCHII (Doz. & Molk.) Jaeg.

New to Fiji. On dead wood, Mts., Labasa, Vanua Levu, c. 300 ft., 3.6.23; Greenwood (485).

TRICHOSTELEUM BOSCHII, var. MINUS Dix., n. var.

Minus. Seta perbrevis, circa 6-7 mm. longa.

Hab.—On dead wood, Mts., Labasa, Vanua Levu, c. 300 ft., 17.12.22; Greenwood (462); *ibidem*, Greenwood (460).

A small plant with very short seta, which is very nearly the same thing as *T. brachypelma* (C.M.).

TRICHOSTELEUM FISSUM Mitt.

New to Fiji. On wood, Mts., Labasa, Vanua Levu, c. 300 ft., 7.10.22; Greenwood (452). On rotten logs, Mts., Wainikoro, Macuata Coast, Vanua Levu, c. 400 ft., 27.3.24; Greenwood (543).

PILOECIUM C.M.

PILOECIUM PSEUDO-RUFESCENS (Hampe) C.M.

New to Fiji. Mts., Wainikoro, Macuata Coast, Vanua Levu, c. 300 ft., 21.7.26; Greenwood (556).

BRACHYTHECIACEAE.

RHYNCHOSTEGIUM Bry. eur.

RHYNCHOSTEGIUM SELAGINELLIFOLIUM C.M.

New to Fiji. Falls, Mts., Lautoka, Viti Levu, c. 1,000 ft., 1.9.17; Greenwood (9b). Dead wood, *ibidem*, c. 2,000 ft., 4.4.20; Greenwood (336).

RHYNCHOSTEGIELLA Limpr.

RHYNCHOSTEGIELLA VITIENSIS Dix., n. sp. Plate ix, fig. 27.

Pro genere robustiuscula. Lignicola, arcte adhaerens, rigidiuscula, subpinatim, complanata, divaricato-ramosa. Folia laxa, subdisticha, rigida, sicca minime mutata, sed contracta et convoluta, 1-1.5 mm. longa, lanceolata, breviter acute acuminata, marginibus planis, apice argute, inferne obsolete denticulata. Costa perbrevis, tenuissima, vix quartam partem folii longitudinis aequans.

Cellulae rhomboideo-lineares, parietibus tenuissimis, inde subobscurae, basilares breviores, latiores, laxae, pellucidae, sed alares haud distinctae.

Autoica. Folia perichaetialia erecto-appressa, caulinibus sat similia sed minora. Seta tenuis, laevis, circa 6 mm. alta. Theca parva, oblonga, paullo curvata, inclinata, sub ore leniter constricta, aetate nigrescens; exothecii rete laxum, e cellulis quadratis vel breviter rectangularibus, parietibus tenuibus, haud collenchymaticis instructum. Operculum haud visum. Peristomium sat magnum; dentes angustiusculi, opaci, striolati; internum aurantiacum; membrana circa $\frac{1}{2}$ altitudinem endostomii aequans, processus lineares, anguste rimosi; cilia aut nulla aut valde rudimentaria.

Hab.—On dead wood, Loloti, Lautoka, Viti Levu, Sept., 1920; Greenwood (362).

A pretty and distinct species, nearer to some undescribed Indian species than to any published species, but distinct in the smooth seta, very faint and short nerve, and the absence of any differentiated alar cells.

HYPNODENDRACEAE.

HYPNODENDRON Mitt.

HYPNODENDRON ARBORESCENS Mitt.

Ovalau, Seemann, 845. Milne, 351. Ovalau, in sylvis montosis, et in cacumine montis Tana-lailai, 2,000 ped., Graeffe. On rotten wood in forest, Nadarivatu, Viti Levu, 2,800 ft., Sept., 1907; Gibbs (708).

HYPNODENDRON VITIENSE (C.M.) Mitt.

Syn. Hypnum Graeffeanum C.M.

Viti, Seemann, 842. Ovalau, ad arbores reg. montosae, Graeffe.

HYPNODENDRON REINWARDTHI (Hornsch.) is given by Paris for the group, but I find no evidence of its occurrence.

MNIODENDRON Lindb.

MNIODENDRON TAHITICUM Besch.

New to Fiji. On dead wood, Mt. Evans, Lautoka, Viti Levu, c. 3,960 ft., 4.1.20; Greenwood (230).

Agrees well with the type (leg. Nadeaud) in herb. Bescherelle. The leaves are sometimes a little less narrowly acuminate, but even this is inconstant.

DIPHYSCIACEAE.

DIPHYSCIUM (Ehrh.) Mohr.

DIPHYSCIUM SUBMARGINATUM Mitt.

Syn. *Webera submarginata* Broth.

Viti, Seemann. Summit of Mt. Victoria, Viti Levu, 4,000 ft., covering stones, Sept., 1907; Gibbs (799).

POLYTRICHACEAE.

POGONATUM P. Beauv.

POGONATUM VITIENSE Mitt.

Viti, Milne.

POGONATUM GRAEFFEANUM (C.M.) Jaeg.

Ovalau, in reg. montosa, Cuming, 1854. Clay bank by roadside, Nadarivatu, Viti Levu, c. 2,700 ft., Oct., 1907; Gibbs (858). On damp clay bank, Mts., Lautoka, Viti Levu, c. 600 ft., 22.9.17; Greenwood (40). *Ibidem*, 4.4.20; Greenwood (308); 29.8.20; Greenwood (352).

PSEUDORHACELOPUS Broth.

PSEUDORHACELOPUS PHILIPPINENSIS Broth.

New to Fiji. On damp clay bank, Wainikoro, Macuata Coast, Vanua Levu, c. 100 ft., 29.2.24; Greenwood (520). On wet banks, Labasa, 8.8.22; Greenwood (445).

A very interesting discovery. The plant has only been recorded from the Philippines, from Luzon. No. 445 differs from this plant only in the very short stem with few leaves, less crisped when dry, but 520 approaches the original plant very closely. The felt of the young calyptra is strongly spirally twisted.

Brotherus in describing the Philippine plant makes no mention of the long and very conspicuous ochrea, often showing above the perichaetial leaves; I find this in both the Philippine and Fiji plants.

SPHAGNACEAE.

SPHAGNUM Dill.

SPHAGNUM SEEMANNII C.M.

Syn. *S. cuspidatum* Mitt., nec Ehrh., *fide* C.M. et Warnstorf.

Ovalau, Seemann.

SPHAGNUM VITIANUM Schimp.

In herb. Kew, apud Warnst. In Hedwig., xxx, 144. Viti (no collector given).

SPHAGNUM REICHHARDTII Hampe e Warnst.

In Hedwig., xxix, 206.

Syn. *S. acutifolium* Mitt. in Fl. Vit.

Viti (herb. Mitten).

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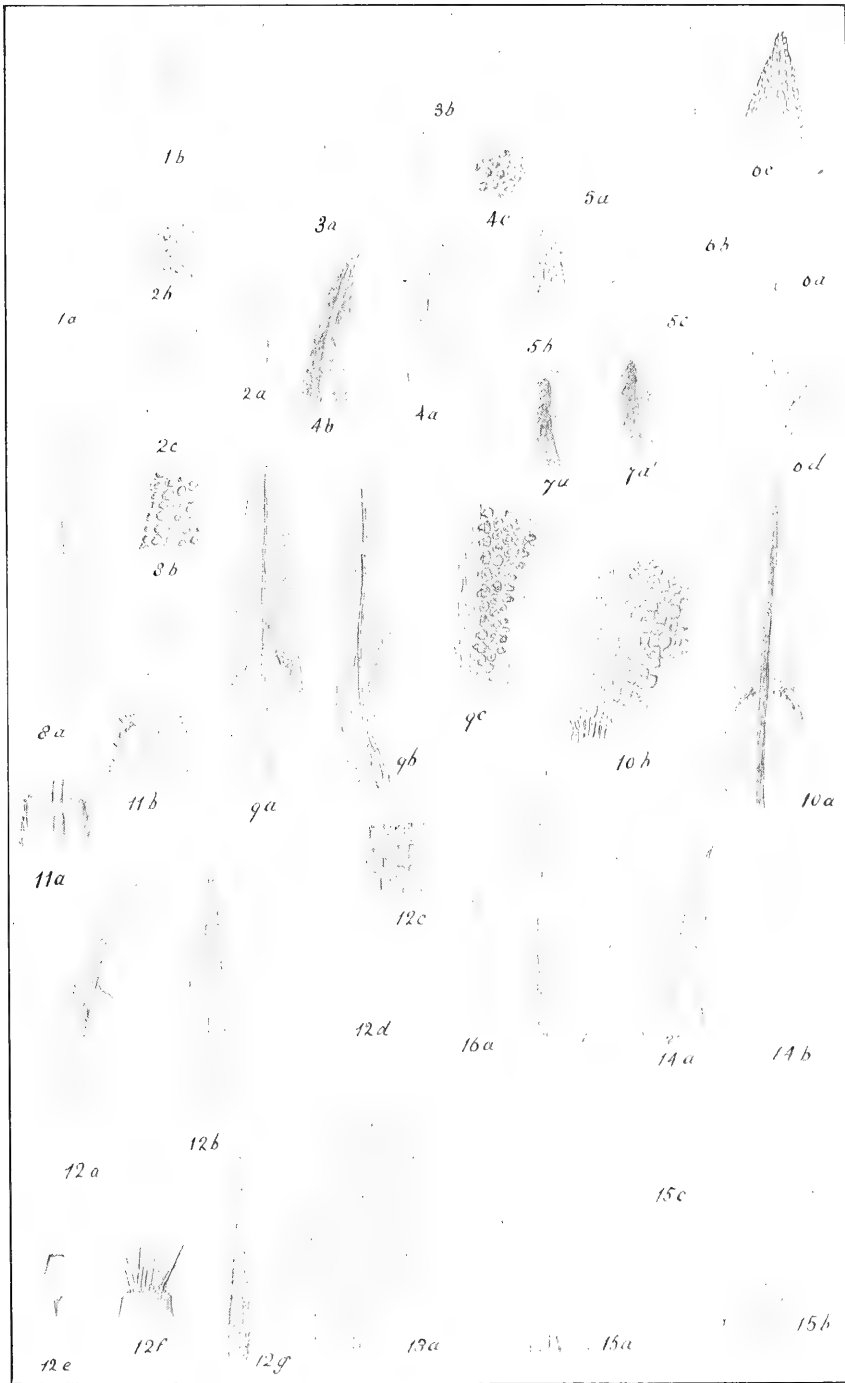
EXPLANATION OF PLATES VIII-IX.

Plate viii.

- Fig. 1.—*Fissidens glosso-bryoides*. a, leaf, $\times 20$; b, leaf-apex, $\times 50$.
 Fig. 2.—*F. diversiretis*. a, leaf, $\times 20$; b, upper cells, $\times 200$; c, basal cells, $\times 200$.
 Fig. 3.—*F. cuspidiferus*. a, leaf, $\times 20$; b, apices of leaves, $\times 20$.
 Fig. 4.—*F. lautokensis*. a, leaf, $\times 20$; b, leaf-apex, $\times 50$; c, upper cells, $\times 200$.
 Fig. 5.—*F. vitiensis*. a, leaf, $\times 20$; b, leaf-apex, $\times 50$; c, upper cells, $\times 200$.
 Fig. 6.—*F. altisetus*. a, plant, $\times 2$; b, leaf, $\times 20$; c, leaf-apex, $\times 50$; d, upper cells, $\times 200$.
 Fig. 7.—*F. perobtusus*. a, a', leaves, $\times 20$.
 Fig. 8.—*F. peracuminatus*. a, leaf, $\times 20$; b, upper marginal cells, $\times 200$.
 Fig. 9.—*Calymperes albo-limbatum*. a, b, leaves, $\times 20$; c, cells at shoulder, $\times 200$.
 Fig. 10.—*C. marginatum*. a, leaf, $\times 20$; b, cells at shoulder, $\times 200$.
 Fig. 11.—*C. tahitense* var. *truncatum*. a, a', leaf-apices, $\times 20$.
 Fig. 12.—*Rhamphidium Veitchii*. a, upper, b, lower leaves of stem, $\times 20$; c, upper cells, $\times 200$; d, basal cells, $\times 200$; e, capsule, $\times 5$; f, peristome, moist, $\times 20$; g, peristome tooth, $\times 100$ (drawn rather too broad for its length).
 Fig. 13.—*Barbula leucobasis*. a, leaf, $\times 20$.
 Fig. 14.—*Mniobryum rubrum*. a, leaf, $\times 20$; b, leaf-apex, $\times 50$.
 Fig. 15.—*Bryum vitianum*. a, leaf, $\times 20$; b, upper cells, $\times 100$; c, leaf-apex, $\times 40$.
 Fig. 16.—*Bryum Greenwoodii*. a, leaf, $\times 8$.

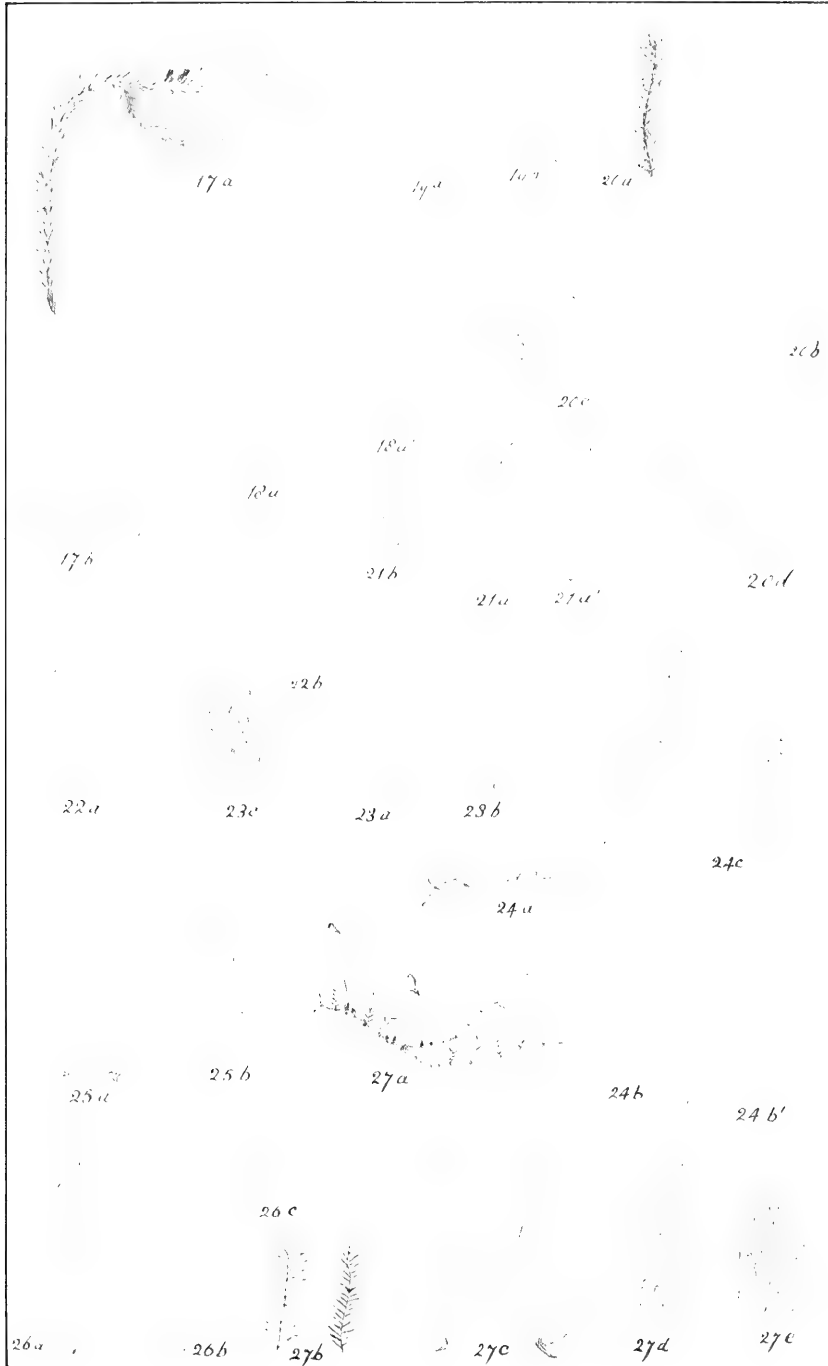
Plate ix.

- Fig. 17.—*Euptychium vitiense*. a, stem, $\times 1$; b, leaf, $\times 10$.
 Fig. 18.—*Thamnum sublatifolium*. a, a', leaves, $\times 20$.
 Fig. 19.—*Stereophyllum vitiense*. a, leaf, $\times 20$; b, base of leaf, $\times 40$.
 Fig. 20.—*Distichophyllum torquatifolium*. a, stem, dry, $\times 1$; b, leaf, $\times 20$; c, leaf-apex, $\times 50$; d, upper median cells, $\times 200$.
 Fig. 21.—*Claopodium amblystegioides*. a, a', leaves, $\times 20$; b, upper marginal cells, $\times 200$.
 Fig. 22.—*Ectropothecium molle*. a, stem-leaf, $\times 20$; b, upper cells, $\times 200$.
 Fig. 23.—*Taxithelium polyandrum*. a, lateral, b, dorsal leaf, $\times 20$; c, upper cells, $\times 200$.
 Fig. 24.—*Taxithelium protensum*. a, stem, $\times 1$; b, b', leaves, $\times 20$; c, upper cells, $\times 200$.
 Fig. 25.—*Meiothecium serrulatum*. a, leaf, $\times 20$; b, leaf-apex, $\times 50$.
 Fig. 26.—*Rhaphidostichum pallidifolium*. a, b, leaves, $\times 20$; c, alar cells, $\times 50$.
 Fig. 27.—*Rhynchostegiella vitiensis*. a, stem, $\times 1$; b, branch, moist and dry, $\times 2$; c, leaves, $\times 20$; d, upper cells, $\times 200$; e, alar cells, $\times 100$.



del. H. N. Dixon.

Mosses of Fiji.



del. H. N. Dixon.

Mosses of Fiji.

NOTES ON AUSTRALIAN DIPTERA. XXIV.

By J. R. MALLOCH.

(Communicated by I. M. Mackerras.)

(Forty-four Text-figures.)

[Read 25th June, 1930.]

This paper completes the notes on Tachinidae, of which the first section was published as No. xxiii of the series (see above, pp. 92-135).

Tribe ACTINI.

In the last shipment of Tachinidae from Dr. Mackerras there were many specimens of this tribe and I purpose to present a key for the identification of all the species now available to me from Australia. I have in the press a similar treatment of the Oriental species, and have compared the two groups of species so that there may be no synonyms created in the papers.

One of the most remarkable species of the tribe is described in the present paper, but, unlike all of those possessing such remarkable antennal characters which have previously been described, it is treated as a subgenus and not a distinct genus. The reason for this action is that in all probability the female possesses no exceptional characters such as does the male and it would be impossible to distinguish it generically from many of the other species retained in *Actia*. I tentatively accept *Schizoceromyia* Townsend, which antedates *Schizactiana* Curran, as a subgenus on the basis of the antennal characters of both sexes, but doubt if it can be maintained.

Key to the Species.

1. Third antennal segment remarkably specialized, either split into two subequal parts from near base to apex, or with a branch on outer side emanating from near base which is furnished with lateral forked filaments (males) 2
Third antennal segment simple, of the normal form 4
2. Third antennal segment with a branch emanating from near base on outer side which bears many forked and simple filaments on one side (Fig. 31); lower stigmatal bristle long and strong, directed downward (Subgenus *Talaractia*) *baldwini*, n. sp.
Third antennal segment with a simple cleft from apex to near base dividing the segment into two almost equal portions (Fig. 32); lower stigmatal bristle very short and fine, directed upward (Subgenus *Schizoceromyia*) 3
3. Second segment of arista longer than the third *fergusoni* Bezzi
Second segment of the arista distinctly shorter than the third *invalida*, n. sp.
4. Second segment of the arista not less than six times as long as thick; parafacials haired to or below middle close to eyes (Subgenus *Schizoceromyia*) 5
Second segment of arista less than four times as long as thick; parafacials rarely haired below level of lower frontal bristle (Subgenus *Actia*) 6
5. Second segment of the arista about four-fifths as long as third *fergusoni* Bezzi
Second segment of the arista about half as long as third *invalida*, n. sp.

6. First wing-vein bare above 7
 First wing-vein setulose in part, at least on upper side 10
7. Fourth wing-vein obliterated beyond the subapical bend; apical section of fifth vein subequal to the preapical one *eucosmae* Bezzi
 Fourth wing-vein distinct beyond the preapical bend; apical section of fifth vein much shorter than the subapical one 8
8. Sixth wing-vein obsolete at apex, not traceable to margin of wing; upper anterior sternopleural bristle much longer and stronger than the lower one; antennae entirely black 9
 Sixth wing-vein weak apically, but distinctly traceable to margin of wing; upper anterior sternopleural bristle weaker and shorter than the lower one; antennae orange-yellow at bases, third segment largely fuscous apically .. *norma* Malloch
9. Mid tibia with a distinct and quite long anterodorsal bristle near middle; thorax with three pairs of postsutural dorsocentral bristles; abdomen broadly translucent yellowish on sides of basal half; third antennal segment very wide, about half as wide as eye in profile *lata*, n. sp.
 Mid tibia without a submedian anterodorsal bristle; thorax with four pairs of postsutural dorsocentral bristles; abdomen entirely black, with rather conspicuous white-dusted bases to the tergites; third antennal segment not nearly half as wide as eye in profile *parviseta*, n. sp.
10. First, third and fifth wing-veins setulose on upper side; fourth vein faint, but evident beyond the preapical curve; mesonotum with three pairs of postsutural dorsocentral bristles *darvini* Malloch
 First and third wing-veins setulose above, fifth vein bare 11
11. Lower stigmatal bristle undeveloped; fourth wing-vein very faint beyond the preapical curve; mesonotum with three pairs of postsutural dorsocentral bristles; first vein setulose from near base to apex above, and at apex below *brevis*, n. sp.
 Lower stigmatal bristle long and strong, directed downward; fourth vein quite conspicuous beyond the apical curve; mesonotum with four pairs of postsutural dorsocentral bristles 12
12. First wing-vein setulose from near base on upper side; abdomen entirely black, the tergites white-dusted at bases *nigritula*, n. sp.
 First wing-vein setulose only on apical portion beyond the slightly thickened portion; abdomen more or less largely yellow on sides 13
13. Frons of male when seen from the side and in front densely silvery-white dusted; inner cross-vein of wing a little proximad of middle of discal cell *argentifrons*, n. sp.
 Frons of both sexes greyish-dusted on orbits, less evidently so on interfrontalia; inner cross-vein of wing usually quite evidently beyond middle of discal cell .. *plebeia*, n. sp.

Subgenus SCHIZOCEROMYIA Townsend.

Phil. Journ. Sci., 29, 1926, 542.

Tentatively I accept this subgenus, but I rather incline to the belief that it will ultimately be sunk as a synonym of *Schizotachina*. There are possibly four species in Australia, to judge from my material, and accepting *valida* Curran as distinct from those in my hands. I present some notes on the three forms available now.

ACTIA (SCHIZOCEROMYIA) FERGUSONI Bezzi.

This species was the first one with fission corn antennae described from Australia, and it is represented by a number of specimens of both sexes in my material. I have figured the antenna of the male, showing the much elongated second aristal segment (Fig. 32a). In addition to the characters already listed as distinguishing the male, it is worthy of mention that the mid tibia lacks the anterodorsal bristle beyond the middle, and the scutellum is shining black when

seen from the side and slightly from behind, the apex being not at all paler than the disc. The female is similar to the male, but has the third antennal segment simple, and the abdomen is usually darker, generally entirely shining black, with white-dusted fasciae at bases of the tergites.

Locality, Sydney, N.S.W., various dates, September–December (Health Dept.).

ACTIA (SCHIZOCEROMYIA) VALIDA Curran.

In his original description, Curran describes the arista of this species as having the second segment scarcely, if any, longer than the third. I have seen no examples that have the second segment so nearly equal to the third and, unless there is more variation in the genus than I at present suspect, it is probable that the species is not amongst my material.

ACTIA (SCHIZOCEROMYIA) INVALIDA, n. sp.

This species is so very similar to *fergusoni* that it is necessary to mention only the distinctions between them to enable anyone to identify it. The antennal characters may be gleaned from a study of the figure (32*b*) presented herein; and, in addition to this, the presence of a strong but rather short bristle about one-third from apex of mid tibia on its anterodorsal surface in the male will distinguish it from *fergusoni*. Curran does not mention whether this bristle is present or absent in *valida*.

I at one time considered the present species as *valida*, but decided finally to accept it as distinct, pending further information on the above points.

Length, 3–3.5 mm.

Type, male, Sydney, N.S.W., 16.12.1923; allotype, same locality, 7.12.1923; paratypes, same locality, 26.10.1924, 30.11.1924, 18.12.1923, and one no date; Collaroy, near Sydney, N.S.W., 24.1.1924 (E. W. Ferguson).

ACTIA (SCHIZOCEROMYIA) SP.

I have a single male specimen before me which differs from *fergusoni* in having the second segment of the arista only about two-thirds as long as the third, and from *invalida* in having no anterodorsal bristle beyond middle of the mid tibia. It is possible that this specimen represents another species, but there is nothing to be gained by describing it from one example, so I leave it aside pending the receipt of more material.

Locality, Warburton, Vict., 13.1.1924 (F. E. Wilson).

Subgenus TARARACTIA, n. subgen.

This subgenus approaches *Talarocera* Williston and *Cryptocladocera* Bezzi in the subdivision of the third antennal segment, but it is a true member of the Actiini, whereas the other two genera belong to distinct tribes. The structure of the insect, apart from that of the third antennal segment, is much the same as in *fergusoni*, but the lower stigmatal bristle is long, strong and downwardly directed, the first wing-vein is setulose from about level of humeral cross-vein to apex on upper side and bare below, the third is setulose at base below and to a point about midway between inner cross-vein and its apex above, the apical section of fifth vein is about as long as the preapical one, and the outer cross-vein is about one-fourth of the distance between the inner cross-vein and the bend of fourth vein.

Subgenotype, the following species.

ACTIA (TALARACTIA) BALDWINI, n. sp.

♂. Head testaceous yellow, frontal orbits and occiput darkened, densely yellowish-grey dusted; antennae orange-yellow, third segment with the simple inner portion darkened apically; the filamented portion fuscous; palpi orange-yellow. Thorax black, densely brownish-grey dusted, not vittate. Abdomen glossy black, bases of visible tergites 2 to 4 narrowly white dusted. Legs black, fore coxae, trochanters, and tibiae testaceous yellow. Wings hyaline. Calyptrae white. Halteres yellow.

Frons more than one-third of the head-width at vertex, normally bristled; eyes bare; parafacials not visible in profile except at upper extremities; antennae fully as long as face (Fig. 31). Mesonotum with four pairs of postsutural dorso-centrals, sternopleurals three. Apical bristles on tergites 2 to 4. Legs normal. First posterior cell ending almost exactly in wing-tip; bend of fourth vein rounded.

Length, 3.5 mm.

Type, Palm Is., Qld. (M. Taylor).

Named in honour of Dr. A. H. Baldwin, of the Australian Institute of Tropical Medicine, Townsville, Queensland, who submitted the specimen for study.

Subgenus ACTIA Robineau-Desvoidy.

There are several well defined groups in this subgenus, some of them readily distinguished by the nature of the armature of the wing-veins, and others by the chaetotaxy of the thorax. The remarkably strong lower stigmatal bristle in some of the species might be accepted by some authorities as sufficient basis for the erection of a distinct genus, but other characters do not bear this out, so

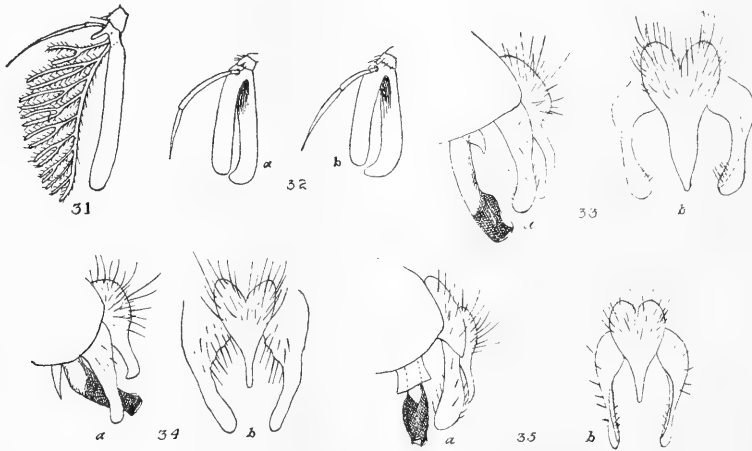


Fig. 31.—*Actia baldwini*. Antenna.

Fig. 32.—*Actia fergusonii* (a) and *invalida* (b). Third antennal segment.

Fig. 33.—*Actia norma*. Hypopygium of male; a, from the side; b, from behind.

Fig. 34.—*Actia selangor*. Hypopygium of male; a, from the side; b, from behind.

Fig. 35.—*Actia plebeia*. Hypopygium of male; a, from the side; b, from behind.

I leave the species listed hereunder as members of the subgenus *Actia*. In all species the parafacials are bare, except rarely just below level of lower frontal bristle.

ACTIA (ACTIA) EUCOSMAE Bezzi.

This species is readily distinguished from all the others now known from Australia by the complete lack of the fourth vein beyond its preapical bend, and the absence of setulae on the first vein. The dorsum of thorax has four pairs of postsutural dorsocentral bristles, the lower stigmatal bristle is undeveloped and the mid tibia lacks the anterodorsal submedian bristle in the male.

Localities: Como, N.S.W.; and South Australia (A. H. Elston). I have also a male before me from the Philippines, which I cannot distinguish from this species.

ACTIA (ACTIA) NORMA Malloch.

I described this species from one male specimen in one of my more recent papers in this series. I have now before me a large series containing both sexes and add a few more details of the structure. The postsutural dorsocentrals are three in number, the lower sternopleural bristle is usually slightly larger than the upper anterior one, the male has an anterodorsal submedian bristle on the mid tibia, the lower stigmatal bristle is undeveloped, the first vein is bare, the third is setulose above to, or nearly to, the inner cross-vein, the outer cross-vein is a little nearer to bend of fourth than to the inner cross-vein and about its own length from the apex of fifth.

Localities: Sydney, Kuring-gai, and Barrington Tops, N.S.W.; Beaconsfield, Vict.; and Narrogin, W.A. Twenty-four specimens representing both sexes, September-February.

The species is very similar to *selangor* Malloch, but differs in the structure of the hypopygium (Figs. 33 and 34); *selangor* is an Oriental species.

ACTIA (ACTIA) LATA, n. sp.

♂. Head testaceous yellow, upper half of occiput black on each side, grey-dusted, frontal orbits, face, and cheeks, with dense yellowish-grey dust; antennae and arista black; palpi testaceous yellow. Thorax black, mesonotum densely yellowish-grey dusted, with faint traces of four dark vittae, apex of scutellum slightly yellowish. Abdomen testaceous yellow, first and second visible tergites each with a large central black spot, third black except at anterior lateral angles above, fourth all black above, each tergite with a centrally interrupted white-dusted basal fascia that is about one-third of the length of tergite on fourth. Legs black, fore coxae and the trochanters testaceous yellow, tibiae brownish, possibly sometimes paler. Wings hyaline. Calyptrae yellowish-white. Halteres yellow.

Frons at vertex about one-third of the head-width, slightly widened anteriorly, with the usual bristling, ocellars not very strong; parafacials bare below the lower frontal bristle, linear below, third antennal segment extending to mouth-margin, and about half as wide as eye in profile; second segment of arista a little longer than thick; palpi normal; proboscis not very thick. Thorax with three pairs of postsutural dorsocentral bristles; apical scutellar bristles very short and fine, the preapical discals hardly longer; lower sternopleural bristle minute, the upper anterior one as long as posterior one; lower stigmatal bristle

undeveloped. Abdomen with two apical central bristles on second visible tergite, and six rather short bristles at apex of fourth. Legs normal, mid tibiae lacking in type. Outer cross-vein of wing about mid-way from inner cross-vein to bend of fourth vein and at about its own length from apex of fifth, inner cross-vein at middle of discal cell; first vein bare, third with setulae up to inner cross-vein; bend of fourth vein broadly rounded.

Length, 3.5 mm.

Type, Sydney, N.S.W., 18.12.23 (Health Dept.). One specimen.

ACTIA (ACTIA) PARVISETA, n. sp.

♂. Head testaceous yellow, occiput almost all black, grey dusted, interfrontalia red, frontal orbits, face, and cheeks, densely greyish-yellow dusted; palpi testaceous yellow; antennae and arista black. Thorax and abdomen shining black, both with greyish dust, the abdomen with the dust more yellowish and very dense on bases of visible tergites 2 to 4, where it forms a basal fascia which is very distinctly interrupted in centre on each. Legs black, only the trochanters more or less yellowish. Wings hyaline. Calyptrae and halteres brownish-yellow.

Head in profile almost vertical in front, the parafacials of almost equal width on entire extent, not narrowed below; frontal orbits as wide as interfrontalia; parafacials bare below lower frontal bristle; third antennal segment extending almost to vibrissae, not more than one-third the width of the eye in profile; arista distinctly pubescent, second segment fully twice as long as thick; palpi normal. Thorax with four pairs of postsutural dorsocentrals, the posterior pair only long; lower sternopleural about half as long as upper anterior one, the latter subequal to posterior one; apical scutellar bristles very short and fine. Abdomen broadly ovate, apical bristles on all tergites very much shorter and finer than usual. Fore tibia with the anterodorsal setulae longer and stronger than usual and forming an almost complete series, basal segment of fore tarsi rather longer setulose above than usual; other tibiae with the bristles much shorter than usual, none of them longer than diameter of tibia, the mid pair lacking the anterodorsal submedian bristle, the hind pair with almost complete series of short setulae on anterodorsal and posterodorsal surfaces. Wing venation as in *lata*, the sixth vein incomplete.

Length, 3.5-4 mm.

Type, Sydney, N.S.W., 16.12.23 (Health Dept.); one paratype, Collaroy, N.S.W., 24.1.1924 (E. W. Ferguson).

ACTIA (ACTIA) DARWINI Malloch.

I described this species from a single male in my preceding paper on the family. I have now before me the female and some other examples, and give the additional locality records. The female is similar to the male, but has the yellow colour of the abdomen reduced in extent, confined to the sides of first, or first and second visible tergites, and the tarsi are a little darkened.

The female used in drawing up the above details is the allotype.

Type, male, Darwin, N. Aust., 11.10.1916 (G. F. Hill); allotype, Sydney, N.S.W., 25.1.1925; other specimens, Sydney, March, 1921, and 26.1.1921; Coramba, N.S.W., 15.2.1925.

This species is not very closely related to *eucosmae* Bezzi, in which the fourth wing-vein is obsolete beyond the bend.

ACTIA (ACTIA) BREVIS, n. sp.

♂. Very similar to the preceding species and possibly but a variant of it, differing as it does essentially only in having the inner cross-vein at about two-fifths from apex of discal cell, the abdomen darker, more like the female of *darwini*, the fifth vein without setulae, and the third with the setulae on the upper side not so far extended apically. I have reason to doubt its specific distinctness, because of the presence on one wing of a fine setula near base of the discal cell on fifth vein. Possibly an examination of the hypopygia would settle the matter, but I have only one male of *brevis* and do not desire to destroy its appearance by dissection, so prefer to await the discovery of more specimens for an opportunity to test the validity of the species.

Length, 3.5 mm.

Type, Sydney, N.S.W., March, 1921 (Health Dept.).

ACTIA (ACTIA) NIGRITULA, n. sp.

♀. Head testaceous, occiput largely fuscous, interfrontalia yellow, frontal orbits, face, and cheeks densely whitish-grey dusted; basal two antennal segments and palpi testaceous yellow, third antennal segment black, arista fuscous. Thorax black, rather densely greyish dusted, without evident vittae. Abdomen glossy black, with a centrally interrupted narrow basal fascia of white dust on tergites 2 to 4. Legs black. Wings greyish hyaline. Calyptrae white. Halteres yellow.

Interfrontalia a little narrower than either orbit, frontal armature strong, the ocellars quite long, no hairs below the lower frontal, parafacial linear below; third antennal segment hardly more than twice as long as second, extending almost to vibrissae; second segment of arista about twice as long as thick; palpi not much dilated at apices. Thorax with four pairs of postsutural dorsocentral bristles, the lower stigmatal long and strong, directed downward, lower sternopleural nearly as long as anterior one, the latter shorter than the posterior one; apical scutellar bristles of moderate length and cruciate. Abdomen with the apical tergal bristles long. Legs normal. Wings almost identical with those of *darwini*, but the fourth vein is distinct to apex, and the fifth vein is entirely bare above.

Length, 3.5-4.5 mm.

Type, and one paratype, Cairns, N. Queensland (Dodd); paratypes, Sydney, N.S.W., 21.11.1920; Coramba, N.S.W., 15.2.1925. Four specimens.

This species is most closely related to *monticola* Malloch, from the Philippines, but the fourth wing-vein beyond the bend is different, and the third antennal segment is shorter.

ACTIA (ACTIA) ARGENTIFRONS, n. sp.

♂. Head whitish-yellow, densely silvery-white dusted, the frons when seen from one side in front entirely white dusted, the interfrontalia not darker than the orbits, occiput largely blackened on the sides; antennae orange-yellow, third segment dark brown except at base and narrowly below, aristae concolorous with antennae; palpi orange-yellow. Thorax black, densely grey-dusted, apex of scutellum slightly testaceous yellow. Abdomen glossy-black, sides of first three tergites translucent yellow, bases of tergites quite conspicuously white-dusted, the fasciae interrupted in middle. Legs black, fore coxae, the trochanters,

apices of fore femora, and the fore tibiae, yellow, mid and hind tibiae brownish. Wings greyish-hyaline. Calyptrae yellowish-white. Halteres yellow.

Frons at vertex about one-half of the head-width, slightly widened in front, the interfrontalia more than twice as wide as either orbit, the latter with the usual bristles, ocellars of moderate length; third antennal segment extending almost to mouth margin, about three times as long as second, and of moderate width; second aristal segment about three times as long as thick; palpi normal; parafacials linear below. Thorax with four pairs of postsutural dorsocentrals, the lower stigmatal bristle very long and strong, directed downward, lower and anterior sternopleural bristles about equally long; apical pair of scutellar bristles rather well developed. Abdomen narrowly ovate, with normal bristling. Mid tibia with the submedian anterodorsal bristle strong. Wings almost as in the preceding species, the inner cross-vein a little proximad of middle of discal cell.

Length, 3.5 mm.

Type, Sydney, N.S.W., 2.12.1921 (Health Dept.). One specimen.

ACTIA (ACTIA) PLEBEIA, n. sp.

♂, ♀. Very similar to the preceding species, but the interfrontalia is yellow and well differentiated from the grey-dusted frontal orbits; the latter are fully half as wide as the interfrontalia, the ocellar bristles are longer and stronger, the hind tibial bristles are longer and stronger, especially on the anterodorsal surface, and the mid and hind tibiae paler than in *argentifrons*, and the inner cross-vein is slightly beyond the middle of the discal cell.

From *hyalinata* Malloch, an Oriental species, this one differs but slightly, the hypopygia being rather similar. The third antennal segment in *hyalinata* is more than four times as long as the second, and it is narrower than in *plebeia*. In all three species the arista is rather noticeably pubescent. I figure the hypopygium of *plebeia* (Fig. 35). In *hyalinata* the inferior forceps are more curved and more distinctly dilated at apices.

Length, 3.5-4.5 mm.

Type, Coramba, N.S.W., 15.2.1925; allotype, Sydney, N.S.W., 26.12.1920; paratypes, Sydney, N.S.W., 9.1.1924; March, 1921; 13.4.1925; 25.9.1921; and one with no date.

There is no doubt that many more species of this genus will be found in this country as there are a large number of species in the Orient, Europe, the Americas and Africa, though so far none has been recorded from New Zealand. None of the known species exceeds 6 mm. in length.

Tribe LINNAEMYIINI.

Genus CHAETOPHTHALMUS Brauer and Bergenstamm.

(*Amphibolosia* Surcouf.)

The genus *Amphibolosia* was described by Surcouf in 1920 in his "Revision of the Muscidae Testacea" for the reception of *Ochromyia flavipennis* Macquart 1851, not 1843. I have listed the references to both in my catalogue, the first one, from Brazil, being a valid species, and the Australian one obviously invalid, being a homonym. In connection with Surcouf's work there are several points that appear worthy of notice. He very fully describes Macquart's type, but nowhere does he indicate the character's of the arista. On Plate V he figures the species from dorsal view entire. On the same plate we find a figure labelled

Via, but there is no such figure listed in the explanation of the plate, though there is a figure Va which is listed as the head of *Amphibolosia flavipennis*. If one examines this last figure carefully it will be noticed that the arista, instead of being represented by sharp complete engraved lines, is merely dotted in, and though I note no mention of the lack of this in the type I am certain that this was really the case and that the artist merely drew upon his imagination to fill out the figure.

Bezzi (*Bull. Ent. Res.*, 17, pt. 3, 1927, 244) records the species as having been recognized by him from Sydney, N.S.W.

He possibly did not connect the figures of the head and the entire insect on Surcouf's plate, but he did state that the arista is bare. He does not indicate the relationships of the genus, which he evidently accepts, nor does he mention that the palpi are minute. Surcouf does not show the palpi in his figure, which is not remarkable, as they are frequently difficult to see. Had Bezzi related the figures, I am certain that he would have been of the same opinion as I am, that *Amphibolosia* is a synonym of *Chaetophthalmus*.

It is not possible, of course, to make certain of the identity of Macquart's species, but I am fairly certain that it is merely *brevigaster* Macquart, as it agrees in all details with what appears to be the commonest species of the genus in Australia.

CHAETOPHTHALMUS BISERIATUS, n. sp.

♂. Similar in general coloration and structure to *brevigaster* Macquart. Head reddish-yellow, with yellow dust which is paler and somewhat changeable on the frontal orbits; third antennal segment browned apically above; palpi yellow. Thorax reddish or fulvous yellow, dorsum broadly black to hind margin, the dark portion with whitish dust and four narrow black vittae; pleura with yellow dust, sternopleura dark on lower portion; all pleural hairs dark. Abdomen coloured as thorax, dorsum broadly black at base, more narrowly so on second tergite, the vitta widening on third and fourth, the dust on dark portion whitish, on sides yellowish. Legs fulvous, apical two segments of each tarsus dark. Wings yellowish hyaline. Calyptrae and halteres fulvous yellow.

Eyes densely haired; frons at vertex about one-third of the head-width, orbits at centre as wide as interfrontalia, each with two proclinate outer bristles and a series of inner marginal incurved bristles as well as many fine hairs, the hairs sparse on entire extent of parafacials, the latter not as wide as third antennal segment, which is slightly concave on upper surface. Thorax with three plus three dorsocentrals, four plus three acrostichals, no posterior sublateral bristle, and one plus one sternopleurals. Abdomen ovate, with a pair of central apical bristles on second and third visible tergites and a preapical and apical series on fourth; third and fourth sternites each with a dense complete series or fringe of stiff black hairs across apex and for a short distance before it; fifth sternite deeply cleft, the inner apical angles of processes rounded, slightly darkened, and without exceptional armature. Legs as in *brevigaster*; mid tibia with a submedian ventral bristle. Bend of fourth vein angular.

Length, 7.5 mm.

Type, Narromine, N.S.W., no other data. One specimen.

Distinguished from *brevigaster* by the presence of an apical fringe on the third sternite. This fringe and the one on fourth sternite is more dense and broader, hence more conspicuous, than the one on fourth sternite in *brevigaster*.

Tribe CYLINDROMYIINI.
Genus CYLINDROMYIA Meigen.

Since the completion of my last paper on this tribe I have received some additional species which are dealt with below. One species has the centre of the propleura haired, and will thus fall in the first segregate of my generic key, being distinguished from all the included genera by the high, vertical, entirely chitinous, area above bases of hind coxae and below the base of the abdomen. The bare arista and the lack of a vertical carina on the face are additional distinguishing characters.

Below I present a key for the identification of the species now available, with descriptions of the new species, and data upon the distribution.

Key to the Species.

1. Centre of the propleura haired; first visible abdominal tergite narrowed apically, and with a pair of well developed discal, as well as a pair of apical central bristles; apical venation of wing as in Figure 36; glossy black species, humeri, apex of first visible abdominal tergite, apex and base of second, and the base of third, and a broad patch on entire length of dorsum of fourth tergite, densely yellow dusted; legs tawny yellow, coxae, fore femora, except their apices, and all the tarsi, black *nigricosta*, n. sp.
Centre of the propleura bare; first visible abdominal tergite wider at apex than at base, and without discal bristles 2
2. Thorax and abdomen glossy black, with white-dusted markings 3
Thorax usually black, abdomen largely red or reddish-yellow basally, both with white or yellowish dusted markings 4
3. Genitalia of the female with a process on each side (Fig. 37) *sydneyensis*, n. sp.
Genitalia of the female without a process on each side (Fig. 38) *atratala*, n. sp.
4. Pleura largely testaceous yellow; costa of wing quite distinctly, and rather broadly browned; fourth abdominal sternite of male without any short stout bristles at apex in centre; apical venation of wing as Figure 40 *brunnea*, n. sp.
Entire thorax black; wings not, or very faintly, browned along the costa 5
5. Abdomen with black dorsocentral spots or vitta on one or both of the red segments of basal portion, first visible tergite with a very narrow apical white-dusted fascia *flavifrons* Macquart
Abdomen lacking black dorsocentral spots or vitta on first and second visible tergites, the former without a white-dusted apical fascia *tricolor*, n. sp.

N.B.—I am unable to include *tristis* Bigot in the above key through lack of information on certain structural features. If it belongs to this genus and has the centre of the propleura bare, it will run down to the segregate containing *sydneyensis* and *atratala*, from both of which it may be distinguished by its larger size (14 mm.), dark margins to the lower calyptrae, and the presence of dark clouding along the wing veins.

CYLINDROMYIA NIGRICOSTA, n. sp.

♂. Head black, frontal orbits and parafacials densely yellow dusted, the latter becoming whitish dusted below, centre of face, all of cheeks, and lower half of occiput, silvery-white dusted, upper occiput shining, but lightly dusted, upper postocular orbits brownish dusted; antennae, arista, and proboscis black; interfrontalia dull black; genal and occipital hairs yellowish-white. Thorax black, humeri densely golden-yellow dusted, mesonotum when seen from behind with white dust which is almost uniform behind suture, but broken and vittiform presuturally, the central vitta most distinct; scutellum and pleura slightly white dusted. Abdomen black, with two narrow golden-yellow annuli, one at suture

between first and second visible tergites, the other at that between second and third, fourth tergite with a large discal mark of same coloured dust. Legs tawny-yellow, coxae, the greater part of fore femora, and all of tarsi fuscous. Wings hyaline, with a dark-brown costal streak from base, which fills all of the area anterior to fourth vein up to, or slightly beyond, inner cross-vein, and from there to apex of first posterior cell extends a little over third vein. Calyptrae yellowish-white. Halteres yellow.

Frons at vertex a little more than one-sixth of the head width, inner verticals long but fine, upper postocular ciliae quite prominent, ocellars not differentiated, orbits linear above, widened below, with rather closely placed, quite long, fine

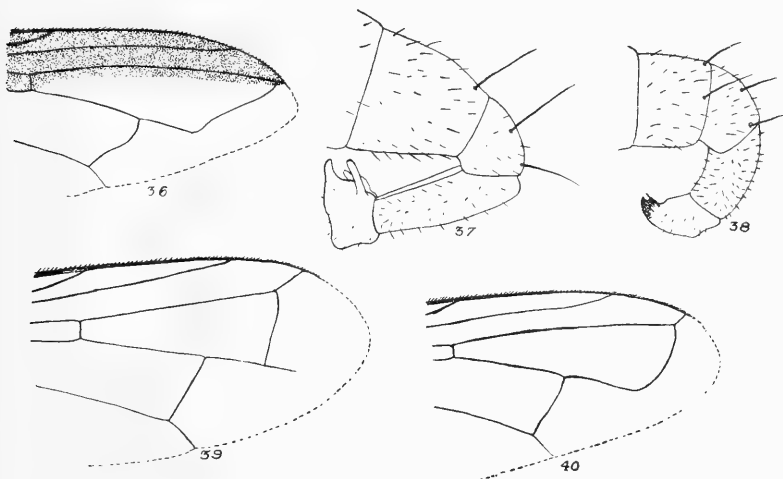


Fig. 36.—*Cylindromyia nigricosta*. Apex of wing.

Fig. 37.—*Cylindromyia sydneyensis*. Apex of abdomen of female from the side.

Fig. 38.—*Cylindromyia atratula*. Apex of abdomen of female from the side.

Fig. 39.—*Cylindromyia atratula*. Apex of wing.

Fig. 40.—*Cylindromyia brunnea*. Apex of wing.

bristles along their inner margins, and mesad of these some shorter and finer hairs, interfrontalia of uniform width throughout its length; antennae more than four-fifths of the facial length, third segment nearly twice as long as second; arista subnude; parafacial as wide as third antennal segment; cheek twice as high as width of third antennal segment; vibrissa long; cheek rather long haired on raised portion; palpi undeveloped. Thorax with the prosternal plate bare, the dorsal hairs and bristles long and erect, the dorsocentrals three or four plus four; scutellum with two strong bristles on each side, the second one from base diverging apically, the apical bristles fine and long, curving upward; sternopleurals fine, two plus one, not well differentiated from the surrounding hairs. Abdomen narrowed at base, all tergites with apical and discal bristles, those on disc of fourth weak, fourth sternite with about five short stout spines in centre near apex and a long bristle on each side at same level. Mid tibia with a submedian ventral bristle; hind femur with bristles on basal half or more of the

anteroventral and posteroventral surfaces; tarsal claws and pulvilli on all legs longer than the fifth tarsal segment. Third wing-vein with several fine hairs at base above and below; petiole of first posterior cell short; apical venation as Figure 36.

Length, 11 mm.

Type, Kosciusko, N.S.W., 7.12.1922 (Goldfinch). One specimen.

CYLINDROMYIA ATRATULA, n. sp.

♂, ♀. Shining black, with white-dusted markings. Frontal orbits of male yellow-dusted, those of female white-dusted anteriorly, shining black posteriorly; interfrontalia dull-black; face, parafacials, cheeks, lower occiput, and upper postocular orbits, silvery-white dusted, upper occiput shining, with slight dusting; antennae, aristae, and proboscis black, third antennal segment slightly reddish at base on inner side; genal and lower occipital hairs pale. Thorax with white dusting on dorsum, which leaves two broad shining black vittae in front of suture and a broad central postsutural black mark; pleura with a vertical silvery-white erect stripe over anterior margin and another above mid coxae. Abdomen with the sutures between first and second and second and third visible tergites silvery-white dusted. Legs black, all coxae and the posterior surface of fore femora silvery-white dusted. Wings greyish hyaline. Calypterae yellowish-white. Halteres fuscous.

Frons of male about one-fourth of the head width at vertex, orbits of almost uniform width except anteriorly, and each as wide as interfrontalia on upper half, inner vertical bristles strong and long, ocellars distinct, each orbit with about eight incurved bristles along inner margin; frons of female a little wider than that of male, the orbits not as wide as interfrontalia above, and each with at least one forwardly-directed outer upper bristle; face quite noticeably convex, almost carinate above in centre, visible in profile, parafacial not as wide as third antennal segment, the latter extending almost to mouth margin, broader than in *nigricosta*, and more than one and a half times as long as second segment; arista subnude, swollen at base; cheek in profile very narrow owing to a quite pronounced infolding of the central lower part. Thorax with the dorsal hairs sparse, the dorsocentrals two or three plus three; sternopleurals one plus one; scutellum as in the preceding species, but the apical bristles are cruciate and do not curve upward. Abdomen without discal bristles, except on fourth visible tergite, the apical bristles present; genitalia of female as in Figure 38; fourth sternite of the male with two central apical bristles and a longer bristle on each side at apex, which are not so strong as in *nigricosta*. Third wing-vein with one or two setulae at base above and below; apical venation as in Figure 39.

Length, 5-6 mm.

Type, female, Sydney, N.S.W., 6.11.1921; allotype and one male paratype, same locality, March, 1921, and 30.10.1921, respectively (Health Dept.). The paratype lacks the head.

CYLINDROMYIA SYDNEYENSIS, n. sp.

♀. This species is quite similar to the preceding one, but it is considerably larger, the pleura are more evenly white-dusted, the female genitalia are furnished with a process on each side near base (Fig. 37), and the prosternal plate has a pair of quite strong bristly hairs which are lacking in *atratura*.

Unfortunately the head is broken off in the only specimen available and the male is not amongst my material, so that it is not possible to describe the species completely. There are indications, however, that there may be venational differences, as there is almost no trace of a spur vein at the preapical angle of the fourth vein, and the latter is more noticeably curved at its extremity than in *atratura*.

Length, 7.5 mm. (estimated with head present).

Type, Sydney, N.S.W. (C. Gibbons).

CYLINDROMYIA BRUNNEA, n. sp.

♂. Reddish-brown, distinctly shining, with yellow or white dusted markings. Interfrontalia chocolate-brown, paler on sides, frontal orbits, and parafacials golden-yellow dusted, the face paler dusted, cheeks and lower occiput white-dusted, upper occiput fuscous, yellow-dusted; antennae orange, third segment black, except at base and below; aristae black; proboscis rufous at base, black apically; genal hairs black in front, pale behind. Mesonotum more or less bronzy, with yellowish dust which leaves four incomplete dark vittae; scutellum fuscous, with a bronzy tinge; pleura brownish-yellow, rather evenly yellowish-dusted. Abdomen reddish-brown, with the dorsocentral region darker, bases of all tergites broadly, and apices of second and third narrowly, pale-dusted. Legs red, extreme apices of femora and all of tarsi fuscous. Wings browned, darker along costa much as in *nigricosta*, but the dark cloud not as clearly defined as in that species. Calyptrae white, with yellow border. Halteres brown.

Frons at vertex about one-fourth of the head-width, verticals irregular in type, but the inner one strong, ocellars distinct; orbits narrowed above, at middle about half as wide as interfrontalia, each with about ten inner marginal bristles; parafacial not as wide as third antennal segment, the latter rather broad for this genus, and not much longer than second segment, extending to about three-fourths of the facial length; face in centre slightly vertically convex, produced below; arista subnude. Thorax with the prosternal plate bare, three plus three dorsocentrals, sternopleura with two bristles and some long hairs; scutellum as in *atratura*. Abdomen with bristles as in that species, fourth sternite without strong apical central bristles. Mid femur with an irregular and almost complete series of bristles on the anteroventral surface and a similar series on posteroventral surface; mid tibia with a strong submedian ventral bristle; hind femur with bristling much as the mid pair, but the posteroventral series is not continued to apex; hind tibia with about four strong anteroventral bristles; all tarsal claws and pulvilli longer than the fifth tarsal segment. Apical venation of wing as Figure 40.

Length, 9 mm.

Type, Perth, W.A. (J. Clark). One specimen.

CYLINDROMYIA FLAVIFRONS Macquart.

I have already fully described this species. I have now on hand specimens from the following localities: Sydney, Barrington Tops, Manly, Tarro, Toronto, Mt. Kosciusko, Wentworth Falls, and Perth.

CYLINDROMYIA TRICOLOR, n. sp.

♀. This species is very similar to the preceding one, differing, in addition to the manner stated in the foregoing key, in having the mesonotal dusting yellowish

on lateral anterior margins, and the preapical bend of the fourth wing-vein rounded and without a spur-vein, similar to that of *brunnea*, instead of angular and with a more or less elongate spur-vein which is the case in *flavifrons*.

Length, 8.5 mm.

Type, "Allowrie", Killara, N.S.W., 17.11.1920. One specimen.

There are, in all probability, many more species of this interesting genus yet to be discovered in Australia. The genitalia of both sexes provide characters for the distinction of the species, but, except in one case, I have not been compelled to depend upon these for specific distinction.

Tribe TACHININI.

I have in the following pages segregated the species into groups by means of characters which I make use of in my generic key, heading the group with a short diagnosis of such character or characters as are met with in all the species, and where the genus is not included in my key I give a summary of the characters by means of which it may be distinguished from its nearest allies that are so included.

Section with hairs at apices of hind coxae above bases of femora.

In its most restricted sense this tribe is poorly represented in the Australian material now in my hands, only one genus being at present known to me. If we use as the typical forms those most closely related to the genus *Tachina* Meigen as at present accepted (= *Echinomyia* Dumeril), the distinguishing characters are to be found in the presence of hairs on the hind coxae above bases of the femora, and the short and peculiarly-shaped third antennal segment, which is usually not longer, and often much shorter, than the second segment.

Genus CUPHOCERA Macquart.

This genus is distinguished from all others in its restricted tribe by the very small palpi, the lack of ocellar bristles, and the presence of one or two strong bristles on the lower portion of the parafacials. This last character it has in common with *Peteletia* Robineau-Desvoidy, but the latter has long palpi.

There are three species in my present material which are dealt with below. The most dependable characters for the distinction of the species are to be found in the structures of the male hypopygia and, as a reliable guide to the identities of the species now dealt with, I figure these organs for each species.

Key to the Species. (Males.)

1. Fifth abdominal sternite without strong bristles on any part of its surface (Fig. 42) *pilosa*, n. sp.
- Fifth abdominal sternite with a number of long strong bristles on each lobe 2
2. Third antennal segment very little shorter than second; palpi extremely short, papilla-like (Fig. 44) *emmesia*, n. sp.
- Third antennal segment very distinctly shorter than second (Fig. 44a); palpi longer *setigera*, n. sp.

CUPHOCERA PILOSA, n. sp.

♂, ♀. Head yellow, with dense yellow dust, almost golden, interfrontalia red; third antennal segment fuscous except at base and below in male, more narrowly darkened above in female; aristae black; proboscis black; palpi yellow; occipital and most of the genal and parafacial hairs golden-yellow, remainder of hairs and

the postocular ciliae black. Thorax black, slightly shining, with quite dense yellowish dusting which is slightly changeable, leaving four rather broad bronzy-black vittae on the mesonotum, the submedian pair not continued to the hind margin, the sublateral pair narrowly broken at the suture; scutellum dark along middle. Abdomen coloured as the thorax, more distinctly shining, and with grey checkered dusting somewhat similar to that on the abdomen of many species of the genus *Sarcophaga*; hypopygium tawny-yellow. Legs black, tibiae more or less evidently brownish or reddish. Wings greyish hyaline. Calyptrae yellowish-white. Halteres brownish-yellow.

Eyes bare; frons at vertex nearly one-third of the head-width in male, more than one-third of the head-width in female, similarly armed in both sexes, the orbits wider than interfrontalia above, each with two forwardly-directed outer

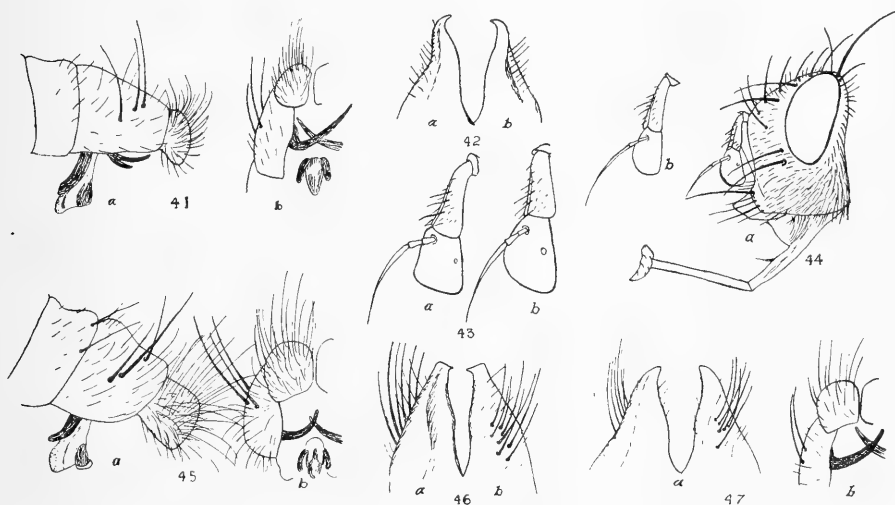


Fig. 41.—*Cuphocera pilosa*. Hypopygium of male; *a*, from the side; *b*, from below, one side.

Fig. 42.—*Cuphocera pilosa*. Fifth sternite of male; *a*, from above; *b*, from below.

Fig. 43.—*Cuphocera pilosa*. Antennae of female (*a*), and male (*b*).

Fig. 44.—*Cuphocera emmesia*. *a*, head from side, and antenna of *setigera* (*b*).

Fig. 45.—*Cuphocera setigera*. Hypopygium of male; *a*, from the side; *b*, from below, one side.

Fig. 46.—*Cuphocera setigera*. Fifth sternite; *a*, from above; *b*, from below.

Fig. 47.—*Cuphocera emmesia*. *a*, fifth sternite, right side, from above, left side, from below; *b*, hypopygium from below, one side.

bristles, four verticals, and no ocellars; parafacials as wide as third antennal segment, with two strong bristles and many fine hairs; antennae as Figure 43; palpi fully as long as basal two segments of arista. Thorax with three plus four dorsocentrals, three plus three acrostichals, three postsutural intra-alars, five bristles on the presutural lateral area, the prealar long and strong, three sternopleurals, prosternum, centre of the propleura, and the regions above and below lower calypter, bare. Abdomen with apical bristles on visible tergites 2 to 4, and discals on 4; hypopygium and fifth sternite as Figures 41 and 42. Inner cross-vein of wing well proximad of level of apex of first vein, outer cross-vein not more

than half as far from bend of fourth vein as from inner cross-vein; first posterior cell ending well in front of apex of wing; third vein with setulae at base above and below. Hind coxae soft-haired at apices above bases of femora; mid tibia with a strong submedian ventral bristle; apical four segments of fore tarsi in female quite distinctly widened.

Length, 10 mm.

Type, male, allotype, and one male paratype, Woy Woy, N.S.W., 2.9.1923, and 4.10.1925 (Nicholson). Type and paratype labelled "Sand Bush" and taken on same date.

CUPHOCERA SETIGERA, n. sp.

♂. Differs from the preceding species in having the hairs on parafacials partly and most of those on the cheeks, black, the abdomen largely reddish-brown, most markedly so on the sides, and yellow-dusted, the tibiae paler, and the halteres dull-yellow.

Structurally similar, but larger, the parafacials wider, second antennal segment longer (Fig. 44a), and the hypopygium and fifth abdominal sternite as Figures 45 and 46.

Length, 13.5 mm.

Type and one paratype, Kosciusko, N.S.W., 5,000 feet, 14.3.1920, and 6,000 feet, 13.3.1920; no other data.

CUPHOCERA EMMESIA, n. sp.

♂. Similar in size and general appearance to *pilosa*, but with the dust of thorax and abdomen grey, and the frontal orbits more greyish-dusted than in that species. There is also a larger number of black hairs on the parafacials and cheeks, the central portions of the tibiae are quite noticeably yellowish, and the veins are slightly darkened on apical portions of wings.

Head as Figure 44; the palpi are very small. Fifth abdominal sternite as Figure 47, hypopygium almost as in *pilosa*.

Length, 10 mm.

Type, Geraldton, W.A., 5.9.1926 (E. W. Ferguson).

CUPHOCERA SP.

A female which appears to belong to a fourth species has the third antennal segment entirely black, not much widened, rounded at apex, and about three-fourths as long as second segment. This may be *Micropalpus vittatus* Macquart.

Length, 11 mm.

Locality: Sydney, N.S.W., 3.9.1922 (Health Dept.).

It may be pertinent to note that this genus will run down to Caption 24 in my key to the Australian genera where it will readily separate from the genera with the palpi aborted by the apically haired hind coxae, all the others having the hind coxae without hairs at apices above the bases of the femora.

Section with outer cross-vein not distinctly nearer to bend of fourth vein than to inner cross-vein, first posterior cell open, and erect apical or discal scutellar bristles.

Genus *VORIA* Robineau-Desvoidy.

The present is the first record of this genus from Australia. It belongs to the group in which the outer cross-vein of the wing connects with the fourth at

a point not much nearer to the bend of the latter than to the inner cross-vein. In my generic key *Voria* will run down to Caption 17a, where it is readily distinguished from *Hyleorus* Aldrich by the presence of only a few hairs or setulae instead of a series of strong bristles above the vibrissae, and from *Calcageria* Curran, a New Zealand genus, by the presence of only one strong downwardly-directed bristle on each parafacial, which is situated above the middle, instead of a series of about six such bristles. The venation of the wing is somewhat different from that of *Calcageria*, but I do not emphasize this character. The scutellum has several long erect bristles on disc near apex as in most related genera, the abdomen lacks discal bristles, and the second segment of the arista is about as thick as long. The fifth wing-vein, though generally accepted as bare, has sometimes one or more bristles on upper side near the base.

VORIA RURALIS Meigen.

This species, the genotype, occurs in Europe and North America. It is also the genotype of *Plagia* Meigen. The larvae parasitize the larvae of Lepidoptera in Europe. I figure the hypopygium of the male (Fig. 48), and the head (Fig. 49), from Australian examples.

The species is shining black, with dense grey or yellowish dust on head, in the American specimens often golden-yellow on frons, and whitish dust on thorax and abdomen, the thoracic dorsum quadrivittate, and the abdominal tergites quite broadly fasciate with dust at bases; antennae black, second segment yellowish at

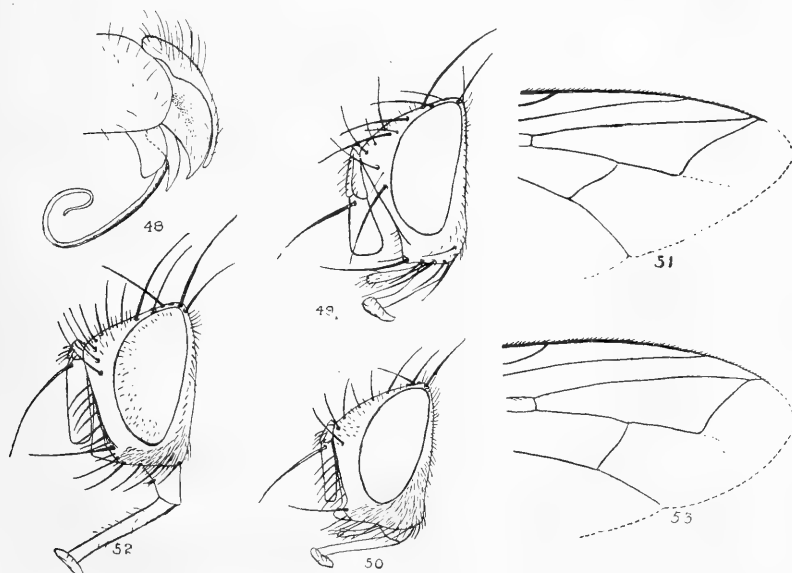


Fig. 48.—*Voria ruralis*. Hypopygium of male from the side.
 Fig. 49.—*Voria ruralis*. Head from the side (male).
 Fig. 50.—*Plagiprospherysa acuminata*. Head of male from the side.
 Fig. 51.—*Plagiprospherysa acuminata*. Apex of wing.
 Fig. 52.—*Stomatomyia micropalpis*. Head from the side, male.
 Fig. 53.—*Vorina setibasis*. Apex of wing.

apex, palpi black, paler at apices. Legs black. Wings greyish hyaline. Calyptrae yellowish-white.

Frons about one-third of the head-width at vertex in both sexes, frontal orbits wider than the interfrontalia at anterior extremities, and with forwardly-directed outer bristles in both sexes. Thorax with three plus three dorsocentrals, and three sternopleurals almost equilaterally arranged.

Length, 7-8 mm.

Locality: Sydney, N.S.W., 29.5.1910, 27.11.1920, 2.12.1920, 29.11.1921, and Narrandera, 25.3.1925. Nine specimens.

Genus PLAGIPROSPHERYSA Townsend.

This genus is very similar to *Stomatomyia* Brauer and Bergenstamm, being distinguished therefrom by the much less distinctly haired eyes, the absence of discal abdominal bristles on the second and third tergites, and the larger palpi. The validity of the genus is doubtful, but I retain it for the present.

I identify, as occurring in Australia, the following European species:

PLAGIPROSPHERYSA ACUMINATA Rondani.

Very similar to *Voria ruralis* Meigen in coloration, but the frons, face, and cheeks quite obscured by white dusting, and the bases of the abdominal tergites with quite broad white or yellowish dusted fasciae.

Head as in Figure 50. Apical venation of wing as in Figure 51; first vein bare above, third setulose at base above and below, the setulae not extending to inner cross-vein on upper side. Hypopygial forceps much as in *Thrycolyga sorbillans* Weidemann, excavated behind, tapered to a fine point which is slightly forwardly curved, and furnished in the hollowed-out basal portion of the posterior surfaces with yellow, slightly flattened hairs.

Length, 6-8 mm.

Localities: Cairns district, and Kuranda, Qld. (Dodd), Loowanna, N.S.W., 31.1.1923 (Health Dept.); Collaroy, near Sydney, N.S.W., 30.1.1924 (E. W. Ferguson); and South Perth, W.A., 17.12.1905 (H. M. Giles). I have also seen a specimen in the United States National Museum collection from New Caledonia (Koebele).

I know nothing of its larval habits.

In my generic key this genus will run down to Caption 18 and fit the first two characters of the first section thereof, differing from *Calcager* Hutton in the following manner:

- | | | |
|-----|--|-----------------------------------|
| A. | Third antennal segment subequal to second; prosternum bare; facial ridges with a few fine hairs just above vibrissa | <i>Calcager</i> Hutton. |
| AA. | Third antennal segment at least three times as long as second; prosternum setulose in part; facial ridges with strong bristles to above middle | <i>Plagiprospherysa</i> Townsend. |

Genus STOMATOMYIA Brauer and Bergenstamm.

This genus is, as pointed out under the preceding genus, distinguished from it by rather trivial characters, consisting mainly of the more conspicuously haired eyes, and the presence of discal bristles on the second and third visible tergites of the abdomen. The frontal bristles descend to about the lower level of the upper third of the parafacials, and the facial ridges are strongly bristled to above the

middle. Wings much as in *Plagiprospherysa*, the first posterior cell open, and the outer cross-vein a little nearer to the bend of fourth vein than to the inner cross-vein; ultimate section of fifth vein about half as long as the penultimate.

STOMATOMYIA MICROPALPIS, n. sp.

♂. Shining black, with white dusting. Head coloured as in *Vorina setibasis*. Thoracic dorsum with the presutural black vittae narrow and separated, the post-sutural area largely black on disc, but with traces of two grey-dusted vittae centrally. Second and third visible tergites of abdomen almost entirely whitish dusted, fourth with faint brownish dust when seen from certain angles. Legs black. Wings greyish, darker at bases. Calyptrae white. Halteres fuscous.

Eyes with quite conspicuous pale hairs; frons at vertex a little less than one-third of the head-width, widened in front, interfrontalia parallel-sided, at middle as wide as either orbit; frontal bristles all long and strong, upper two on each orbit backwardly curved; parafacial about half as wide as third antennal segment, bare below the lower frontal bristle which is at one-third from upper extremity; profile as in Figure 52; palpi minute. Thorax as in *Voria*, with three plus three dorsocentrals and acrostichals, three sternopleurals, the pteropleural long and strong; discal hairs and the apical pair of bristles on the scutellum erect; prosternum setulose. Abdomen narrowly ovate, strongly bristled on centre of dorsum and on fourth visible tergite. Legs as in *Voria*. First wing-vein bare, third setulose to inner cross-vein on upper side; outer cross-vein a little nearer to bend of fourth vein than to inner cross-vein.

Length, 7 mm.

Type, Sydney, N.S.W., 26.4.1928 (Health Dept.). One specimen.

Distinguished from *filipalpis* Rondani, by the very much shorter palpi.

Genus VORINA, n. gen.

This genus will run down to *Hyleorus* Aldrich in my generic key, and may be readily distinguished from it by its having the first posterior cell of the wing petiolate (Fig. 53), the bend of fourth vein without a spur-vein, the outer cross-vein less oblique, the ultimate section of fifth vein not more than two-thirds as long as penultimate, and the setulae on the upper surface of third vein discontinued a little beyond the inner cross-vein. The eyes are also much less distinctly haired, the parafacials are wider, and there are but two outer forwardly-directed bristles on each orbit.

Genotype, the following species.

VORINA SETIBASIS, n. sp.

♀. Head black, with dense white dust except on the interfrontalia, the latter black-brown, epistome testaceous; antennae and aristae black; palpi brown; occipital hairs white, the others black. Thorax shining black, quite densely white-dusted, mesonotum when seen from behind with a broad glossy black vitta laterad of each series of dorsocentrals in front of suture which is fused partially with the linear one on each side of the acrostichal area, and a broad black central mark behind suture which does not extend to posterior margin; scutellum more densely dusted apically than basally. Abdomen glossy black, with conspicuous white-dusted bases to tergites. Legs black. Wings greyish hyaline. Calyptrae white. Halteres fuscous.

Head much as in *Plagiprospherysa acuminata*, but the parafacials narrower and the eyes larger, quite inconspicuously haired, the female with two outer forwardly-directed orbitals, and the antennae descending almost to the mouth margin; palpi about as long as width of interfrontalia and very slender. Thorax as in *acuminata*. Abdomen narrowly ovate, with apical bristles on all tergites, a pair of discals on second and third tergites, and a discal series on fourth. Legs as in *Voria*. Basal half of first wing-vein setulose above.

Length, 5-6 mm.

Type, female, Sydney, N.S.W., 20.10.1921, and allotype, Belaringar, N.S.W., 1.6.1923 (Health Dept.).

The male is in poor condition, lacking one wing. It differs from the female in having the outer cross-vein nearer to inner cross-vein, and no forwardly-directed orbitals.

Section with outer cross-vein about equidistant between bend of fourth vein and inner cross-vein, the first posterior cell open, and no erect bristles on scutellum.

Genus MACROPIA, n. gen.

This genus, because of the position of the outer cross-vein, not much nearer to the bend of fourth vein than to the inner cross-vein, and the ultimate section of fifth vein exceeding in length the outer cross-vein, will run to Section 17 in my generic key. It may be readily distinguished from all the genera in the group segregated by those characters by the position of the antennae, which are inserted far below the middle of the head in profile, and by the very large and posteriorly emarginate eyes (Fig. 54). In addition to these characters the male has at least three, and the female five or more, proclinate outer bristles in a series on each orbit; the apical scutellar bristles are not directed upward; and the first, third, and fifth wing-veins are setulose above. The peculiar head characters clearly indicate that the genus is not closely allied to any of those in the segregate indicated at Caption 17 of my key, nor is it at all closely related to *Hobartia*, a new genus described in the previous paper, in which the antennae are inserted even farther below the middle of the head in profile.

Genotype, the following species.

MACROPIA RUFIVENTRIS, n. sp.

♂, ♀. Head black, with dense white, almost silvery, dusting except on the interfrontalia, the face showing yellowish beneath the dusting; interfrontalia brownish-black; antennae and palpi orange-yellow, third segment of the former more or less browned apically; arista fuscous; occipital hairs dark. Thorax black, almost entirely dull because of the presence of dense yellowish-grey dusting, the mesonotum with two narrow dark submedian vittae anteriorly, and two broader and more nearly complete dark vittae laterad of these. Abdomen shining black, broadly orange on sides and venter on basal half or more, visible tergites 2 to 4 each with a conspicuous basal fascia of white dust. Legs orange, tarsi fuscous, basal segment of fore pair largely reddish-orange. Wings greyish hyaline. Calyptrae white. Halteres yellow.

Frons of male about one-fifth of the head-width at vertex, widened anteriorly, each orbit at middle about twice as wide as the interfrontalia, the inner bristles

as far from inner margin as the outer series is from the eye, the upper four or five curved backward, the anterior two or three incurved; frons of female nearly one-third of the head-width at vertex, much as in male, but with the proclinate outer bristles on each orbit five or more instead of three or four in number, and carried almost to anterior extremity; ocellars small and weak, outer verticals short; profile of male as in Figure 54; second segment of the arista short; eye slightly emarginate behind. Thorax with three pairs of postsutural dorsocentrals, one plus one sternopleurals, no long pteropleural, prosternum and centre of the propleura bare, scutellum with six marginal bristles, the apical pair much shorter than the preapical pair, cruciate. Abdomen cylindrical, all tergites with apical, and second to fourth tergites with discal, bristles. Tibiae and tarsi slender, hind tibia with irregular bristles, one near middle longer than the others. Wing venation as in Figure 55; first vein setulose on entire extent above in both sexes, and on apical third below in female; third vein setulose at extreme base below and to near apex above, fifth setulose nearly to apex of discal cell above. Lower calypter broad, rounded at apex.

Length, 5 mm.

Type, male, and allotype, Sydney, N.S.W., 31.12.1922, and 8.1.1923, respectively (Health Dept.).

The head is quite large and with its peculiar armature, and the added character of the setulose first, third and fifth wing-veins, the species should be readily distinguished from any described Australian species.

The species has much the appearance of some of the calliphorid subfamily Metopiinae, but it has a very well developed postscutellum and is a true Tachinid. Nothing is indicated of its life-history on the labels of the two specimens.

It may be pertinent to note here that the Dexiini normally have the antennae inserted below the middle of the eyes in profile, while typical Tachinidae have them inserted above that point.

Section with outer cross-vein as last section, but first posterior cell petiolate.

Genus LEUCOSTOMA Meigen.

This genus, like the preceding one, falls in the group in my generic key in which the outer cross-vein is not distinctly nearer to the bend of fourth vein than to the inner cross-vein. It does not belong to the Actiini, having the first posterior cell closed and petiolate, and the head quite different. In the key it runs down to Caption 21, because of the wing venation, but there are no bristles on the facial ridges above the vibrissae, and it is thus distinguished from *Phorocerosoma* Malloch, and *Hillia* Malloch.

It therefore falls into a new segregate with pedunculate first posterior cell and unarmed facial ridges containing at present this and one other genus, *Hyalomyodes* Townsend. The different preapical curvature of the fourth wing-vein (Fig. 56), and the strong erect, or slightly backwardly curved ocellar bristles (Fig. 57) will distinguish this genus from *Hyalomyodes*.

Genotype, *Leucostoma simplex* Fallen.

LEUCOSTOMA SIMPLEX (Fallen).

♂, ♀. Glossy black; frontal orbits, face, parafacials, cheeks, and lower occiput white-dusted. Antennae black; palpi brownish-yellow. Thoracic dorsum

slightly whitish dusted when seen from in front. Abdomen without dusting. Legs black. Wings greyish hyaline, paler at bases. Calyptrae white. Halteres fuscous.

Eyes bare; frons of male about one-fourth of the head-width at vertex, widened anteriorly, each orbit at middle about as wide as interfrontalia at same point, with a series of about eight fine inner marginal bristles, the upper one recurved, the others incurved, the anterior two short, the series ending opposite base of antenna; frons of female about one-third of the head-width at vertex,

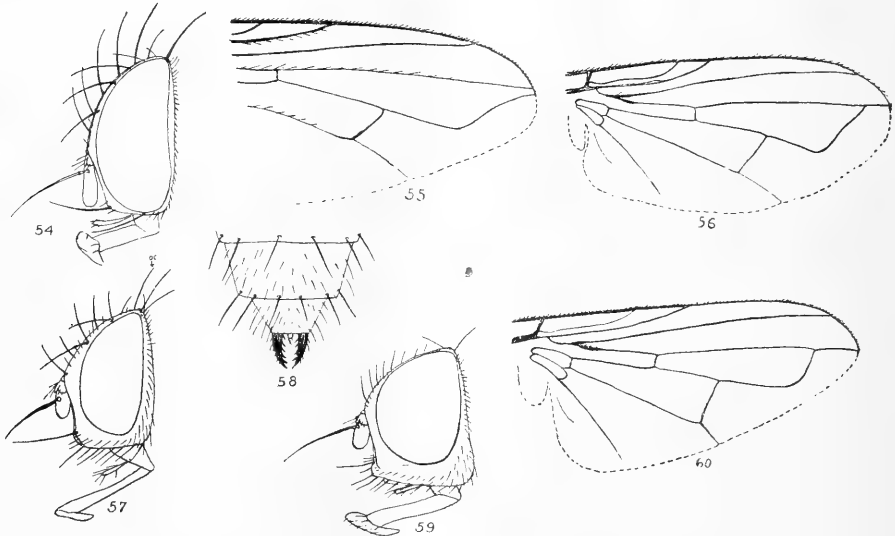


Fig. 54.—*Macropia rufiventris*. Head of male from the side.

Fig. 55.—*Macropia rufiventris*. Apex of wing.

Fig. 56.—*Leucostoma simplex*. Wing.

Fig. 57.—*Leucostoma simplex*. Head of female from the side.

Fig. 58.—*Leucostoma simplex*. Apex of abdomen of female from above.

Fig. 59.—*Hyalomyodes australasiae*. Head of male from the side.

Fig. 60.—*Hyalomyodes australasiae*. Wing.

each orbit at middle distinctly wider than interfrontalia at same point, and with two strong forwardly directed outer bristles on upper half; ocellars long, erect or slightly backwardly directed, divergent at apices; verticals not distinguishable from the rather long and numerous setulae in male, all four strong and well differentiated in the female; head in profile as Figure 57. Thorax with two plus three dorsocentrals, two plus one acrostichals, three sternopleurals in an almost equilateral triangle; scutellum with no discals and six marginals, the apical pair shortest. Abdomen with strong apical central bristles on visible tergites 2 to 4 inclusive, fifth tergite in female about as long as fourth, genital processes in that sex protruded forceps-like (Fig. 58); hypopygium of male of moderate size. Legs moderately stout, fore tarsi slender in both sexes; mid tibia with a median ventral bristle; hind tibia with a series of rather widely spaced bristles, one at middle of anterodorsal surface much longer than the others. Wing as in Figure 56, usually one setula at base of third vein above and below.

Lower calypter large, bulging above, subtransverse behind, and almost totally devoid of fringe except at base on outer side.

Length, 3.5-4 mm.

Locality: Sydney, N.S.W., 6.12.1920, no other data. The species occurs in Europe, North America, and the Hawaiian Islands.

The larvae are parasitic upon Hemiptera of the families Nabidae and Coreidae.

Genus HYALOMYODES Townsend.

This genus will run down to *Caption 21* in my key to genera, and will there fall in the segregate with the first posterior cell closed and rather long petiolate. All the others in the group included in the key have the facial ridges bristled on the lower two-thirds or more, while here they are bare except just above the vibrissa. I figure the head of the species before me (Fig. 59). The preceding genus, *Aequia*, is distinguished from the present one by the strong erect ocellar bristles, and the wing venation. The prosternal plate in *Hyalomyodes* is bare. Other characters may be gleaned from the description of the species given below.

HYALOMYODES AUSTRALASIAE, n. sp.

♂. Deep black, subopaque. Frontal orbits narrowly yellowish-grey dusted, interfrontalia velvety-black, face, parafacials, cheeks, postocular orbits, and lower half of occiput densely whitish-grey dusted; antennae black; palpi dull yellow; all cephalic hairs black. Thorax with two golden-dusted fasciae on dorsum, one at the transverse suture, the other on the hind margin of mesonotum, the former connecting with one on pleura which widens out behind and extends over hypopleura; scutellum black. Abdomen with dense golden-yellow dust on visible tergites 2 to 4 inclusive, second tergite with a large black mark on each side of middle line which extends almost the entire length of tergite at its inner extremity and tapers off outwardly, forming a narrower hind marginal fascia to almost the extreme lateral margin of tergite, third tergite with two small submedian hind marginal spots and smaller dark dots at bases of the large marginal bristles, fourth tergite with only the dark setiferous dots. Legs black. Wings greyish hyaline, veins black. Calyptrae dark-brown, paler at junction. Halteres fuscous.

Eyes bare; frons at vertex about one-ninth of the head-width, narrowed below ocelli and widened above antennae, ocellars short and fine, proclinate and divergent, inner verticals short; each orbit with a series of short inner marginal bristles, all incurved; profile as Figure 59; second segment of arista not longer than thick. Thorax with two plus three dorsocentrals and acrostichals, sternopleurals one plus one; scutellum with a pair of short discals and six marginals, the apical and basal pairs longest. Abdomen broadly ovate, with apical bristles in a series on each tergite, the discals present but rather weak. Mid tibia with a submedian ventral bristle; hind tibia with two or three anterodorsal and posterodorsal bristles. Third wing-vein setulose at base above (Fig. 60). Lower calypter broad, subtransverse at apex.

Length, 5 mm.

Type, Sydney, N.S.W., 1.1.1924 (Health Dept.). One specimen.

There is no indication of the larval habits of this species on the label, but the North American species is parasitic upon Chrysomelid and Coccinellid beetles.

Genus PHOROCEROSTOMA, new name.

This genus was described as *Phorocerosoma* in my last paper on this family and is known to me only from the following species. The name *Phorocerosoma* is pre-empted by Townsend.

PHOROCEROSTOMA SETIVENTRIS Malloch.

Two males which agree perfectly with the type specimen are from Eidsvold, Qld., no other data.

The female is still unknown to me.

Section with centre of propleura haired, arista short-haired, pubescent or bare, and face not carinate.

Genus EUPHASIA Townsend.

This genus falls in the segregate of my key in which the propleura is haired in centre. It will not run out to any genus contained therein because of the lack of a facial carina, the bare arista, and prominently convex postscutellum. It finds a place in my additions to the key (see below) next to *Acucera*, a new genus, *Eustacomylia* Malloch, and one or two others described herein, having the parafacials entirely haired, but it is distinguished from the two above-named by the closed first posterior cell of the wing. A quite striking character of both sexes is the centrally obsolete suture between the fourth and fifth visible tergites of the abdomen. The female has, and the male lacks, outer forwardly-directed orbital bristles; the prosternum, postalar declivity, and sides of metanotum, are bare; sternopleurals one plus one; abdomen without discals; lower calypter widened behind, subtruncate at apex; first vein bare, third setulose at base above and below.

Genotype, the following species.

EUPHASIA PICTA (Brauer and Bergenstamm).

♂, ♀. Head orange-yellow, with golden-yellow dusting on frontal orbits, parafacials, and postocular orbits, the cheeks yellow-dusted; interfrontalia brownish-black; upper occiput fuscous, with yellowish dusting; antennae and palpi orange-yellow; aristae black; a brownish mark above level of vibrissae on suture between facial ridge and parafacial; occipital hairs pale, the others dark. Thorax shining black, a broad streak of golden-yellow dust extending over each humerus to a little beyond suture, and the scutellum similarly dusted except narrowly at base; mesonotum with a narrow central presutural white-dusted vitta; pleura largely white-dusted; hairs black. Abdomen orange-yellow, with deep black markings as follows: male, all of dorsal exposure of first visible tergite, a posterior marginal fascia on second and third which are extended centrally to anterior margin, a central vitta and a hind marginal spot on each side at curve on fourth, and a central spot on fifth tergite; female, first visible tergite with only the centre black, third with all of dorsal exposure black, otherwise as male; all tergites with white dust on bases. Legs orange-yellow, coxae black; tarsi fuscous, basal segment of mid pair yellowish in part. Wings tricoloured, yellow at bases (the light stippled part in the figure), black on a zig-zag area centrally, and pale at apices and behind (Fig. 61). Calyptrae and halteres orange-yellow.

Eyes with very short sparse hairs; frons of male about one-sixth, of female about one-fourth, of the head-width at vertex, much widened to anterior

extremity, orbits at middle narrower in male, wider in female, than interfrontalia, entirely haired, the inner marginal bristles weak, all incurved; all four verticals present; ocellars distinct but short; parafacials haired, as wide as third antennal segment, the latter angular at upper apex, extending to lower third of the face; profile of head as Figure 62; second segment of arista about as thick as long. Thorax with three plus four dorsocentrals and two plus two acrostichals, the dorsal hairs numerous and quite prominent; scutellum convex, rounded in outline, with six strong marginals, the apicals short and fine. Abdomen ovate, bluntly rounded at apex, the fifth visible tergite curving forward underneath and the

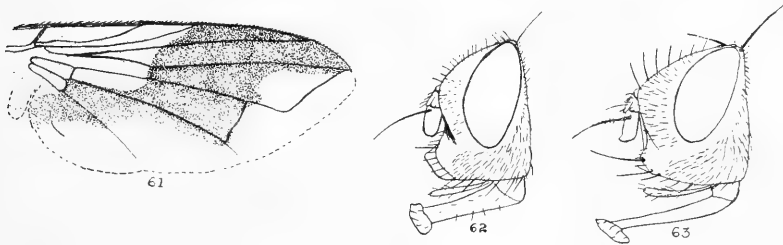


Fig. 61.—*Euphasia picta*. Wing.

Fig. 62.—*Euphasia picta*. Head of male from the side.

Fig. 63.—*Acucea monticola*. Head of male from the side.

genital organs in both sexes at some distance from the tip of abdomen; first to fourth visible tergites with apical central bristles. Legs normal, fore tarsi of female not widened; both sexes with a submedian ventral bristle on mid tibia; hind tibia with a rather regular series of short bristles on anterodorsal surface. Wing venation as Figure 61.

Length, 7-8.5 mm.

Localities: Gundamaian, National Park, N.S.W., 1.1.1926 (Mackerras); Sydney, N.S.W., 1.12.1928 (Wassell); Heathcote, N.S.W., 9.12.1923, on *Angophora* flowers (Nicholson); Berowra, N.S.W., 11.12.1923, on *Angophora* flowers (Nicholson). The last two examples are damaged.

Originally described from Western Australia. The type specimen lacked the antennae. I have presented the above full description to make up for deficiencies in the one given by Brauer and Bergenstamm. These authors named the genus *Neophasia*, but that name was preoccupied in Lepidoptera and it was renamed by Townsend.

Genus GERALDIA, n. gen.

A genus of rather doubtful tribal position, but possibly a dextiine because of the position of the antennal insertions which are slightly below the middle of the eye in profile. However, I leave the matter open. It has much the appearance of *Prosenina*, but the face is not carinate, the arista is pubescent, and the proboscis is similar to that of *Lasiocalypter*, but the palpi are long. Parafacials strongly haired, centre of propleura haired, prosternum bare; for other characters see description of species.

Genotype, the following species.

GERALDIA HIRTICEPS, n. sp.

Black, shining, with grey dust on head, thorax and abdomen. Face, anterior portion of cheeks, and basal two antennal segments and palpi reddish testaceous. Thorax with four black dorsal vittae. Abdomen with the dust checkered, and with a fine black dorsocentral vitta. Legs black, tibiae brownish, paler in male than in female. Wings hyaline. Calyptrae white. Halteres brown.

♂. Eyes bare; frons at vertex about one-fifth of the width of one eye; profile similar to that of *Acucera*, but the mouth margin more distinctly produced, the arista almost bare, and the third antennal segment angulate but not pointed at upper apex. Thorax with three plus three dorsocentrals, two plus one or two acrostichals, sternopleurals one or two plus one, the scutellum with six or eight marginal and two discal bristles, and the centre of propleura haired. Abdomen cylindrical, strong apical bristles present on visible tergites 2 to 4. Legs normal; mid tibia with a strong submedian ventral bristle. Third wing-vein setulose from base to more than midway to inner cross-vein; bend of fourth vein angular, with a strong stump vein, petiole of first posterior cell longer than inner cross-vein. One strong bristle at apex of auxiliary vein on costa.

♀. Similar to the male, but the frons at vertex one-third of the head-width, and each orbit with two strong outer proclinate bristles. The petiole of first posterior cell is shorter than in the male.

Length, 7 mm.

Type, male, Geraldton, W.A., 5.9.1926 (E. W. Ferguson). The allotype was loose in the box and had lost the head, which I recovered, and also the locality label.

Genus ACUCERA, n. gen.

This genus is one of two known to me from Australia in which the third antennal segment is produced in the form of a short point at its upper apical angle, the other being *Myothyria* van der Wulp, dealt with in this paper. *Acephana* Townsend has the same type of antenna, but has the abdomen without macrochaetae, and in certain other respects differs from *Acucera*. In many characters the new genus resembles *Froggattimyia* Townsend, but the face is not deeply sunken and furnished with a linear vertical carina, being concave in profile, visible from the side, and with a slight central vertical convexity on the upper portion, which cannot be considered as a definite carina, and the prosternal plate is bare. First posterior cell of wing open, outer cross-vein much nearer to the bend of fourth vein than to inner cross-vein.

Genotype, the following species.

ACUCERA MONTANA, n. sp.

♂, ♀. Shining black, with greyish dust. Frontal orbits, face, cheeks, and occiput in male, with whitish-grey dust, in female with yellowish-grey dust; antennae and palpi brownish-yellow, third segment of former and the aristae fuscous; all cephalic hairs black. Mesonotum with four black vittae. Abdomen almost uniformly grey dusted above and below in male, and more evidently so at bases than at apices of the tergites in the female. Legs black, tibiae brownish or reddish. Calyptrae yellowish-white. Halteres brown.

Eyes almost bare; frons of male about as wide as third antennal segment behind, much widened in front, interfrontalia complete, orbits quite strongly bristled along inner margins, the bristles incurved, and strongly haired laterally, the hairs continued to lower level of eyes, parafacials wider than third antennal segment; frons of female about one-third of the head-width at vertex, each orbit with two strong forwardly-directed outer bristles, the upper two on each curved outward; ocellars strong; profile of male as Figure 63. Thorax with three plus three dorsocentrals and two or three plus three acrostichals, sternopleurals two plus one, posterior sublateral lacking, propleura haired, prosternum bare, some short hairs below the lower calypter, scutellum with six marginal and two discal bristles. Abdomen of male narrowly ovate, with apical central bristles on tergites 2 to 4. Fore tibia with the anterodorsal bristles well developed; fore tarsi in female not widened; both sexes with a submedian ventral bristle; hind tibia with several long and short anterodorsal and posterodorsal bristles. Bend of fourth vein angular, with a short spur; outer cross-vein about one-fourth from bend of fourth vein; costa with a quite long bristle at apex of auxiliary vein.

Length, 8-10 mm.

Type, male, Blue Mts., 25.3.1922; allotype and two male paratypes, same locality, 4.3.1922; paratypes: one female, same locality, 12.3.1922; one male, Barrington Tops, 25-27.1.1922. Two of the male paratypes lack their heads.

The peculiar third antennal segment, strongly haired parafacials, and haired propleura, taken in conjunction, ought readily to distinguish this genus from its allies.

Genus PILIMYIA, n. gen.

Closely similar to the next genus, differing in having the eyes densely haired, and the facial ridges bristled to above their middle. The second antennal segment has short bristles as in the next genus, and the frons of the male is similar to that of *Delta major*, but narrower. First posterior cell of wing open, ending rather close to apex of wing. For other characters see accompanying generic key and the description of the species given below.

Genotype, the following species.

PILIMYIA LASIOPHTHALMA, n. sp.

♂. Head black, with dense yellowish-grey dusting except on the interfrontalia and upper occiput; antennae and arista black; palpi brownish-yellow; lower occipital hairs white, genal and other hairs black. Thorax shining black, mesonotum with dense yellowish-grey dust, presuturally with five black vittae, the sublateral pair widest and interrupted at the suture, the central three fused behind suture and not continued to posterior margin; pleura rather densely grey-dusted; scutellum with but light grey dusting. Abdomen shining black, conspicuously yellow on sides of first three visible tergites at the lateral curve, the hind margin of first, all of second, and the fore margin of third being semipellucid yellow when seen from above, the yellow colour extending to lateral extremities of first and second tergites when seen from below; anterior margins of tergites 2 to 4 densely yellowish-grey dusted, less broadly so centrally on the first two. Legs black. Wings greyish hyaline. Halteres brown.

Frons at vertex less than half the width of either eye, the interfrontalia complete, orbits with an inner marginal series of bristles which become stronger in front and descend to beyond the level of apex of second antennal segment, and many lateral hairs; ocellars hardly differentiated; inner verticals of moderate length, outer pair undeveloped; profile of head as in Figure 64; arista almost bare, second segment not elongated; face almost flat between the ridges. Thorax with three plus four dorsocentrals, three plus three acrostichals, the posterior sublateral bristle lacking, prosternum and centre of propleura haired, and the scutellum with six marginal and two discal bristles. Abdomen ovate, with apical central bristles on all tergites, no discals on second and third visible tergites. Fore tibia with the anterodorsal setulae weak, and present only basally; mid tibia with a long submedian ventral and anterodorsal bristle; hind tibia with a complete series of rather irregular and quite long bristly hairs, the posterodorsal surface with three or four longer and stronger bristles; claws and pulvilli of all tarsi long. Outer cross-vein about one-third from bend of fourth vein, and nearly as long as that vein from bend to its apex.

Length, 7.5 mm.

Type, Blue Mts., 21.1.1922 (Health Dept.).

The characteristic pale yellowish colour of the abdomen of this species is met with in several allied genera, including the next one, but the bristled facial ridges, long-haired eyes, entirely haired parafacials, and haired centre of propleura and sides of the prosternal plate taken in conjunction will readily distinguish the genus from any other at present known to me from Australia.

The female is unknown to me, as are also the larval habits of the species.

Genus ZITA Curran.

Curran compared this genus with *Arctophyto* Townsend, a North American genus, but there are many distinctions between the genera other than those mentioned by that author which lead me to conclude that they are not very closely related. The head of the type specimen of the genotype is slightly distorted, which gives the face the appearance of being faintly carinate, a feature which I am sure will not be noticeable in perfect examples of the species.

I have before me the type specimens of *aureopyga* Curran, and have seen no other.

The genus will run down to *Pygidia*, a new genus, in my extended key to the genera, but is distinguished therefrom by the presence of discal bristles on the second and third visible tergites of the abdomen, the shorter first visible tergite and much longer and unrecurved fourth.

The paired submedian dorsal spots of silvery-white dust on the second and third visible tergites of the abdomen, and the quite conspicuous white-dusted lateral marks on the mesonotum, are reminiscent of certain Rutiliini, but the bright-yellow-dusted fourth tergite is quite distinctive.

Genus PYGIDIA, n. gen.

This genus is very similar to the preceding one, but it has no strong discal bristles on the second and third visible tergites of the abdomen, the first visible tergite of same is about as long at centre as is the fourth, and the fifth tergite is not much shorter than the fourth. The apex of the abdomen is rather elongated and curved towards base ventrally, which character suggested the

generic name. The eyes are almost bare, the parafacials lack hairs, the prosternum is bare, centre of propleura haired, first wing-vein bare, third setulose at base, bend of fourth vein rounded angular, first posterior cell open; lower calypter broadened behind, lying close to lateral margin of scutellum, apex subtransverse.

Genotype, the following species.

PYGIDIA RUFOLATERALIS, n. sp.

♂. Interfrontalia, occiput, upper portions of frontal orbits, and greater part of cheeks fuscous, face, parafacials, anterior portion of cheeks, and anterior portions of frontal orbits testaceous yellow, frontal orbits, parafacials, and cheeks brassy-yellow-dusted, occiput grey-dusted; antennae orange-yellow, third segment dark-brown, except at base and below; palpi testaceous yellow; central occipital and genal hairs yellow. Thorax black, mesonotum grey-dusted and with four narrow black vittae, pleura yellow-dusted, and almost entirely yellow-haired. Abdomen translucent testaceous yellow, with a broad black dorsocentral vitta which occupies about the median third of the first two visible tergites and almost all of dorsal exposure of third and fourth, hypopygium fulvous yellow, venter and hypopygium yellow-haired, dorsum black-haired. Legs yellow, tarsi slightly darkened at apices, all femora with long yellow hairs basally, the bristles black. Wings yellowish hyaline. Calyptrae and halteres yellow.

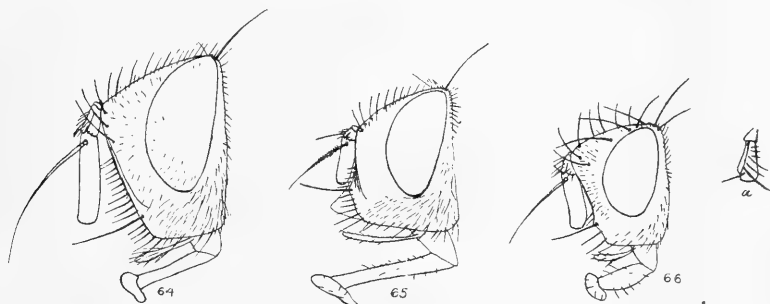


Fig. 64.—*Pilimyia lasiophthalma*. Head of male from the side.

Fig. 65.—*Pygidia rufolateralis*. Head of male from the side.

Fig. 66.—*Delta australiensis*. Head of female from the side, and (a) second antennal segment from above.

Eyes bare; frons at vertex about one-fourth as wide as one eye, inner verticals long, outer pair undeveloped; ocellars present, proclinate; interfrontalia entire, orbits with a series of inner marginal bristles and practically bare laterad of them; antennae inserted above middle of eye in profile, third segment more than three times as long as second, extending to a little above vibrissae, and not as wide as parafacial; epistome projecting; palpi slender, distinctly longer than antenna; profile as Figure 65; arista distinctly pubescent. Thorax with three plus three dorsocentrals, two plus two acrostichals, two plus one sternopleurals, two pairs of intra-alars, the posterior sublateral bristle lacking, prosternum bare, propleura haired, about eight marginal scutellars, and a few hairs below lower calypter. Abdomen strikingly recurved ventrally at apex, the hypopygium rather bulbous. Legs with the femora thickened basally; fore tibia without a series of bristles on anterodorsal surface and with one submedian

posterior bristle; mid tibia without a submedian ventral bristle and with one anterodorsal; hind tibia with two anteroventral and posterodorsal and about four anterodorsal bristles; claws and pulvilli long. First posterior cell open, ending before apex of wing, fourth vein much curved beyond the preapical angle.

Length, 11 mm.

Type, Kosciusko, N.S.W., 11.2.1924 (Nicholson).

Genus DELTA, n. gen.

A genus containing mostly small dull-coloured species, recognizable by the possession of hairs on centre of propleura, sides of prosternum, and entire parafacials, and two rather short stout bristles at apex of second antennal segment which are normally divergent from each other (Fig. 66). The position of the outer cross-vein and the strength of the ocellar bristles is quite variable in the genus, the latter being occasionally entirely lacking. Other characters may be gleaned from the descriptions of the species given below. None of the genera of this group is included in my key to the Australian Tachinidae and the accompanying additional key must be utilized to identify them.

Genotype, *Delta australiensis* n. sp.

Key to the Species.

1. Thorax with three pairs of postsutural dorsocentral bristles; posterior sublateral bristle present; fore tarsus of female compressed centrally, not as long as fore tibia; ocellar bristles moderately long and strong; frons of male less than one-half as wide as either eye *australiensis*, n. sp.
Thorax with four pairs of postsutural dorsocentral bristles 2
2. Females 3
Males 5
3. Ocellar bristles undeveloped; interfrontalia pale-yellow, hardly darker than the greyish-white-dusted frontal orbits; posterior sublateral bristle present; pre-sutural dorsocentrals 3; scutellum densely pale-grey-dusted, hardly noticeably yellow at apex *grisea*, n. sp.
Ocellar bristles well developed, of moderate length and strength; interfrontalia always much darker than the pale-dusted frontal orbits, or quite strongly contrasted with them in colour 4
4. Posterior sublateral bristle lacking or hair-like; palpi slightly thickened; dorsum of thorax entirely dull, lead-grey dusted, with linear dark vittae in front *opaca*, n. sp.
Posterior sublateral bristle quite strong; palpi slender; dorsum of thorax largely shining black, with whitish-grey dusting, and four rather faint dark vittae *scutellata*, n. sp.
5. Thoracic dorsum largely shining black, with slight greyish dusting and five linear black vittae, the submedian pair ceasing a little behind the suture; scutellum except base, and the sides of second and third visible abdominal tergites translucent brownish-yellow *scutellata*, n. sp.
Thoracic and abdominal dorsa densely grey-dusted, not shining, the former with four linear dark vittae, the submedian pair ceasing about midway between the suture and posterior margin; scutellum at apex and second and third visible abdominal tergites on sides faintly yellowish *major*, n. sp.

DELTA AUSTRALIENSIS, n. sp.

♂. Head black, frontal orbits, parafacials, cheeks, and occiput, dark-grey dusted, the frontal orbits darker behind; antennae black; palpi fuscous. Thorax shining black, with grey dust, the mesonotum with five black vittae, the central one ceasing about midway between suture and hind margin and a little longer

than the submedian pair, the sublateral pair complete. Abdomen shining black, when seen from behind, with the dorsum densely yellowish-grey dusted, the second visible tergite with a pair of large subtriangular blackish marks, the third with these less distinct, and all tergites with a rather faint dark central line. Legs black. Wings brownish hyaline, darker at bases. Calyptrae brownish-yellow, disc of the lower one broadly dark-brown. Halteres brown.

Eyes microscopically haired; frons fully one-third of the head-width at vertex, interfrontalia complete, orbits narrow above, with a series of rather long fine bristles along their inner margins which continue downward to at least the level of apex of second antennal segment, the lateral portions and entire parafacials with numerous black hairs; profile much as in the female (Fig. 66); inner verticals well developed, outer pair lacking; ocellars as long as inner verticals; arista bare. Thorax with two plus three dorsocentrals and three plus three acrostichals, three intra-alars, one plus one sternopleurals; scutellum with six marginal and two discal bristles of unequal lengths. Abdomen ovate and depressed, first visible tergite without apical central bristles, all the others to fourth with apical and discal bristles; hypopygium small. Legs normal, fore tibia with two or three posterior bristles; mid tibia with a submedian ventral bristle; hind tibia with a series of irregular bristles on anterodorsal surface, three of which are usually much longer than the others. Outer cross-vein of wing nearer to bend of fourth vein than to inner cross-vein; first posterior cell almost or quite closed in margin of wing. Lower calypter much widened behind.

♀. Differs from the male in being more densely pale-grey dusted, with the interfrontalia brownish-yellow, the face showing testaceous below the dust, the palpi testaceous yellow, and the thoracic vittae much less distinct, the median one absent, and the outer pair incomplete.

Structurally different in having the frons at vertex about one-half as wide as either eye, the orbits each with two strong outer proclinate bristles, and the fore tarsi with the apex of first segment, the second and third, compressed and with a carina or keel on ventral surface.

Length, 4-5 mm.

Type, male and one male paratype, Mullewa, W.A., 3.9.1926 (E. W. Ferguson); allotype, and two female paratypes, Tammin, W.A., 31.8.1926 (E. W. Ferguson).

I may be in error in connecting the sexes, but they appear to be the same species. If they should eventually be found to be different, the male will bear the name *australiensis*, and the other will require to be renamed.

DELTA GRISEA, n. sp.

♀. Similar to the female described above, but the general colour is even paler grey, the interfrontalia is pale reddish-yellow, the second antennal segment is yellow, and the abdominal dusting is more pronouncedly checkered.

The type specimen lacks ocellar bristles, the thorax has the dorsocentrals three plus four, the acrostichals three plus three, and the sternopleurals have a weaker bristle between them which is lacking in *australiensis*. The fore tarsi are not compressed but slightly widened. In other respects similar to the foregoing species.

Length, 6 mm.

Type, Mullewa, W.A., 3.9.1926 (E. W. Ferguson). One specimen.

DELTA OPACA, n. sp.

♀. Similar to the preceding species in coloration.

Differs as stated in the key to species. The thoracic dorsocentrals are two plus four, the ocellars are well developed, there is no central sternopleural bristle present, and the fore tarsi are slender, and longer than their tibiae.

Length, 5 mm.

Type, Sydney, N.S.W., 24.10.1923 (Health Dept.).

A second specimen has the discal bristles lacking on the third visible tergite and may not belong to this species. Locality, Maroondah, Trangie, December, 1920 (L. J. Perry).

DELTA SCUTELLATA, n. sp.

♂. Similar to *australiensis*, but more shining black, the face below and the cheeks yellowish, the interfrontalia reddish-brown, the scutellum largely or entirely testaceous yellow, and the sides of the basal two or three visible tergites of the abdomen translucent yellowish.

Frons about half as wide as one eye, ocellars variable, sometimes indistinct. Thorax with the dorsocentrals three plus four, the posterior sublateral strong, sternopleurals one plus one plus one. Abdomen as in *australiensis*, but the bristles are rather variable; when a full complement is present there is a weak pair at apex of first visible tergite, a pair of discals on second and third, and apical series on second to fourth. Legs as in *australiensis*.

♀. Differs from the male in having the sides of abdomen without yellow, the scutellum less extensively yellow, and the frons almost as wide as one eye.

Type, male, and three male paratypes, Mullewa, W.A., 3.9.1926 (E. W. Ferguson); allotype, Wyalkatchem, W.A., 1.9.1926 (E. W. Ferguson).

DELTA MAJOR, n. sp.

♂. Head testaceous yellow, upper occiput broadly fuscous on each side, with dense grey dust; orbits slightly darkened, grey-dusted; parafacials, cheeks, and face whitish-grey dusted; antennae orange-yellow, third segment dark-brown except narrowly at base; palpi testaceous yellow. Thorax black, slightly shining, with dense grey dust, mesonotum with four dark vittae, the submedian pair discontinued between suture and hind margin; scutellum yellowish apically. Abdomen black, slightly yellowish on sides basally, densely grey dusted, with a narrow dark dorsocentral line on basal two tergites, a pair of faint dark marks on dorsum of second visible tergite, and dark dots at bases of the hairs and bristles. Legs black, tibiae very slightly brownish. Wings hyaline. Calyptrae white. Halteres brownish-yellow.

Eyes bare; frons fully one-third of the width of one eye, ocellars lacking, the other characters as in *australiensis*. Thorax with three plus four dorsocentrals, the posterior sublateral bristle strong, and the sternopleurals three in number. Abdomen broadly ovate and depressed, no apical or discal bristles on first and second visible tergites, no discals on third, discals and apicals on fourth and apicals on third. Legs normal; mid tibia with a submedian ventral bristle; hind tibia with a series of quite regular anterodorsal setulae amongst which there is one longer bristle. Outer cross-vein of wing not more than one-third from bend of fourth vein, the latter straight beyond the bend, the first posterior cell a little wider at apex than usual.

♀. Palpi larger and thicker than in the male; frons at vertex about three-fourths as wide as one eye; fourth vein beyond the bend distinctly arcuate; fore tarsi subequal to fore tibiae, slightly broadened. Otherwise as male.

Length, 7 mm.

Type, male, Eccleston, Allyn R., 26.2.1921; allotype, Eidsvold, Qld.

I have before me one female specimen which does not agree in some essential particulars with the above genus, nor with *Voriella*, the parafacials being furnished with a series of hairs on their lower halves, and the second antennal segment being without the cruciate bristles. I do not care to deal with it further than to mention its occurrence at this time. The specimen is from Sydney, N.S.W.

Genus VORIELLA, n. gen.

This genus is distinguished from *Delta*, to which it appears to be most closely related, by the absence of hairs on the lower half or more of the parafacials, and the presence of a variable number of quite strong bristles on the facial ridges above the vibrissae. It is possible that, when more material is available, the genus may be broken into two or three subgenera or even genera, as there are structural characters present in the three species which some authorities would consider justification for that course. However, in the light of present material, I include all in one genus, the distinguishing characters being pointed out in the key to species and the descriptions given below.

Genotype, *Voriella recedens*, n. sp.

Key to the Species.

1. Four or five strong frontal bristles either in a single or partial double series below level of antennal insertion, laterad of which there are no fine short hairs; only one setula at base of third vein both above and below *uniseta*, n. sp.
Two to four strong bristles in a single series below level of antennal insertion, and laterad of these, and usually to a short distance below them, some short fine hairs; one setula below and two or more above at base of third wing-vein .. 2
2. Facial ridges strongly bristled to well above middle; fore tarsi of female normal; outer cross-vein of wing almost twice as far from inner cross-vein as from bend of fourth vein *armiceps*, n. sp.
Facial ridges each with about two bristles above the vibrissae which do not extend to middle; fore tarsi compressed centrally; outer cross-vein of wing about midway between inner cross-vein and bend of fourth vein *inconspicua*, n. sp.

VORIELLA UNISETA, n. sp.

♂. ♀. Black, slightly shining, with grey dust on head, thorax and abdomen. Antennae entirely black; palpi orange-red at apices, more conspicuously so in the female; interfrontalia black-brown in both sexes. Thorax with four black vittae on dorsum, less distinct in female, and sometimes a fifth in centre in male. Abdomen with the grey dust rather checkered, most dense at bases of tergites, and in the male a narrow black dorsocentral vitta evident. Legs black. Wings greyish hyaline, brownish basally. Calyptrae white. Halteres yellow.

♂. Frons at vertex about one-third as wide as one eye, interfrontalia entire, of uniform width, orbits linear above, with a series of inner marginal bristles which descend to about middle of parafacials, and no fine lateral hairs, ocellars and inner verticals present but not very strong; profile of head as Figure 67; second segment of arista about three times as long as thick; palpi slightly dilated at apices. Thorax with two or three plus three dorsocentrals and three

plus three acrostichals, sternopleurals one plus one, apical scutellars fine and short, hypopleura with a fine hair at upper anterior angle. Abdomen cylindrical, with or without a fine pair of central apical bristles on first visible tergite and with apical central and discal bristles on the other tergites. Fore tibia with a few short setulae on anterodorsal surface basally, and one or two posterior bristles; fore tarsi normal; mid tibia with a submedian ventral bristle; hind tibia with irregular anterodorsal and posterodorsal bristles; claws and pulvilli rather long. Outer cross-vein about midway between inner cross-vein and bend of fourth vein; first posterior cell very narrowly open, ending rather close to wing tip.

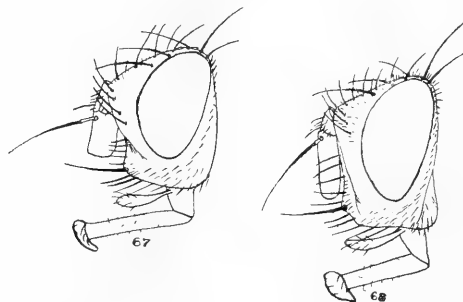


Fig. 67.—*Voriella uniseta*. Head of female from the side.

Fig. 68.—*Voriella armiceps*. Head of female from the side.

♀. Differs from the male in having the frons about one-third of the head-width, the outer verticals present, but weaker than the inner pair, the upper bristle on each orbit curved backward, and two outer proclinate bristles on each orbit. In both sexes the third antennal segment is not twice as long as second. Palpi of female more distinctly dilated at apices than in male. Fore tarsi slightly dilated at apices.

Length, 5-6 mm.

Type, male, Sydney, N.S.W., 16.11.1922; allotype, same locality, 2.7.1924; paratypes, all same locality, 27.11.1921, 3.10.1921, 22.10.1922, 9.12.1923, 31.8.1924, and 19.10.1924. All Health Department collection. Nine specimens.

VORIELLA ARMICEPS, n. sp.

♀. Similar to the preceding species in general coloration, but the interfrontalia is paler, reddish-brown, and the face below and cheeks yellowish.

Structurally this species differs from *uniseta* in the more strongly armed facial ridges, general shape of head, including the longer third antennal segment (Fig. 68), much weaker discal bristles on abdomen, those on second visible tergite being almost undeveloped in the type, and the different wing-venation and armature of the base of third vein.

Length, 6 mm.

Type, Eradu, W.A., 8.9.1926 (E. W. Ferguson). One specimen.

VORIELLA INCONSPICUA, n. sp.

♀. General colour similar to that of the two preceding species.

Structurally this species is more slender than either of the others, the frontal bristles do not descend as far on parafacials, the frontal orbits are narrower, the

third antennal segment is narrower than in *armiceps*, and comparatively as long as in that species, the second and third segments of fore tarsi and the apex of first segment are distinctly compressed when seen from the side, the wing-venation is much as in *uniseta*, but the fourth vein beyond the preapical angle is as long as the portion from outer cross-vein to angle, not distinctly shorter, and there are three or four short hairs at base of third vein on its upper side. The pair of discal bristles on second visible tergite of abdomen is short while the one on third is quite long.

Length, 5 mm.

Type, Sydney, N.S.W., 20.11.1921 (Health Dept.). One specimen.

This genus resembles *Hypostena* Meigen, but all the species of the latter that I have seen have the propleura bare on centre. *Chaetophlepsis* Townsend has the propleura haired centrally, and the fore tarsus compressed in the female of *tarsalis* Townsend, but the first wing-vein is setulose above. Although I can find no genus with which the above one agrees in all characters it is not at all impossible that some subsequent worker will discover that it has already been described from some other region under a different name.

Key to the Genera of this Section.

1. Parafacials haired on practically their entire extent 2
Parafacials bare below level of apex of second antennal segment 6
2. First posterior cell of wing closed and petiolate, sometimes closed only in the margin of wing, if the latter the wing is conspicuously marked with black 2a
First posterior cell of wing open, if almost closed the wings are hyaline 3
- 2a. Wings pictured, first posterior cell very short petiolate (Fig. 61); suture between the fourth and fifth visible abdominal tergites obliterated centrally, the apex of abdomen bluntly rounded *Euphasia* Townsend
Wings hyaline, first posterior cell quite long petiolate; suture between fourth and fifth visible abdominal tergites normal, apex of abdomen of the usual form *Geraldia*, n. gen.
3. Third antennal segment with an acute point at upper apical angle (Fig. 63); prosternal plate bare; outer cross-vein of wing very much nearer to bend of fourth vein than to inner cross-vein *Acucera*, n. gen.
Third antennal segment rounded or subtransverse at apex, without a sharp point at upper apical angle; prosternum setulose 4
4. Lower calypter straight on inner side, not at all lobed, lying clear of side of scutellum, and evenly rounded at apex (Palpostomini) *Eustacomomyia* Malloch
Lower calypter lying close to side of scutellum, distinctly lobed on inner side, subtransverse at apex 5
5. Eyes almost bare; facial ridges setulose on lower fourth *Delta*, n. gen.
Eyes densely hairy; facial ridges bristled to above middle *Pilimyia*, n. gen.
6. Antennae inserted below level of middle of eye in profile; arista haired, the longest hairs more than twice as long as its basal diameter 7
Antennae inserted above middle of eye in profile; arista pubescent or bare 8
7. Ocellars long and strong (Fig. 26*); first posterior cell ending well before tip of wing *Anatropomyia*, n. gen.
Ocellars minute (Fig. 27*); first posterior cell ending close to tip of wing *Hobartia*, n. gen.
8. Thoracic region above hind coxae and below base of abdomen quite high and vertical, usually transversely convex, and entirely uniformly chitinous; palpi vestigial *Cylindromyia* Meigen
Thoracic region above hind coxae and below base of abdomen not high, largely membranous centrally; palpi well developed 9
9. Frontal bristles descending well below level of apex of second antennal segment (Fig. 67); second and third visible tergites of abdomen with discal bristles;

* See above, p. 128.

- outer cross-vein of wing about equidistant between inner cross-vein and bend of fourth vein; prosternum setulose *Voriella*, n. gen.
- Frontal bristles not descending below level of middle of second antennal segment (Fig. 65); outer cross-vein of wing twice or more than twice as far from inner cross-vein as from bend of fourth vein; prosternum bare 10
10. Second and third visible tergites of abdomen with discal bristles, central length of first visible tergite not half as great as that of fourth, the abdomen curved under from base of sixth visible tergite, the fifth very short (male)
..... *Zita* Curran
- Second and third visible tergites of abdomen without discal bristles, central length of first visible tergite greater than that of fourth, the abdomen curved under from base of latter, fifth visible tergite not much shorter than fourth
..... *Pygidia*, n. gen.

N.B.—It must be understood that the genera contained in the above synopsis are arbitrarily linked together for purposes of identification only and that there are several groups represented. *Eustacomylia* Malloch belongs to the Palpostomini, and in the character of the wing-venation is very similar to *Voriella*, but the latter is not closely related, having the lower calypter distinctly widened behind and lying close to the scutellum. Nor is the latter at all closely related to *Pygidia* and *Zita*, the structure of the head and the armature of the thorax being quite distinct from those found in the other two genera.

There will undoubtedly be more genera of this group found in Australia and, despite the artificial nature of such a synopsis as the above one, it will be of material assistance in identifying either new genera or those already known, but in all cases care should be taken to compare the insects with the full descriptions of both the genera and species to prevent mistakes.

Section with bare eyes and parafacials, and outer cross-vein near bend of fourth vein.

Genus MYOTHYRIA van der Wulp.

This American genus has apparently two representatives amongst the Australian species now before me. The bare eyes, acutely pointed upper apical angle of the third antennal segment, and the very strong apical central bristles on the second and third visible tergites of the abdomen distinguish the genus from any other now known to me from Australia. *Acemyia* Robineau-Desvoidy of the Nearctic and Palaearctic regions is very similar to *Myothyria*, but it has the prosternal plate bare, while in the latter it is setulose on the sides. In *Myothyria* there is also a series of three or more proclinate outer orbital bristles on each frontal orbit which are lacking in *Acemyia*, and in the female there is a complete series of such bristles in the former and only two or three bristles in the female of *Acemyia*. The species of *Myothyria* known to me all have but one setula above and below at extreme base of the third wing-vein, while those of *Acemyia* have more numerous setulae. The first posterior cell of the wing may be closed in margin of wing, short petiolate, or narrowly open, and it is distinctly preapical in termination in both genera. The Philippine genus *Eoacemyia* Townsend is very similar to *Myothyria*, having the prosternal plate setulose, but it is furnished in the female with fewer proclinate orbitals, has much weaker ocellar bristles, and the first posterior cell of the wing is open and terminates very close to the tip of the wing. Unless there are more intermediate forms, I would retain *Eoacemyia* as a distinct genus. All the genera under discussion

have the female genital organs with the apical sternite glossy, chitinous, and more or less scoop-like, the lower surface rounded, and the apex blunt.

Acucera Malloch, described in the present paper, I do not place close to *Myothyria* because of its possession of hairs on the centre of the propleura, and on the parafacials, and the lack of them on the prosternum. The female does not appear to have the same form of genital plate.

Acephana Townsend was erected for the reception of *Masicera rubrifrons* Macquart, the author of the genus using as its chief distinguishing feature the shape of the third antennal segment, which is the same as in the genera above referred to, but in *Acephana* the eyes are hairy, and the tergal bristles are weak. I have not seen this genus, nor had Townsend, whose generic concept was based upon notes on Macquart's type published by Brauer, as indicated in my Catalogue.

I figure the head and wing of the Australian species *fergusoni* herein.

MYOTHYRIA FERGUSONI, n. sp.

♂, ♀. Shining black, more or less obscured by pale-grey dust. Interfrontalia brownish-black, orbits and remainder of head densely white dusted, more yellowish on frons in the female, less conspicuously dusted on upper occiput; antennae black; palpi brownish-yellow; occipital hairs white, postocular cilia and other cephalic hairs black. Mesonotum with four partial vittae which appear brown when seen from the side, interrupted at the suture, and ceasing about midway between it and posterior margin, the surface otherwise slightly dark dotted; scutellum lightly grey dusted. Abdomen partly translucent yellowish on sides of the basal three visible tergites in the male, without pale sides in female, tergites broadly but not very conspicuously white dusted. Legs black. Wings greyish hyaline. Calyptrae white. Halteres brown.

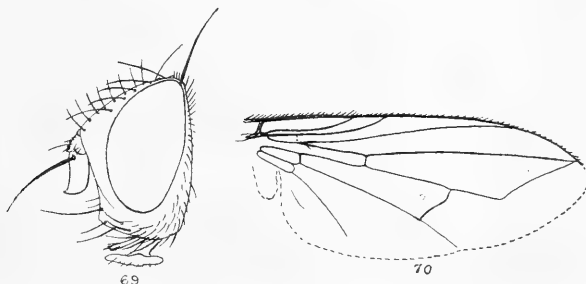


Fig. 69.—*Myothyria fergusonii*. Head of male from the side.

Fig. 70.—*Myothyria fergusonii*. Wing.

Eyes nude; frons of male at vertex one-fourth of the head-width, widened in front, inner verticals long, outer pair absent, ocellars moderately long, proclinate and divergent, each orbit at middle fully as wide as the interfrontalia, with about nine inner marginal bristles, the upper two recurved, the others incurved, and four outer proclinate bristles; the frons of female about one-third of the head-width, each orbit at middle as wide as interfrontalia at same point, the proclinate outer bristles more irregular in length than in the male; profile of head of male as in Figure 69. Thorax with two plus three dorsocentrals, two plus two acrostichals, sternopleurals one plus one, prosternum haired on sides, propleura bare on centre, scutellum with six bristles, the apical cruciate pair

shorter than the preapical pair. Abdomen cylindrical, tapered apically, visible tergites 2 and 3 each with a pair of long strong central apical bristles, the apical series sometimes complete on 3 and always so on 4; hypopygium small, forceps tapered to a sharp point. Legs normal, tarsal claws as long as fifth tarsal segment in male and female; fore tarsus in female not widened; mid tibia in both sexes with a submedian ventral bristle; fore tibia with the anterodorsal setulae longer than its diameter basally, becoming much shorter apically; hind tibia with irregular series of about four widely spaced bristles on posterodorsal and anterodorsal surfaces, the latter with some much shorter setulae also. Venation of wing as Figure 70; third vein with one setula at base above and below; petiole of first posterior cell variable, but always very short. Calypter broadly rounded at apex, bulged up centrally, the fringe very short and fine.

Length, 6.5-7.5 mm.

Type, male, allotype, and one male and one female paratype, Eradu, W.A., 8.9.1926 (E. W. Ferguson).

MYOTHYRIA ARMATA, n. sp.

♀. Similar to the preceding species, but with the dusting of the frons grey, the abdomen more uniformly grey-dusted and not so noticeably checkered, the ocellar bristles stronger, and the second visible abdominal tergite with four very strong bristles on middle of the apical margin. The fore tibia has also a much stronger series of bristles on the entire length of the anterodorsal surface which are all decidedly longer than the diameter of the tibia, and the first posterior cell of the wing is narrowly open in margin of wing. While I do not place too much emphasis upon the details of the wing-venation, it appears possible that the position of the outer cross-vein may be of specific significance. This is situated at distinctly less than its own length and less than one-third of the length of the section between the inner cross-vein and bend from the latter and at about its own length from apex of fifth vein. In *fergusoni* the outer cross-vein is farther from the bend of fourth vein and from apex of fifth vein as shown in Figure 70.

Length, 8 mm.

Type, Kosciusko, N.S.W., 5.12.1921 (Health Dept.). One specimen.

This genus will run down to Caption 40 in my generic key, but may be distinguished from any in the remaining part of the key by the pointed upper apical angle of third antennal segment, the others all having it angular or rounded.

Section with the sutures between the tergites of abdomen obliterated centrally, the tergites of apical half of abdomen immobile; arista pubescent; face not carinate.

Genus DODDIANA Curran.

I have before me a paratype male of *Doddiana pallens* Curran and find that the genus is the same as *Semisuturia* Malloch, though the genotypes are distinct and in a measure entitled to consideration as separate subgenera. The species which I placed in *Semisuturia* are, with the exception of the genotype, similar in nearly all respects to *Doddiana*, the genotype of *Semisuturia* alone differing in having a pair of strong proclinate outer bristles on each orbit in the male. I had only the female of *australis* before me when I described the genus and species, and

now I have a series of specimens, including one male. Besides the paratype of *pallens* I have specimens of this species submitted by Mr. F. H. Taylor, and below I present some notes on the genus.

Key to the Species.

1. Entire occiput testaceous yellow; submedian ventral bristle on mid tibia very short and weak, not as long as diameter of tibia *australis* Malloch
Upper half of occiput black on each side; submedian ventral bristle on mid tibia strong, at least as long as diameter of the tibia 2
2. Ventral bristle on mid tibia hardly longer than tibial diameter; third antennal segment more than twice as long as second; costal division between apices of auxiliary and first veins about two-thirds as long as the preceding one
..... *parviseta*, n. sp.
Ventral bristle on mid tibia much longer than tibial diameter; third antennal segment not twice as long as second; costal division between apices of auxiliary and first veins not more than half as long as the preceding one 3
3. Interfrontalia yellow; dorsum of abdomen largely glossy black *flavifrons*, n. sp.
Interfrontalia red; dorsum of abdomen glossy testaceous yellow *pallens* Curran

DODDIANA AUSTRALIS (Malloch).

The male of this species has a pair of strong proclinate outer orbitals not present in any other species in which the male is known to me. In the specimens before me there are four black spots on each side of the apical half of the abdomen, which are not mentioned in my original description. I have been unable to find the type specimen of the species and pending its discovery, which is merely a matter of thorough search amongst my mass of material, I accept the specimens as *australis*. The venation is the same as in *parviseta*, of which latter the male is unknown to me. A thorough examination of the series of specimens of *australis* has failed to disclose any microscopic setulae on the upper surface of first vein such as are present in *parviseta*.

Localities: Oxford Falls, 15.3.1923, the first known male and allotype, and one female; Kenthurst, 3.6.1922, six females (Gallard); National Park, N.S.W., 28-29.9.1922, three females (Health Dept.).

This species, and possibly the next one, will fall in the subgenus *Semisuturia*, distinguished from *Doddiana* by the proclinate outer orbital bristles in the male, the short ventral bristle on mid tibia, and the longer costal division between apices of auxiliary and first vein.

DODDIANA PARVISETA, n. sp.

♀. Glossy testaceous yellow, third antennal segment except the base, the arista, and each side of upper occiput black, the latter and the frontal orbits and parafacials white dusted. Thorax with slight even white dusting on mesonotum when seen from in front, which is not divided into vittae and is rather indistinct presuturally. Wings yellowish.

Third antennal segment about two and one-fourth times as long as second; arista almost bare; head in other respects as in *australis*. Thorax and abdomen as in that species. Ventral bristle on mid tibia very little longer than diameter of tibia. First wing-vein with a few very short black hairs on upper side apically which may possibly be lacking in other specimens; wings otherwise as in *australis*.

Length, 6.5 mm.

Type, Sydney, N.S.W., February, 1928 (F. H. Taylor). One specimen.

DODDIANA PALLENS Curran.

Because of the lack of mention of the fused abdominal tergites, I would not have been able to place this species definitely without access to type material, and, though there is no mention made in the original description of the large black occipital marks, they are very prominent in the paratype before me. There are no setulae on the upper side of the first vein, and the other characters by which it may be distinguished from its congeners may be gleaned from the above key to species.

Localities: Palmerston (Dodd), paratype; Roberts Plateau, Macpherson Range, 2,500-4,000 feet, Feb.-March, 1929 (Dr. A. J. Turner).

DODDIANA FLAVIFRONS, n. sp.

♀. Very similar to the foregoing species but smaller, with the interfrontalia lemon-yellow, and the dorsum of the abdomen largely glossy-black; this last possibly a variable character. The mesonotum has three white-dusted vittae in front of the suture, which are more evident than in *pallens*.

Third antennal segment hardly longer than second, deep-black except at extreme base on inner side; interfrontalia wider than in *pallens*; arista practically bare, not as long as entire antenna. Thorax and abdomen as in the other species. Ventral bristle on mid tibia distinctly longer than tibial diameter. First vein bare on the upper side; third with two setulae at base above; venation as in *australis*, except for the shorter costal division between apices of auxiliary and first veins.

Length, 6.5 mm.

Type, Eidsvold, Qld., December, 1922, no other data. One specimen.

It may be of interest to note that this genus differs from *Hyalurgus* Brauer and Bergenstamm, with which Curran compared it, in having one or more strong bristles on the raised central portions of the cheeks, in having no distinct tergal sutures centrally, and the eyes much less distinctly haired. *Hyalurgus lucidus* Meigen, the genotype, has discal bristles on the second and third abdominal tergites, and the palpi considerably longer than in *Doddiana*. There are some other distinctions of less import also.

Section with the facial ridges bristled to above middle, and parafacials haired.

Genus QUADRA Malloch.

I have found a second species of this genus amongst my recently received material, and, though it differs quite strikingly from the genotype in colour, it agrees in all essential details with it. The species is represented by a male specimen and, as would be expected, the eyes are a little more distinctly haired. The facial ridges are similar in form to those of the genotype, bulging out in profile rather abruptly at, or close to, the level of the base of the third antennal segment, the vibrissae are situated at some distance above the mouth margin, and are differentiated from the numerous shorter bristles which are above them, the latter extending well beyond midway to bases of antennae. The discal bristles on the second and third abdominal tergites are not as strong as in the genotype, and show indications of possible variability in number.

It might be well to add to the characters given in Caption 40 of my key the character of the form of the facial ridges and their armature to insure the identification of the genus.

QUADRA DISSIMILIS, n. sp.

♂. Black, shining, with yellowish-grey dust. Head with the ground colour largely obscured by dense brownish-yellow dusting, the parafacials and cheeks showing brownish, the facial ridges and face yellowish testaceous; interfrontalia dark-brown; antennae orange-yellow, third segment fuscous except at extreme base; aristae fuscous; palpi orange-yellow; occipital hairs yellowish-white, the other cephalic hairs black. Thorax and abdomen black, the latter showing indications of testaceous colour on the sides of basal half; thoracic dorsum with four dark vittae in front of, and five behind, the suture; the abdomen with the dusting changeably checkered. Legs fuscous, tibiae reddish-brown. Wings greyish hyaline. Calyptrae white, margins yellow. Halteres brown.

Eyes with sparse but rather evident hairs; frons at vertex about half as wide as either eye, upper two bristles on each orbit recurved, the inner series incurved, the lower portion of the series diverging at base of antenna and ending more than half-way to eye at about level of apex of second antennal segment, the lateral hairs long and numerous, continued to about lower level of eye; ocellars and postverticals present, not as long as the inner verticals, the outer verticals absent; vibrissae about as far above mouth margin as length of second antennal segment; bristles on facial ridges extending to well above middle, in two or three series below; antennae elongate, third segment about three times as long as second, and not more than one-third as wide as parafacial, extending to a little above level of vibrissa; arista thickened on basal half, the apical half filiform; palpi slender, normal in length. Thorax with the posterior sublateral bristle present, dorso-centrals three plus four, acrostichals three plus three, sternopleurals two plus one, the prealar long, prosternum haired, centre of propleura bare, numerous hairs in front of the hypopleural series of bristles, but none on the upper margin of hypopleura; apical pair of scutellar bristles short, discal pair quite long. Abdomen ovate, the first visible tergite without apical central bristles, second and third with both discal and apical bristles; no sexual tufts present on third and fourth tergites. Legs normal; fore tibia with a series of short bristles on the entire length of the posterodorsal surface, which are longer than the one on anterodorsal surface, except at base; mid legs missing in type; hind tibia with a rather irregular series of bristles on the anterodorsal surface, one or two of the bristles much longer than the others. Wings as in the genotype, the petiole of the first posterior cell very short, the cell really closed just in the margin of the wing; third vein with not more than three bristles at extreme base above and below.

Length, 11.5 mm.

Type, and one paratype, Como, N.S.W., 18.10.1925 and 3.11.1923 (Nicholson).

The type specimen shows indications of translucence on the sides of the abdomen on basal half, which is much more pronounced in the paratype, though it is possible that the females may not show this colour. The scutellum may also be rather more noticeably yellowish in other examples, as is shown in the paratype, but it is not so evident here to warrant mention of it in the description.

The genotype, *ornata* Malloch, is distinguished from the above species in having the thorax and abdomen densely white-dusted, the former with four conspicuous black vittae and the abdomen with a large deep-black spot on each side of second and third tergites.

Section with the eyes densely haired, facial ridges bristled to above the middle, and the parafacials bare on at least the lower half.

Genus AUSTROPHOROCERA Townsend.

This genus was erected by Townsend on the basis of notes on *Phorocera biserialis* Macquart published by Brauer. I have before me a male and female which are evidently congeneric with Macquart's species, and agree closely enough with his description to justify the belief that they belong to the species.

In distinguishing the genus from *Phorocera* Robineau-Desvoidy the bristling of the frons is practically the only character that can be used, and possibly, if there are a few intermediate forms, the genus cannot be upheld. Townsend stated that the facial bristles were in two series, which is erroneous. In typical *Phorocera* there are two upper backwardly-curved bristles on each frontal orbit, and laterad of the inner marginal bristles on the orbits there are some hairs which are never as strong as the bristles; in *Austrophorocera* there is but one backwardly-directed upper bristle on each orbit, and on at least the anterior half of its extent there are bristles laterad of the inner series, most numerous in front (Fig. 71). The ocellar bristles are quite long, the prosternum is setulose, and sometimes there are irregular discal bristles on at least the third visible tergite of the abdomen.

AUSTROPHOROCERA BISERIALIS (Macquart).

A shining black species, with pale-grey dust on head, thorax, and abdomen. Interfrontalia brown, face and cheeks testaceous, frontal orbits fuscous beneath the dust; basal two antennal segments and the palpi orange-yellow, third antennal segment black. Mesonotum with four black vittae; scutellum testaceous yellow. Abdomen testaceous yellow on sides basally, most extensively so in male, the dusting slightly changeable. Calyptrae white. Halteres fuscous.

Eyes densely pale-haired; frons of male about one-fourth, of female about one-third of the head-width at vertex, each orbit wider than the interfrontalia, with two forwardly-directed outer bristles in female only; third antennal segment more than twice as long as second (four times as long in Macquart's description); palpi normal. Thorax with three plus four dorsocentrals, the sternopleurals 1:1:1. Abdomen broadly ovate, no genital hair patches on third or fourth visible tergites in the male. Both sexes with a submedian ventral bristle on mid tibia; fore tarsi of female not widened; hind tibia with a series of bristles on the entire anterodorsal surface, most dense in male, and with one of the bristles outstanding.

Length, 8-9 mm.

Localities: South Perth, W.A., 17.2.1906 (H. M. Giles); and Kojarena, W.A., 6.9.1926 (E. W. Ferguson).

The tibiae in both specimens are slightly yellowish centrally, while in Macquart's description the legs are given as black.

Genus PALIANA Curran.

This genus has the frons in both sexes quite different from any other that is closely related, the orbits being very much wider than the interfrontalia, with incurved bristles which are rather widely spaced along almost the entire inner margin to level of second antennal segment in male, and one recurved bristle proximad of level of ocellar triangle which is much laterad of the inner marginal series; the latter in the female is less regular than in the male, except on the

anterior half of its extent, there are two proclinate outer bristles on posterior half, the reclinate upper bristle being in line with the second of these. Ocellar bristles lacking; prosternum setulose.

I have examined both of Curran's types and incline to the opinion that they represent the sexes of one species, the paler femora and general coloration of the female being merely a sexual colour dimorphism. The very striking coloration of the wings is a ready identification mark, the bright orange-yellow basal third, and broad dark-brown suffusion of the veins beyond that being quite distinctive.

If my surmise is correct there will be but one species, *basalis*, *intensa* falling as a synonym. It appears pertinent to note that the name written on the label of the type specimen of the latter is "*intensica*", not *intensa*.

Both examples are from Kuranda, Qld. (Coll. Lichtwardt).

Section with eyes subnude; facial ridges bristled to or above middle, and two strong recurved bristles on each orbit laterad of the inner bristles.

Genus APILIA, n. gen.

This genus has much the appearance of a *Phorocera*, but the eyes are subnude, the facial ridges are less strongly bristled, and the frontal orbits each have two strong recurved bristles on upper half laterad of the inner marginal bristles. The genus would appear to belong near *Pseudochaeta* Coquillett, but it lacks the setulae on the prosternal plate which that genus, and those most closely related to it, have. In my recent key to the Australian genera it will run down to Caption 28, section one, but the lack of prosternal setulae will distinguish it from the genus listed at that point, and also from *Frontina* Meigen.

Genotype, the following species.

APILIA CILIFERA, n. sp.

♂. Head black, interfrontalia opaque-black, the other portions densely whitish-grey dusted; antennae black, second segment hardly paler; palpi fuscous, the apices yellowish testaceous. Thorax shining black, with grey dusting, mesonotum with four black vittae and a fifth one behind suture in centre when seen from behind, this central vitta more densely pale-grey dusted when the thorax is viewed from in front; scutellum slightly rufous at apex, when seen from behind with the apex broadly grey-dusted, the base shining black. Abdomen coloured as thorax, with the bases of tergites broadly whitish-grey dusted and traces of a dark dorsocentral vitta, the extreme lateral margins of tergites on venter densely whitish-grey dusted. Legs black. Wings hyaline, slightly darkened at bases. Calyptrae white. Halteres fuscous.

Eyes almost bare; frons at vertex about one-third of the head-width, interfrontalia narrowed above, at upper extremity not wider than either orbit, the latter with a series of incurved inner marginal bristles, two strong recurved bristles laterad of this series on upper third and some weaker bristles laterad of the series anteriorly, the inner series continued downward to a little beyond level of apex of second antennal segment; profile as Figure 72; arista nude; facial bristles biseriate. Thorax with three plus four dorsocentrals, three plus three acrostichals, posterior sublateral bristle present; prealar strong; sternopleurals two plus one; prosternum and centre of propleura bare. Abdomen ovate, with sometimes a pair of bristles at apex of first, and always a pair at apex of second

and a series of bristles at apex of third tergite, the latter with a large patch of fine depressed black hairs on each side below the curve; hypopygium as Figure 73. Fore tibia with a series of short anterodorsal bristles and a similar series on the basal portion of posterodorsal surface besides two or more longer posterior

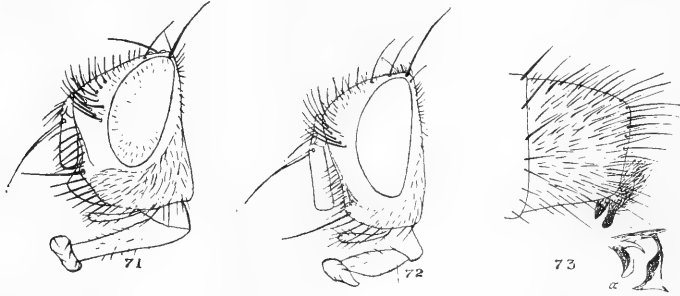


Fig. 71.—*Austrophorocera biserialis*. Head of male from the side.

Fig. 72.—*Apilia setifera*. Head of male from the side.

Fig. 73.—*Apilia setifera*. Apex of abdomen of male from the side, and (a) penis.

bristles; fore tarsi shorter than tibia; mid tibia with a strong submedian ventral bristle; hind tibia with a series of closely placed bristles on entire length of anterodorsal surface, and some longer bristles on posterodorsal surface. Black costal setulae not in evidence beyond apex of second vein; first posterior cell open, ending well proximad of apex of wing; bend of fourth vein subangular, the vein arcuate beyond it.

Length, 12 mm.

Type: Eidsvold, Qld., December, 1922, no other data. One specimen.

Another male before me has the basal two antennal segments testaceous yellow, the frontal orbits, parafacials, cheeks, face, and occiput yellow-dusted, only the narrow inner margins of the frontal orbits grey-dusted, the palpi entirely testaceous yellow, and a narrow dark vitta in centre of mesonotum in front of the suture.

It is possible that this is a different species, but I can detect no differences in the hypopygium and therefore leave it tentatively as *cilifera*.

Locality: Cairns district (Dodd).

A female agrees very well with the last male, but the face is white-dusted, almost silvery, as are also the frontal orbits, parafacials, and postocular orbits. There are a few microscopic hairs below the lower frontal bristle in both specimens, which are not evident in the genotype, and the facial ridges have but one series of moderately strong bristles instead of two series. The female has the usual two proclinate orbitals.

Locality: Cairns district (Dodd).

More material is required to enable one to arrive at a conclusion as to the identity of the last two specimens. Three males from the Federated Malay States agree almost perfectly with the type specimen.

Section as preceding one, but the frontal bristles in a single series in male.

Genus VESPIVORA, n. gen.

Closely related to *Frontina* Meigen, but distinguished from it and all closely related genera by the lack of the propleural bristle. The facial ridges are bristled to well above the middle, the eyes are subnude, and the prosternum is setulose. In my generic key it will run to Caption 33, and is distinguished from the genus there listed by the lack of the propleural bristle.

Genotype, the following species.

VESPIVORA NIGRIVENTRIS, n. sp.

♂, ♀. Head testaceous yellow, with dense yellow dust except on the lower portion of the postocular orbits where it is white, interfrontalia red, upper occiput fuscous on each side, third antennal segment largely darkened; palpi yellow. Thorax fuscous, shining, with dense yellowish-grey dust, mesonotum with five dark vittae anteriorly in male, four in female; scutellum largely reddish-yellow. Abdomen reddish-yellow, with yellow dust, most distinct on bases of tergites, venter glossy-black almost up to the curve on each side of the tergites, in male, and a black dorsocentral vitta in both sexes, which is incomplete at apex in male. Legs testaceous yellow in female, femora broadly fuscous at bases in male. Wings hyaline. Calyptrae and halteres yellow.

Frons of male about two-thirds as wide as either eye at vertex, of female but little wider, female with, male without, proclinate outer orbitals; ocellars short in both sexes; all four verticals present in both sexes; upper two or three orbitals in male recurved, the series not on inner margin but at some distance from it and hairs present on both sides of it, the lower bristle below level of apex of second antennal segment; parafacials bare, not wider than third antennal segment, the latter more than three times as long as second segment; arista bare; palpi normal. Thorax with three plus four dorsocentrals, three plus three acrostichals, posterior sublateral strong; sternopleurals one plus one. Abdomen ovate, centre of black ventral portions of tergites 2 and 3 densely haired, visible tergites 2 to 4 with apical, 4 with discal bristles. Mid tibia without a submedian ventral bristle in either sex; hind tibia fringed on anterodorsal surface in both sexes, one outstanding bristle in series in female. Wings as in *Frontina*.

Length, 8-9 mm.

Type, male, allotype, and two male paratypes, Eidsvold, Qld., parasite of wasps.

Section with the eyes densely, or at least very distinctly haired, parafacials with hairs to below middle, and the facial ridges with at most the lower half setulose.

Genus AMPLIPILIS Curran.

The only characters that would appear to warrant one accepting this as distinct from *Winthemia* Robineau-Desvoidy consist of the lack of developed ocellars, and the comparatively higher placed vibrissae. The more densely fringed anterodorsal surface of the hind tibia is assumably a male character, and possibly the others are also, but the female is unknown so that it is not possible to report definitely on this.

The lack of ocellars is again the only character for the separation of *Palia* Curran from *Phorocera* Robineau-Desvoidy, and there is a segregate of *Sturmia*

in which this distinction from the typical form occurs, but it is rather doubtful whether the character is worthy of consideration as of generic value.

I have carefully compared *versicolor* Curran, the genotype and only known species of *Amplipilis*, with the genotype of *Winthemia* and incline to the opinion that it is merely an exaggerated form of the latter genus, though I believe there is nothing to be gained by sinking *Amplipilis* without access to both sexes.

Genus WINTHEMIA Robineau-Desvoidy.

The genus *Chaetolyga* Rondani is distinguished from *Winthemia* in Lundbeck's work on the Danish Tachinidae by the possession of three instead of two sternopleural bristles, and by the male having a strong reclinate upper frontal bristle on each orbit. The original spelling of the genus name is *Chetoliga*. I have one Australian species that is very similar to the genotype of this genus.

There are two species of *Winthemia* represented by males in my Australian material and only one species of the genus is described from here. I append a synopsis of the characters of the species to enable students to recognize them. Two of the examples have evidently been reared, as there are accompanying empty puparia mounted with them. In other regions the species are parasitic upon Lepidoptera, *quadripustulata* Meigen being a very effective and common enemy of the Army-worm in the United States.

In presenting the data upon this genus I must emphasize that it is possible the species described as new may have been described from some adjacent region, and that my presentation is made to enable names to be applied to known Australian forms pending a careful comparative treatment of the species of the world.

Key to the Species.

1. Pleural hairs entirely black; face and parafacials white-dusted, the latter contrasting rather noticeably with the bronzy-yellow-dusted frontal orbits, and with dark hairs; third visible abdominal tergite with a very small tuft of black bristly hairs on the incurved lateral portions near to the lateral posterior angles *diversa*, n. sp.
- Pleural hairs partly pale, the long hairs on posterior margin of mesopleura behind the marginal bristles always conspicuously yellow; face either yellowish-dusted or the parafacials are white-haired; third and fourth visible abdominal tergites with the greater portion of the incurved lateral portions densely covered with black bristly hairs 2
2. Face and parafacials densely white-dusted, the latter with white hairs, frontal orbits white-dusted, becoming greyish at upper extremities *albiceps*, n. sp.
- Face, parafacials, and frontal orbits, brassy-yellow-dusted, the parafacials with black hairs *trichopareia* Schiner ?

WINTHEMIA DIVERSA, n. sp.

♂. Similar in general appearance and coloration to *quadripustulata* Meigen, but with a small tuft of bristly hairs on each side on the incurved lateral portions of the third visible abdominal tergite. Face and postocular orbits white-dusted, frontal orbits yellowish-dusted, cheeks darkened, parafacial hairs dark, palpi testaceous yellow, darkened basally; antennae entirely black; hairs on eyes yellowish. Thorax black, shining, with yellowish-grey dust, mesonotum with five shining black vittae, the central one rather indistinct anteriorly, the sublateral pair complete, the submedian pair not extending to posterior margin; scutellum

testaceous, darkened basally; pleural hairs all black. Abdomen shining black, sides of first three tergites broadly translucent yellowish, apex of fourth narrowly yellowish. Legs entirely black. Wings greyish hyaline. Calyptres yellowish-white. Halteres pale-brown.

Eyes densely haired; frons at vertex about one-third as wide as either eye, interfrontalia entire, orbits rather densely haired on entire extent, their inner margins with a series of bristles, all incurved, ocellars short but distinct, parafacials not as wide as third antennal segment, dark haired, cheek about as high as width of third antennal segment, the latter not three times as long as second segment, extending almost to vibrissae; palpi slightly club-shaped. Thorax with three plus four dorsocentrals, three plus three acrostichals, the posterior sub-lateral strong, prealar of moderate length, three intra-alars, eight scutellars on margin and two on disc. Abdomen normal, except for the presence of a small tuft of bristly hairs on the incurved portion of each side of third visible tergite and rather numerous hairs on same part of fourth; first and second tergites without apical central bristles, third and fourth each with a complete apical series, the one on third strongest. Legs normal, hind tibia with the usual antero-dorsal fringe of regular bristles.

Length, 10 mm.

Type, "Allowrie", Killara, N.S.W., 28.1.1921. One specimen.

WINTHEMIA ALBICENS, n. sp.

♂. Similar in most particulars to the preceding species, but differing as stated in the synopsis. In addition to these characters the frons is a little wider, the species is somewhat larger, and there is a distinct yellowish patch on the hind margin of the mesonotum centrally.

Length, 12 mm.

Type, Sydney, N.S.W., no other data. One specimen.

Coquillett has identified this as *Masicera lata* Macquart, in the United States National Museum collection, but it does not agree with the description. It is possible that it may be *trichopareia* Schiner, but the next species agrees as well with the description and is more common apparently. There is a possibility that it is *dispar* Macquart.

WINTHEMIA TRICHOPAREIA Schiner ?

I believe that the specimens before me are this species, though it is rather unsatisfactorily described by Schiner. It will, however, be possible to check the identification as the type is in all probability in the Vienna Museum. Bezzi has suggested the synonymy of this species and *dispar* Macquart.

In most particulars it is similar to the preceding species, differing in the characters listed in the synopsis.

Length, 10-12 mm.

Locality: Cairns, N. Qld. Four males.

I hope to return to this genus at some future time and further elucidate the species, especially the females, of which I have a number, two of them reared.

Genus CALOPYGIDIA, n. gen.

This genus has the head much as in *Quadra*, but the parafacials are haired to the lower level of eyes with quite strong black hairs, the first posterior cell

of the wing is open, the eyes are densely haired, the ocellars are lacking in the male and present though short in one female, and the abdomen lacks discal bristles on the second and third visible tergites.

Genotype, the following species.

CALOPYGIDIA ANALIS, n. sp.

♂, ♀. Head testaceous yellow, densely yellow-dusted except on the frontal orbits which are slightly shining, interfrontalia reddish in male, paler in female; antennae orange-yellow, third segment black in male, reddish-yellow below and black above in female; aristae black; palpi orange-yellow; proboscis black; frontal, parafacial, and genal hairs black, occipital hairs golden-yellow. Thorax black, with white dusting, the mesonotum with four narrow black vittae; scutellum translucent testaceous yellow. Abdomen glossy-black, fourth visible tergite entirely densely grey-dusted, incurved lateral margins of the other tergites grey-dusted. Legs black. Wings greyish hyaline, yellowish at bases. Calyptrae white, yellowish basally and on margin. Knobs of halteres fuscous.

♂. Frons at vertex more than half as wide as either eye, interfrontalia entire, not as wide as either orbit above, each orbit with a backwardly-curved bristle at upper extremity of the inner series and laterad of them, the inner series strong, extending below level of apex of second antennal segment where it runs diagonally towards eye; ocellars lacking, inner verticals long, outer pair undeveloped; parafacials about twice as wide as facial ridges when seen in profile and fully as wide as third antennal segment; vibrissae situated above mouth margin; third antennal segment about six times as long as second; arista thickened to well beyond



Fig. 74.—*Calopygidia analis*. Apex of abdomen of male from the side.

middle, then abruptly tapered, with microscopic pubescence; face with centre deeply sunken, and a central vertical linear carina; palpi moderately long. Thorax with the same bristling as *Winthemia*, the posterior sublateral present and the sternopleurals two. Abdomen broadly ovate, not longer than thorax, second, third, and fourth tergites with apical central bristles, the series complete on last two, fourth with discal bristles; hypopygium as Figure 74, the forceps quite long. Wings as in *Winthemia*. Mid tibia with a strong submedian ventral bristle; hind tibia with one outstanding bristle in the anterodorsal series of regular bristles; fore tarsi normal, the claws and pulvilli not as long as in *Winthemia* species.

♀. Similar to the male, but with the frons wider, almost as wide as one eye at vertex, and with two strong proclinate bristles on each orbit outside of the

inner series; the ocellars may be developed or undeveloped. The fore tarsi are not dilated.

Length, 8-10 mm.

Type, male, allotype, and one defective paratype, Barrington Tops, February, 1925, on *Leptospermum* (S.U. Zool. Exped.); paratypes, Blue Mts., no other data (Health Dept.); Sydney, N.S.W., no other data, and Blackheath, N.S.W., 26.12.1921 (Health Dept.).

This genus will run down to *Winthemia* in my generic key, but it is distinguished from that genus by the rather prominently visible facial ridges with their bristles on lower half, the longer third antennal segment, sharply carinate face, and broader form.

Section with eyes bare or almost so, parafacials bare, and the facial ridges haired or bristled on not more than their lower third.

Genus *STURMIA* Robineau-Desvoidy.

This genus as defined in my generic key will contain quite a large number of species from Australia, some of them undoubtedly the same as occur in the Orient or on some of the intervening islands between Asia and Australia.

Certain groups of species of greater or lesser magnitude have been split off from *Sturmia* by different authors as genera, and when it devolves upon some worker to make a comprehensive survey of the Australian species, careful comparative work alone will determine the status of these groups. In the meantime I prefer to consider but one genus of the complex valid and refer all to *Sturmia*, *sens. lat.*

Most of the species of which the larval habits are known are parasitic upon the larvae of Lepidoptera, and are thus of considerable economic importance.

In the material now before me, I find one very strikingly coloured species, *semirufa*, which I cannot find any published description to fit, and I describe it as new. It has no evident posterior sublateral bristle, and it also lacks the submedian ventral bristle on the mid tibia of the male, but it is entirely possible that both of these bristles may be present in the female.

STURMIA SEMIRUFA, n. sp.

♂. Head black, frontal orbits yellowish-grey-dusted except on upper extremities, parafacials yellowish-grey-dusted above, becoming grey-dusted below, face and cheeks grey-dusted, the latter brown centrally, postocular orbits grey-dusted, becoming yellow above; antennae and palpi black; all cephalic hairs black. Thorax deep velvety-black, entirely black haired. Abdomen vermilion red, dorsal exposure of first visible tergite black, second to fourth tergites each with a more or less evident narrow dorsocentral black line, which is slightly dilated posteriorly on at least the second tergite; all the hairs black. Wings greyish hyaline, darker at bases. Calyptreae and halteres fuscous.

Eyes with microscopic hairs; frons at vertex not more than one-fifth of the head-width; inner vertical bristles short, outer pair lacking, ocellars short, upper two bristles on each orbit short, recurved, inner marginal bristles incurved, regular and close, extending to level of apex of second antennal segment, hairs laterad of the bristles extending to lowest level of same; parafacial not as wide as third antennal segment, the latter extending almost to vibrissae, which latter are situated a little above mouth margin; facial ridges setulose on lower third;



cheek about three-fourths as high as length of third antennal segment; palpi slightly club-shaped, quite densely fine-haired; arista subnude, swollen on basal fourth. Thorax with three plus four dorsocentrals, three plus three acrostichals, posterior sublateral bristle lacking, sternopleurals two plus one. Prosternum haired; apical scutellar bristles very small and weak. Abdomen broadly ovate, with strong apical bristles on only the third visible tergite; no sexual patches on third and fourth visible tergites. Fore tibia with the anterodorsal setulae very short, mid tibia with one anterodorsal and one or two posterodorsal bristles, hind tibia with a regular series of anterodorsal bristles. Wings normal.

Length, 9 mm.

Type, Kuranda, N. Qld. (Dodd). One specimen.

There are many Australian species of this and related genera. Many of those species referable to this group are of importance in the control of injurious Lepidoptera and other orders of insects and some of them have been widely distributed throughout the world, but they are not at all easy to identify, and are often quite misleading in their close superficial resemblance to other species which may belong to distinct genera. The best method of obtaining reliable data upon the species is to rear them and save not only the adults but their empty puparia, taking care to associate these carefully with each other, as the puparia often present good characters for the generic and specific identification of the species.

New Zealand Species.

I present at this time the description of one New Zealand species.

Genus PROTOHYSTRICIA Malloch.

When I described this genus I had but one species in mind, *pachyprocta* (Nowicki), but there is a similar but smaller species amongst my New Zealand material which I briefly describe below. I do not consider the small size of the palpi sufficient ground for its generic separation from the genotype.

PROTOHYSTRICIA HUTTONI, n. sp.

♂. Similar in general coloration to *pachyprocta*, the face testaceous, with pale-grey dust, the interfrontalia brownish-black, orbits and upper occiput fuscous, with grey dust; antennae black; palpi brown; proboscis black. Thorax fuscous, with brownish-grey dust, most of the fine hairs pale. Abdomen semipellucid testaceous yellow, with grey checkered dusting and a rather broad black dorso-central vitta which expands on fifth tergite and almost covers it, the fine hairs mixed black and pale. Legs black, tibiae and apices of femora testaceous yellow. Wings greyish hyaline, veins brown, paler basally. Calyptrae white. Halteres yellow.

Eyes densely haired; frons at vertex about one-fifth of the head width; ocellar bristles long, erect and divergent; interfrontalia complete; parafacials haired to middle or below it; face almost carinate above; third antennal segment not twice as long as second, extending almost to vibrissa, the latter about the length of second antennal segment above epistome; second arisal segment about twice as long as wide; proboscis with the apical section slender, tapered to the apical labellae, and about one and a half times as long as head; palpi not as long as second antennal segment; parafacials as wide as third antennal segment. Legs

normal, mid tibia with a ventral bristle. Fifth abdominal sternite densely covered with short black bristles; sixth visible tergite with more numerous, seventh with less numerous, bristles than in *pachyprocta*.

Length, 10 mm.

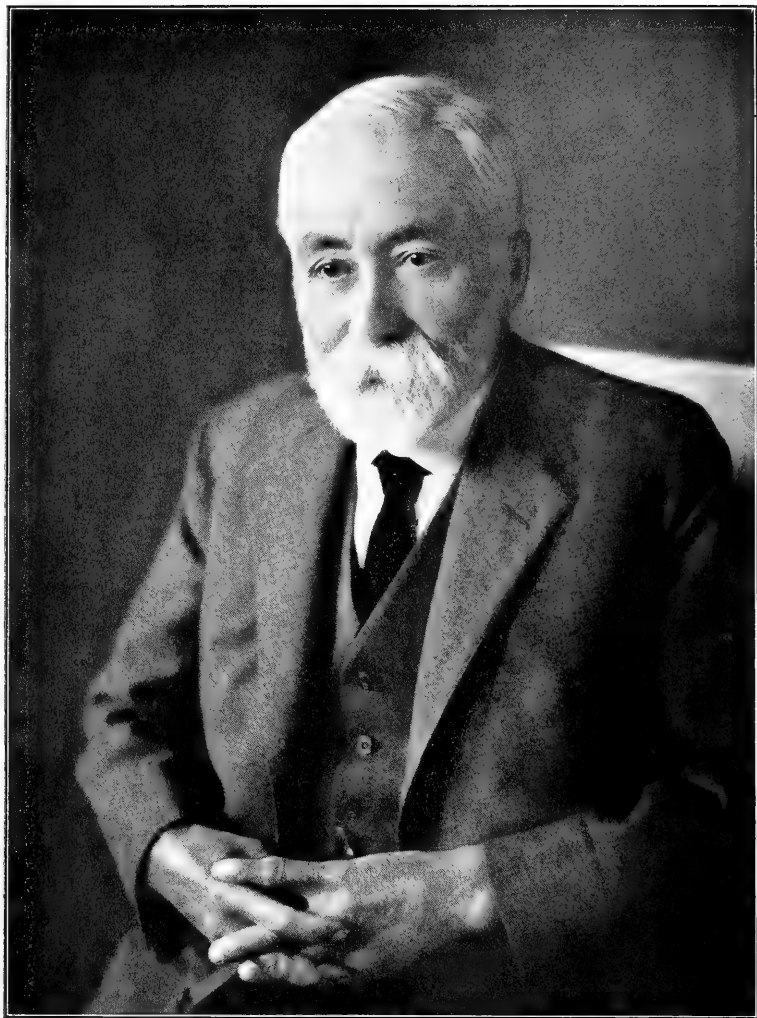
Type, Bold Peak, New Zealand, 24.12.1912 (M. M. Watt).

Readily distinguished from the genotype by the small palpi and longer and more slender apical section of the proboscis. Both have the thoracic dorsum conspicuously quadrivittate with black, the vittae abbreviated behind.

Dedicated to Capt. F. W. Hutton, pioneer New Zealand dipterist.







J. H. Maiden

JOSEPH HENRY MAIDEN.

1859-1925.

(*Memorial Series, No. 3.*)

(With Portrait.)

Joseph Henry Maiden was born at St. John's Wood, London, on April 25th, 1859. He was educated at the City of London Middle Class School. He was a spirited boy and well-minded to defend his rights. He once gave me an amusing picture of himself as a small youth, dressed immaculately in an Eton suit and wearing a high hat, as he stood with his back to some railings on his way home from school, and with clenched fists bade defiance to the pack of street Arabs, who jeered at his attire and threatened violent hands. It was an indication of the man to be.

At school he soon developed a taste for science. Professor T. Barff, Professor of Chemistry at New College, had charge of the teaching of Chemistry at the School, and for three years young Maiden acted as his Demonstrator. Barff was a well-known chemist of the time and had written what was the favourite text-book on Chemistry for the London Matriculation Examination. In this way Maiden must have acquired a good groundwork in Chemistry.

In various ways he gained experience and, amongst other things, he foreshadowed his later Museum Curatorship by being appointed to the care of a fine collection of products which entered the Port of London, and which was used by some of the Masters for lecture purposes. He came out sixth in his final school examinations and matriculated at the University of London.

During the Matriculation Examination he found himself seated next to Mrs. Annie Besant, and, as a student of Natural History, observed that Mr. Charles Bradlaugh used to accompany the lady to the examination hall and call for her when the day's work was over.

Leaving school he worked on at the B.Sc. course. Professor Barff had been so impressed with his ability that Maiden was engaged as Demonstrator for two sessions at the Royal Academy of Arts, where Barff was delivering courses of lectures on Oils and Pigments to the Royal Academicians and an invited audience. Other recognition was made by the wealthy Fishmongers' Company, who offered him a scholarship of £50 a year tenable at Christ's College, Cambridge; and by Sir Frederick Abel, who nominated him for a post in the chemical laboratory of the Royal Arsenal at Woolwich.

He did not avail himself of these offers but "suffered disappointment after disappointment through illness". He was finally induced to try the effect of a long sea voyage and decided on a trip to Australia for the benefit of his health.

He came to Australia then at the end of 1880, with a return ticket, and introductions to a Bishop and to Professor Liversidge. The former was never presented, for the diocese of the Bishop was far from Sydney; and the latter was

not presented till a year after date. The Professor was inclined to find fault with so belated a visit, until the circumstances of the health holiday were explained to him. He added that Professor Barff had written to him twice about his visitor. He wound up by offering Mr. Maiden the post of Curator of the Technological Museum, about to be established in Sydney.

In August, 1878, at a meeting of the Trustees of the Australian Museum, Mr. (after Sir Alfred) Roberts moved a resolution "that, in the opinion of this Board (of the Trustees), a Technological and Industrial Museum, with classes for instruction, would afford much valuable and practical information to a large class of the community, that it may be advantageously associated with this Institution (the Australian Museum), and that the necessary accommodation might be provided in the building about to be erected for the exhibition of works of art." Professor Liversidge was one of the most active and influential Trustees, but he was at this time in England. He was deputed to make inquiries in Europe and to join with the Agent-General in procuring information and in the purchase of specimens. In 1879 a Committee was formed of Professor Liversidge and Messrs. Roberts and Hunt, and by their advice, in 1880, the collections, including specimens, both "suitable and unsuitable", left over from the Sydney International Exhibition, were housed in the Garden Palace, the building erected for the Exhibition. It was of this Technological Museum, then under the administration of the Trustees of the Australian Museum, that Mr. Maiden was appointed Curator in October, 1881.

With the exception of designing a building, then, Mr. Maiden was charged with the formation and stocking of a Museum. In spite of all difficulties, including the disposal of the "unsuitable" reliquia of the Exhibition, he succeeded in the organization of a worth-while Technological Museum. Sir Joseph Hooker, Director of the Royal Gardens at Kew, presented, through Professor Liversidge, a large and valuable collection of specimens of Economic Botany. Some 10,000 specimens were gathered together in the Palace Garden. But in September, 1882, a disastrous fire broke out in the Palace, which destroyed the building and everything except a few of the largest and least destructible of the iron and steel exhibits. Amongst these was a Beam Engine, made by the celebrated James Watt and presented by Messrs. Whitbread & Co., of London.

Neither the Trustees of the Australian Museum nor the Curator were daunted by this great disaster. The Committee went on collecting objects of interest and by September, 1889, estimated that their new collection included some 30,000 specimens, many of great value. Mr. Maiden had to look out for another home for his Museum. In the Outer Domain, at the back of the Sydney Hospital, was a long galvanized iron building, unlined, and floored with battens, which had served as the Horticultural building of the Exhibition. The Hospital had utilized the southern half as an Out-Patients' Department, while the northern half was vacant. It had housed the members of the unfortunate Marquis de Rays Expedition and contained much inflammable rubbish. The bunks and some rough screens remained, very few of which had been touched by the plane. The homeless Curator thought that half a loaf was better than no bread. He went to the Colonial Secretary's Office and begged for the vacant half of the shed, which was granted to him before the end of the year. In these unpromising quarters he set up his Museum, and carried on, and advanced by leaps and bounds for ten years. His efforts were rewarded by the erection of the fine building at Ultimo, its present home, by the Government of New South Wales, which had

meanwhile taken over the Technological Museum from the Trustees of the Australian Museum. The architect, Mr. Kemp, embodied in the design the ideas that Mr. Maiden supplied after an experience of twelve years as Curator. "The Tin Shed" was abandoned and the Ultimo building was opened to the public by the Governor and Lady Duff in August, 1893. The fighting Maiden had won through. And in addition to his official duties he had published valuable papers on Economic Botany and a larger work on "The Useful Native Plants of Australia"; which was received with much favour by the British and Colonial press. The botanic trend is now obvious. In company with Mr. J. J. Fletcher, he made weekly excursions into the bush country, making himself familiar with Australian vegetation as it grows. He also sat at the feet of that venerable and amiable botanist, Rev. William Woolls, who was well acquainted with all the known Port Jackson plants, and he was also in communication with Baron von Mueller.

In 1894 the duties of Superintendent of Technical Education were added. Two years later he was transferred to the Botanic Gardens as Director and Government Botanist, succeeding Mr. Charles Moore, who had been in office for forty-eight years. At the Technological Museum he was ably supported by Messrs. R. T. Baker and Henry G. Smith, who continued the good work when Mr. Maiden removed to the Gardens, and made the Technological Museum famous by their elaborate researches in Australian Timbers and Australian Essential Oils.

Maiden had now found the metier for which his temperament, his experience and his inclination exactly fitted him. He delighted to be the "Watchdog of the Gardens", protecting the plants and keeping the walks and lawns free from objectionable characters, that the citizens of Sydney, and especially the women and children, might possess a safe and pleasant recreation ground. He prohibited smoking in the Gardens even by Members of Parliament. He watched his plants, affectionately as a flower-loving citizen loves his private garden, learned where each grew and saw to it that they were well tended. He fought the flying foxes which, in some years, invaded the Gardens in swarms of thousands. He brought in soil to improve the natural infertility of the sandy ground. He arranged for better drainage and better water supply. He secured better accommodation for his gardeners and was great on labels.

It was in the office that he found greatest scope for his organizing and constructive talents. There was no Herbarium, no collections of the flora of New South Wales even, no museum, no library of botanical works. It seems incredible. However, Maiden was used to starting with nothing, and he at once set himself indefatigably to work to supply these services. His first Report on the Gardens and Domains for the year 1897—the first Report for twenty years!—is interesting reading. He writes:—

"Next to the Garden and the other outside establishments under my supervision, the care of the Herbarium has been my greatest solicitude. My botanical assistant, Mr. Ernst Betehe, is practically the keeper of the Herbarium, and it is impossible to speak too highly of the value of his services in making this Herbarium worthy of the Botanic Gardens, and of the Colony at large. The Herbarium being of course essential to the daily work of the establishment, I spend every hour in it I can possibly spare. After 18 months of incessant labour, barely half of the natural orders are properly arranged—the result, mainly, of the large number of specimens steadily flowing in from many parts of the world

(in the way of exchange), and also those collected by myself and my staff, amongst whom, as earnest and discriminating collectors, I must specially indicate Mr. Betche, and Messrs. Forsyth and Camfield, Overseers of the Centennial Park and Garden Palace grounds respectively. Parliament has been pleased to vote a sum of money for the erection of a building to house the Herbarium, and in my next Report I hope to be able to announce that the building is ready for occupation, or nearly so." And again: "We have already the nucleus of a valuable botanical Museum."

He did not spend all his time, however, in the Herbarium, but, between August, 1896, and December, 1897, he made collecting journeys to Wagga Wagga district; Cooma, Nimitybelle, Tantawanglo Mountain, Bombala, Delegate; Victoria and South Australia; Condobolin and Parkes; Gloucester district; Seaview Range and New England (Port Macquarie to Walcha); Marulan.

He says: "My visit to Victoria and South Australia enabled me to examine the Botanic Gardens in Melbourne and Adelaide, and the smaller provincial establishments, while I studied the forests and forestry matters in both colonies.—With Mr. Walter Gill, Conservator of Forests, Adelaide, I travelled for several days inspecting the various forest-nurseries and State Forests in South Australia, and to him and to Mr. G. S. Perrin, the Conservator of Forests, Melbourne, I am indebted for much information and many valuable specimens."

The Report for 1898 relates that he had made extensive changes, improvements and additions to the Natural Order beds in the Gardens; had given orders for two new hot-houses, one especially for tropical Orchids; and had secured the erection of Packing and Potting Sheds and Store-rooms, together with a kitchen and dining-room for the men; all in brick. He had not yet got his home for the Herbarium but "the Government Architect has designed a commodious building of handsome design which will be in keeping with its beautiful surroundings. As I write a tender for its erection has been let, so I trust that my hope of last year may be realized during the present one." "I think that the number of species in the Herbarium at the end of the year is not less than 15,000."

The journeys this year were made to Mount Kosciusko; Jenolan Caves; Lord Howe Island; Melbourne Herbarium; Dubbo and Narromine districts and Harvey Range; Clarence Siding, the highest point of the Blue Mountains; Appin; Shoalhaven gullies; King's Tableland; Mount Tomah; Tenterfield district and Dividing Range to Mount Spiraby.

It must be remembered, too, that Maiden had not only the control of the various sections of the Botanic Gardens but also the superintendence of the Outer Domain and Centennial Park, and the State Nursery at Campbelltown, as well as the care of the grounds of the Governor at Moss Vale, of the Admiral at North Sydney and the Gaol Reserves at East Maitland. He was also looked to for the supply of palms and shrubs for all sorts of institutions and all sorts of public functions. He had the wisdom of King Louis the Fourteenth in maintaining a general supervision, but leaving the details to his capable lieutenants, Mr. George Harwood, the Superintendent of the Gardens, and to Messrs. Forsyth and Camfield, abovementioned, while Mr. Betche was a tower of strength in the Herbarium. Throughout his tenure of office, too, Mr. Maiden had the magnificently loyal and capable support of the Chief Clerk, Mr. R. Nichol.

It was not until March, 1901, that the Herbarium and Museum building was officially opened by the Hon. John See. It is a two-storey building. On the ground floor—Herbarium of Cryptogams, 41 feet × 31 feet; Museum, 40 feet × 30

feet; Library and Office, 32 feet 6 inches \times 19 feet; Superintendent's Office, Halls, Stores, Seed-rooms, etc. On the first floor—Herbarium for Australian Phanerogams, 41 feet \times 31 feet; Herbarium for Exotic Phanerogams, 40 feet \times 30 feet; Director's Office and Assistant's Room. Tables of Maiden's own design for the purposes of study and for handling the collections are placed in convenient situations. The plants are kept in boxes, 18 \times 12 \times 3 inches, stowed on shelves lining the walls to their extreme height. Iron book-shelves of special design, known as the Oxford book-cases, are placed alongside the plants to which the books refer. The building has no balconies, and plenty of large windows through which comes a flood of light, so that on the dullest day the examination of specimens may proceed without interruption. The walls of the broad staircases and halls are adorned with the portraits of the eminent botanists of the world, Linnaeus, Naegeli, Schleiden, Loewenhock, Humboldt, Robert Brown, Allan Cunningham, Lindley, Hooker, Dampier, Rae, Bentham, Leichhardt, von Mueller, Bailey, and many others. The gathering of these must have cost Mr. Maiden much thought and expense. How on earth he managed to get hold of them one can only wonder. No bibliophile could have done better. But he was a bibliophile, too, and secured a whole library of botanical classics, furnishing both Phanerogamic and Cryptogamic Herbaria with an excellent literature.

In January, 1927, Mr. Edwin Cheel, the Curator, states that there were contained in the Herbarium upwards of 18,000 of the boxes, incorporating about 340,000 sheets of specimens classified into their families, genera and species. In 1926 the staff identified and reported on upwards of 2,225 specimens besides attending to numerous personal inquiries and other routine work.

Probably Maiden's creation of this great Herbarium is his finest contribution to science. Nearly all of the described Australian Phanerogams and many of the Cryptogams are stored in the Herbarium and will serve investigators for ages. Many a Monograph might, and ought to, be written on the material stored in the Maiden Herbarium.

At first he had to rely on the excellent staff bequeathed by Charles Moore, but later he was able to choose officers from men whose marked ability and scientific bias he had noted with the keen eyes which were ever on the watch for efficient helpers. Thus on Mr. Harwood's death he appointed Mr. E. N. Ward to be Superintendent of the Gardens, and introduced Messrs. E. Cheel and A. A. Hamilton and later Mr. W. F. Blakely as Assistants in the Herbarium, with Miss Margaret Flockton as expert botanical artist. Thus the supply of Taxonomic Botanists was maintained by men of his own training. The Gardens was a busy hive. He worked hard himself and had the gift of keeping all his assistants going all the time at full speed.

In 1900 he made a trip to Europe. "Before my departure from the colony the staffs of the establishments under my supervision generously presented me with a handsome souvenir in the shape of a beautifully fitted travelling bag. The kind words that were said on that occasion were not empty words, but were expressive of the very cordial relations that exist between the staff and myself." Such were his relations with his staff in the early days. On the occasion of his retirement in 1924 the staff gathered to bid him farewell. Every available officer in the Sub-Department, from Dr. Darnell Smith, the new Director, to the office boy—about 130 of them—mustered at the Depôt in the Gardens and there were speeches of hearty appreciation of his great work and regret over his retirement by Dr. Darnell Smith, Mr. E. N. Ward and Mr. Mitchell, the Foreman of

the gardeners. Later on the same day there was a leave-taking at the Head Office of the Department of Agriculture, when all Branches were represented. The Hon. F. A. Chaffey, Minister for Agriculture, presided. The Under Secretary, Mr. G. Valder, spoke in feeling terms of his long association with Mr. Maiden, and of the distinguished services he had rendered in so many ways during the twenty-eight years he had been Government Botanist and Director of the Botanic Gardens. Dr. Darnell Smith, in speaking for the Scientific and Professional Staff, commended Mr. Maiden on his wise choice of subordinates, and spoke of his unflinching interest in his botanical studies, as an active worker and officer in learned Societies, and as a prolific author. Mr. E. N. Ward spoke of the late Chief as a hard worker himself and who expected the same of others. At the conclusion Mr. Chaffey presented Mr. Maiden with a wallet of notes as a token of his fellow officers' esteem, and expressed his deep regret that they were losing so distinguished an officer as Mr. Maiden had proved to be.

He showed his usual activity in his trip abroad. He visited many of the principal botanic gardens, parks and herbaria in Great Britain and Ireland, France, Germany, Holland, Belgium and Ceylon. He attended the International Botanical Congress held in connection with the Paris Exhibition and the Botanical Section of the British Association for the Advancement of Science at Bradford. He cemented old friendships, made new ones, and obtained a fund of practical information in regard to botanical and horticultural establishments. He hardly spent a day in recreation. No wonder that he "stepped on the return steamer more dead than alive out of pure weariness". Amongst other achievements he made arrangements for his collection of portraits of eminent botanists and was the means of obtaining from the British Museum nearly 586 botanical specimens collected by the hands of Sir Joseph Banks and his assistants at Botany Bay and in Northern Queensland on the voyage of the "Endeavour", commanded by Captain Cook, in 1770. This collection of original type specimens is the gem of the National Herbarium of New South Wales.

Maiden was an untiring and remarkably methodical worker. He let nothing slip. However weary in body, and in later years his physical afflictions were severe, he carried on with unflinching energy and will power. He made recording and suggestive notes of everything, and all these were placed in docketed and systematized pigeon holes. The notes were clearly expressed and clearly written in a bold hand. In this way he kept a wonderful control of his work. He made a careful and thorough arrangement of the details of preparation for all his enterprises showing great forethought, and so he secured unexampled success.

His excursions were carefully planned campaigns. I had the pleasure of accompanying him in one of his investigations of the Mount Kosciusko flora. His equipment was complete. Messrs. J. J. Fletcher and W. Forsyth and myself were laden with huge vascula. It was a riding trip, and, with one of these vascula in front and one behind, riding was difficult on the steep slopes. We constantly alighted to collect, and I fear that each in turn was also rudely precipitated where no plants called to us. A two days' blizzard of wind and snow added to the difficulties, but Maiden made an exhaustive collection of the flora and extensive notes, and Forsyth made a fine series of ecological photographs. A feature of Maiden's investigations was his close attention to details, and it was his custom to stand in front of the tree or shrub under examination, note-book in hand, and enter his observations on the spot. He did not yield to the temptation to trust to memory.

He was handicapped by physical disabilities, incurred in his public service. He was on a trip to Moss Vale collecting orchids for the Gardens and certain fresh flowering and fruiting twigs for his Forest Flora. He took a sulky from Robertson, and in jumping across a small ravine at the top of Macquarie Pass, he found that something had happened and he hurried to bed at the local hotel. It having been pronounced that he was badly ruptured he took medical advice at Moss Vale and returned to Sydney, where he consulted his own doctor and was measured up for a truss. He says: "Few people can understand the distress and risk I underwent for a few years, and at last I consulted (1911) Sir Alexander MacCormick, who ordered me to "The Terraces" that day. He operated on me the next day. I was in the hospital three weeks but I took no sick leave, only ordinary recreation leave. This specific duty of plant hunting near Robertson must have cost me at least £100. It never occurred to me to come to the Government for leave or medical expenses." His lameness, due to the above accident, increased as the years went on, until it was only possible to move with great difficulty and much pain. But he kept a stiff upper lip and went on with his great labours as before.

In fact, while actually a poor man with a quite inadequate official salary, he spent freely of his own money in carrying out his various enterprises for the benefit of Science and of the country. He was ambitious but with a noble ambition. His last major botanical journey was to Western Australia. Here he travelled and collected wholesale for four months, spending his own money and using his leave. The Government of New South Wales gave no aid, but a kind Melbourne friend made a generous gift of £200. "It all went and very much more out of my own resources." "I had been studying the routes of botanists and explorers for years to make this trip the success it was. But I underwent much hardship."

He found other workers and joined with them, publishing papers in conjunction with R. T. Baker, Ernst Betche, Henry Deane and R. H. Cambage. The last two were great travellers, and both keenly interested in the Eucalypts, and brought their wide field knowledge to add to the taxonomy and distribution of the genus.

He was an active and distinguished member of many scientific Societies, served on their Councils and as President, and furnished an immense number of valuable papers.

He joined the Linnean Society of London in 1888 and was a Fellow of the Royal Horticultural Society. In 1915 he was awarded the Gold Medal of the Linnean Society. The Medal was handed to the High Commissioner, Sir George Reid, for transmission to Mr. Maiden. The Vice-President, from the Chair, addressed him in these words:—"Sir George Reid: It gives me sincere pleasure to ask you on behalf of the President to receive and transmit to Mr. Joseph Henry Maiden of Sydney, New South Wales, the Medal of the Linnean Society, which the Council has thought fit to bestow on him. The pleasure is all the greater as it goes for the first time to one of our great Dominions oversea. Mr. Maiden was born in this city, but he has by his life work identified himself with the scientific aspirations of the Commonwealth of Australia. He has for more than thirty years taken a very prominent part in the study of the Australian flora and the development of applied botany in that country. The number of papers which the publications of the Linnean Society and of the Department of Agriculture of New South Wales owe to his zeal and ability is as considerable

as they are excellent. To them must be added his independent publications, which by their titles indicate the trend of the work that has placed him in the forefront of Australian botanists. . . Will you, Sir George, be good enough to assure him of the most cordial wishes of the Fellows who are assembled here at this anniversary meeting, and are glad to have been associated with him for so many years in the common bonds of this Society?"

He had previously been awarded the Grande Médaille, with diploma, of the National Acclimatisation Society of France. In 1916 he received the high honour of election to the Fellowship of the Royal Society of London, the blue ribbon of British science.

He was also a Corresponding Member of the Pharmaceutical Society of Great Britain; Corresponding Member of the Philadelphia College of Pharmacy, U.S.A.; Honorary Member of the British Pharmaceutical Conference, 1901; Corresponding Member of the National Society of Agriculture, Santiago, Chili; of the Horticultural Society of Algiers; of the National Society of Natural Sciences, Cherbourg; of the Botanical Society of Edinburgh; of the National Institute of Geneva; of the National Society of Acclimatisation of France; of the Netherlands Society for the promotion of Industry, Haarlem; of the Agricultural Union of New Caledonia; of the Southern California Academy of Sciences. He was appointed by the New South Wales Government, representative Member of the Consultative Commission for the International Protection of Nature, Basle, Switzerland.

He was a member of the Royal Society of New South Wales for forty-two years, Honorary Secretary for twenty-two years, and President in 1896 and 1911; a member of the Linnean Society of New South Wales for forty-two years, a member of the Council for thirty-five years, and President in 1901 and 1902; President of the Horticultural Society of New South Wales from 1904 to 1917 and President for eighteen years, and then Patron, of the Horticultural Association of New South Wales; President of the Royal Australian Historical Society for two years; Founder and Patron of the Wattle League.

He was for fourteen years Honorary Secretary to the Australasian Association for the Advancement of Science. He was offered the Presidency in 1921, but was unable to accept for health reasons. In 1922 he was awarded the Mueller Medal of that Association.

He was made Companion of the Imperial Service Order, I.S.O., in 1916.

He was awarded the Clarke Memorial Medal by the Royal Society of New South Wales in 1924.

He was the author of several valuable works on Australian Botany and contributed papers to the journals of the various scientific Societies and innumerable articles to the *Agricultural Gazette* on many practical subjects, such as Forestry and the uses of various timbers, Ring-barking, Fodder Plants, Poisonous Plants, Sand-drift problems, particularly sand-binding along the sea-beaches, and Eradication of Weeds.

His first book was "Useful Native Plants of Australia", 1889. This was a very useful compilation of what was known on our economic plants at that time. It contained nearly 700 pages, witnessing a vast amount of labour, and was well received in Europe as in Australia.

In 1903 he published the First Part of his immense work "The Critical Revision of the Genus *Eucalyptus*". He brought out Part after Part, working on till his death at this which he looked upon as his Magnum Opus. He left

material behind him to complete the Monograph, as far as completion is possible to a growing subject, and the loving hands of R. H. Cambage and W. F. Blakely continued the publication of his observations. In 1929 the seventy-first Part has appeared and still more of Maiden's material remains to be set in order. There are seven volumes, each with an average of 400 quarto pages, and the eighth has been commenced.

The advance made, due to the researches of Maiden and his co-adjutors, may be seen by a comparison of the "Critical Revision" with the "Eucalyptographia" of Baron von Mueller. This, probably the Baron's most prominent work, was published in 1879. It consisted of ten Decades, each comprising the description, together with a full account of the tree and a full size Plate of detailed drawings, of ten species of Eucalyptus. Thus 100 species are fully illustrated. In the Second Edition of the Baron's Census of Australian Plants there appear 137 then known species of Eucalyptus. Before Maiden had finished his work the number had grown to 366.

Maiden's Plates run up to 291. He records all the information which he and others had been able to gather on every part of the tree: roots, stem, bark, branches, leaves, buds, flowers, fruits. He records all the exudations and essential oils, the qualities of the timber, any other economic use. He gives the distribution of each species, and every figure of a part of a plant has attached to it the locality in which it was obtained. He cultivated seedlings by the thousand in order to trace the changes in growth of the foliage. And all his illustrations were drawn by his devoted and skilled and most careful artist, Miss Margaret Flockton. Little indeed could escape the keen eyes of Maiden and his trained artist.

The Monograph will certainly stand as a magnificent life work. But it may be doubted if the "Forest Flora of New South Wales" does not equal it in amount of research and in permanent value. This is another great quarto publication, illustrated in the same ample fashion by the same pencil. He began it in 1904 and continued to issue Parts until his death. In all there are 77 Parts bound up into eight volumes.

All the conspicuous trees and shrubs of the subtropical and the temperate Forests of the State are delineated at length.

Maiden was emphatically a taxonomist. He realized that the first study of our plants must be in the determination of what plants exactly we have. He himself worked at the Phanerogams and at all Families. And he was zealous in promulgating the information he acquired.

He was assiduous in the collection of Cryptogams for the Herbarium but did not himself work on these groups. He gained the aid of specialists. Thus the Ferns of the Herbarium were classified by Rev. W. W. Watts and later by T. Whitelegge; the Mosses and Lichens by W. Forsyth and E. Cheel; the Fungi by Dr. Cleland and E. Cheel; the Algae by A. H. S. Lucas.

In conjunction with W. S. Campbell from 1895 to 1898 he brought out "The Flowering Plants and Ferns of New South Wales." "A Manual of the Grasses of New South Wales" appeared in 1898, an octavo volume of 199 pages; a "Guide to the Botanic Gardens", 108 pages, in 1903; "A Census of New South Wales Plants" with Ernst Betche in 1916; Forestry Handbook, in two parts, 1917; "The Weeds of New South Wales" in 1920.

He was ever interested in the life and labours of his predecessors, and anxious that their part in botanical history should be duly recognized. He greatly

revered Sir Joseph Banks, whom he termed the Father of Australia, and searched out in England details of his life and correspondence. He incorporated these in his "Life of Sir Joseph Banks". This biography is esteemed a classic.

In the Journal of the Royal Society of New South Wales he published long accounts of the earlier botanists, English and French, who worked on Australian plants. These are illustrated by portraits of these old pioneers, portraits which he had been at great pains to secure. He published records, too, of early botanists who had laboured in those colonies, in the scientific journals of Victoria, Tasmania and Western Australia.

He had accumulated detailed information on the early history of the Sydney Botanic Gardens, and left his manuscript with Mr. R. H. Cambage, with a view to later publication. Mr. Cambage's death unfortunately prevented this publication by him, but it is to be hoped that it will not be lost sight of. Maiden also prepared an Early History of the Royal Society of New South Wales and wrote historical articles in the Journal of the Historical Society.

When Maiden had an object in view which he thought to be of great importance, he laid his plans with careful foresight, and then pursued his course in confident determination, turning neither to the right nor the left, but keeping straight on in face of all difficulties and all opposition, until he had achieved the end in view. A good instance of this character is seen in his study of the prickly pear, which had taken front rank among the pest weeds of the Eastern States. He set apart one of the best sites in the Botanic Gardens for the purpose, and planted in it many species, and watched their growth and behaviour. From 1911 to 1917 fifteen articles were published, beautifully illustrated with coloured plates. He deliberately placed the experimental plot in the Gardens, in order that it might be readily accessible to him, and that he might reduce to a minimum the chance of the plants spreading into the country. And he kept this batch of monsters growing on in the Gardens, in spite of daily protests and gibes, until his retirement. He felt that the utilitarian took precedence of the ornamental. It was typical of the man.

Of his married life this is not the place to speak at large. He was fortunate in his wife and four daughters, who made his home life happy, and who cared for him in his later years of suffering. The one evil stroke of fortune was inflicted when his only son, a promising and vigorous young man, was lost at sea, and neither he nor Mrs. Maiden ever quite recovered from the shock. It was a cruel blow, but he carried on with his relentless energy and, though crippled, continued to do two men's work.

He died on November 16th, 1925, at his home in Turrumurra. To quote Mr. R. H. Cambage, the President of the Australasian Association for the Advancement of Science, "Maiden ranks among the half-dozen leading pioneering botanists, and was for many years regarded as the doyen of Australian botanists. He served as an inspiration to very many science students, probably many more than ever will be known; and as some evidence of the affection and esteem in which he was held by his colleagues in Science, he was, in 1916, presented with his portrait in oils." This is now appropriately shown on one of the walls of his Herbarium. A Pavilion has been erected to his memory in the Botanic Gardens where he held sway for so many years, raised by the Government and by the contributions of his friends and admirers. He will not be forgotten. His work lives after him.

A.H.S.L.

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In addition he contributed numberless articles to the Agricultural Gazette of New South Wales, and furnished many reports to his own Government and to those of other States and New Caledonia.

THE ORIGIN OF ENDEMISM IN THE ANGIOSPERM FLORA
OF AUSTRALIA.*

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(Communicated by Dr. J. McLuckie.)

(Plates x-xi.)

[Read 30th July, 1930.]

The large Angiosperm Flora of the island continent of Australia offers an exceptionally favourable field for the investigation of Plant Evolution. It is a flora that has never been devastated by ice and one that has been isolated from other floras for a long period of geological time. Its evolution has not been checked by the action of glaciation, nor has it been seriously affected by the constant invasion of types from beyond its borders. Evolving under such exceptional conditions, it manifests many peculiar and extraordinary features that make it unique and one of the most interesting floras inhabiting the earth.

Among the many unusual features it presents, there are three that are quite obvious and conspicuous and which impart to it a characteristic facies, namely:—

1. *The predominance of the single genus Eucalyptus*, with its three hundred odd species spread very widely over the continent and constituting by far the most conspicuous element in the flora. The Myrtaceae thus bulk very largely as its main constituent. The Leguminosae, although including many more species than the Myrtaceae, and among them especially the important genus *Acacia*, also constitute a very conspicuous and important element, but neither as individuals nor as communities do they bear comparison with the Myrtaceae. The highly xerophytic family Proteaceae is also a very important and conspicuous feature, but takes only third place in predominance. It is the Myrtaceae with its main genus *Eucalyptus*, that gives character to the entire flora. No other continental flora is so greatly dominated by a single genus.

2. *The striking and varied xerophily of the flora*, of which the greater proportion consists of perennials whose foliage is ever-green. The texture of the foliage, especially in the very extensive regions of little rainfall, is remarkable. With high cutinization, sunken stomata, reduced leaf surfaces, or with phyllodes and phylloclades in certain forms taking on the work of photosynthesis, it displays rather striking devices for conserving water and for retarding transpiration. The Myrtaceae, Leguminosae, Proteaceae, Compositae, Orchidaceae, Epacridaceae, Rutaceae, Casuarineae, and many other families furnish innumerable examples. The great majority of such special adaptations, however, are to be found among the endemic types.

* At the time of his death, Professor Lawson left behind a draft of the manuscript, which has been prepared by me for publication. The meaning of the text has not been altered, although it has been considerably condensed to secure conciseness.—J. McLUCKIE.

3. *The presence of so many endemic types.* Among the Myrtaceae, Leguminosae, Proteaceae, Orchidaceae, Epacridaceae, Rutaceae, Goodeniaceae, Casuarineae, and other families there are many genera and species that are limited geographically to this southern continent. With such extraordinary genera as *Eucalyptus*, *Angophora*, *Tristania*, *Syncarpia*, *Backhousia*, *Callistemon*, *Melaleuca*, *Leptospermum*, *Darwinia*, *Pultenaea*, *Gompholobium*, *Bossiaea*, *Acacia*, *Grevillea*, *Hakea*, *Banksia*, *Lambertia*, *Telopea*, *Stenocarpus*, *Xylomelum*, *Petrophila*, *Isopogon*, *Persoonia*, *Epacris*, *Styphelia*, *Sprengelia*, *Boronia*, *Correa*, *Crowea*, *Eriostemon*, *Goodenia*, *Dampiera*, *Casuarina*, *Doryanthes*, *Xanthorrhoea* and other important genera, as well as many species of non-endemic genera limited in their geographical distribution to Australia, the vegetation has a distinct physiognomy and an individuality that sharply contrasts it with all other floras. Seventy per cent. of its species and thirty per cent. of its genera are endemic. Considering the great area of the continent, this high percentage is very remarkable; in Western Australia, where eighty-five per cent. of the species are endemic, we find the highest rate of endemism in any known flora.

From this brief account it is quite clear that endemism is one of the three important features of the Australian Angiosperm Flora. The predominant types of the Myrtaceae, such as *Eucalyptus*, many Leguminosae, the main genera and species of the Proteaceae, are essentially endemic. Practically all of the highly specialized adaptations to xerophytic conditions are characteristic of endemic types.

It seems to me, therefore, that a sound and logical interpretation of this Flora involves the consideration of the origin of its Endemism, and any light thrown upon this problem would clear the way for an understanding of the main factors concerned in the evolution of the Angiosperms, not only of this large continent, but also of other Floras.

As endemism is an important feature of the vegetation of all continents and the majority of islands of the earth, it becomes a subject of profound interest to botanists engaged in the investigation of evolution, especially of the most recent expressions of Plant Life, the Angiosperms, and has attracted the attention of investigators for many years. The important researches of Bentham, De Vries, Schimper, Lotsy, Willis, Guppy, Taylor, Bews, and others, have revealed many interesting and valuable facts which have resulted in placing Endemism among the fundamental problems of organic evolution. The theoretical interpretations of the facts, however, especially those of De Vries, Willis and other followers of that school of thought, have led to controversy and still require careful and critical scrutiny from every possible angle.

The new school of geneticists, founded and developed by such workers as Rosenberg, Bateson, Jeffrey, Lotsy and others, has established a very sound criterion for the identification of hybrids. The credit for discovering this most important and useful criterion belongs to Rosenberg (1909b) who, in his classical investigation of the cytology of a *Drosera* hybrid, pointed out the great significance of the abnormal mitoses in the reduction division in microsporogenesis. In *Drosera ovata*, which is a recognized hybrid between *Drosera longifolia* and *Drosera rotundifolia*, he discovered certain remarkable features of the reduction mitosis which have proved to be of fundamental importance, namely, that in this mitosis of the pollen-mother-cell there were ten chromosomes in *Drosera rotundifolia* and twenty chromosomes in *Drosera longifolia*, the two parents of the

hybrid, that in the hybrid spindle of the corresponding mitosis there are ten bivalent and ten univalent chromosomes. Rosenberg's interpretation of the reduction mitosis of the hybrid is that the ten bivalent chromosomes are derived from both parents, and the ten univalent chromosomes are derived from one parent only, namely, *D. longifolia*. These ten supernumerary univalent chromosomes do not arrange themselves regularly at the equator of the spindle, but lag behind the bivalent chromosomes and give an abnormal appearance to the spindle. As a result of this, a number of small abnormal nuclei are produced which give rise eventually to a number of small abortive microspores in addition to the normal pollen grains. This abnormal condition of the pollen, produced in this manner, has thus provided a very sound criterion for the identification of hybrids.

This important character of the pollen has been recorded by Rosenberg himself in the hybrid species of *Hieracium* and by Taekholm in his investigation of the genus *Rosa* (1920, 1922). The latter investigation shows that, while the normal number of chromosomes here is seven, in the different Roses examined there may be different multiples of this number present, and in such polyploid types there is a marked tendency to sterility and variability. Moreover, they show abortive pollen with its preceding meiotic peculiarities, such as the presence of both bivalent and univalent chromosomes; also the lagging on the spindle of the latter as well as the supernumerary nuclei which Rosenberg established as characteristic of hybrids. Similar results have been obtained in the study of Roses by Blackburn (1921, 1924) and others. But the most recent and convincing results in this important field of enquiry are those furnished by Jeffrey (1914-1925) and his pupils. Jeffrey's investigations cover a wide field of types and they have gone far towards removing any doubts that may have existed as to the soundness of Rosenberg's criterion. The investigations of his pupils have materially extended the field of enquiry and have added greatly to the now rapidly accumulating convincing evidence. All of these results are in harmony with Lotsy's view that the hybrid origin of mutations and variations is of general occurrence in nature.

In view of these important recent researches the writer for some considerable time has been engaged in an investigation of the possible extent of the hybrid origin of Australian Angiosperms, and more especially of the endemic types. The results obtained have been quite astonishing as revealed in the microsporogenesis of endemic types.

In the present paper it is intended to confine inquiries to one aspect of the subject, namely, the possible hybrid origin of endemic types, which has received little attention from other investigators.

THE PROTEACEAE. Plate x.

The protean nature of this tribe of Angiosperms was recognized when the natural order was first established by De Jussieu who gave it the very appropriate appellation it bears. Among the many genera included in it, such as *Grevillea*, *Hakea*, *Dryandra*, *Banksia*, *Lambertia*, *Xylomelum*, *Isopogon*, *Lomatia*, *Petrophila*, and *Persoonia*, there exists a very wide range of habit, foliage, inflorescence, flower and fructification. To a less degree, there is a similar wide range among the species of the various genera. Of the 200 species of *Grevillea*, for instance, there is the greatest possible range of form and habit—from the trailing prostrate shrub, *G. laurifolia*, to the large tree, *G. robusta*. Of the Hakeas, Banksias, Persoonias, and other genera, a similar protean feature is manifest. Even among the

individuals of the species of these larger genera a marked variation which amounts to inconstancy is frequently met with.

In considering such a widely divergent expression of form and habit the question of their origin naturally arises. To one who has studied such variations in the field for several years, it is impossible to be reconciled to the idea that they originated as infinitesimal variations that had been developed by natural selection.

These widely divergent expressions of habit, morphological adaptation, and variability, are associated with another very important characteristic feature of the family, namely, the very high rate of infertility of the seed compared with the great profusion of flowers per individual. A typical example of this may be observed in *Banksia serrata*. On a mature individual of this species many large cone-shaped inflorescences are produced, each of which bears between three hundred and five hundred flowers; but the number of seed-bearing follicles maturing from each inflorescence is notoriously small. In many instances no fruits whatever develop, while in others six to ten, or perhaps in exceptional cases twenty, may mature from a single inflorescence. It is safe to state that not ten per cent. of the flowers produce fertile seed, a statement which is equally true for the various species of *Grevillea*, *Hakea*, *Lambertia*, *Petrophila*, *Isopogon*, *Persoonia*, *Xylometum*, *Telopea* and other genera.

This very marked partial sterility of the flowers, compared with the potential seed-output associated with the notable variations in the foliage and other morphological features, has led the writer to the conclusion that such types are of hybrid origin. After many years of study of the Proteaceae in the field, I believe that such a conclusion has ceased to be tentative, but I realize that, resting solely upon morphological variability and partial sterility of the flowers, this would invite criticism from those who have not had the opportunity of studying these remarkable endemic types for an extended period in their natural soil and climate.

Table Showing Sterility of Pollen of the Proteaceae.

Type.	Percentage of Sterile Pollen.	Remarks.
<i>Grevillea robusta</i> Cunn.	90	The Grevilleas have a large number of abortive seeds, and the sterility of pollen ranges from 90% to 50% in types studied. The sterile grains are variable in size and shape and are devoid of protoplasm.
<i>G. oleoides</i> Sieb.	80	
<i>G. asplenifolia</i> R. Br.	60	
<i>G. lavandulacea</i> Schlecht.	60	
<i>G. buxifolia</i> R. Br.	60	
<i>G. punicea</i> , R. Br.	50	
<i>Banksia integrifolia</i> Linn.	75	In the Banksias each inflorescence bears between 300 and 500 flowers, of which about 10% set seed. This low seed production is associated with pollen sterility ranging from 30% to 75%.
<i>B. marginata</i> Cav.	30	
<i>B. spinulosa</i> Sm.	30	
<i>Dryandra floribunda</i> R. Br.	65	A genus with about 50 species endemic to Western Australia. Moderate seed fertility and fair amount of variation. Abortive pollen grains small, malformed, abundant.

Table Showing Sterility of Pollen of the Proteaceae.—Continued.

Type.	Percentage of Sterile Pollen.	Remarks.
<i>Hakea eriantha</i> R. Br.	65	One hundred species in genus which is endemic. Small percentage of flowers which set seed. Pollen of second species is highly fertile.
<i>H. kippistiana</i> Meissn.	25	
<i>Lomatia silaifolia</i> R. Br.	70	Most species of this genus are endemic, variable in habit and foliage; flowers abundant, fruits and seeds per inflorescence few. High pollen sterility.
<i>L. longifolia</i> R. Br.	70	
<i>Lambertia formosa</i> Sm.	50	Small endemic genus of eight species, one in New South Wales, seven in Western Australia. Few fertile seeds in proportion to flowers. Fairly sterile pollen.
<i>Stenocarpus sinuatus</i> R. Br.	95	Chiefly found in Eastern Australia, but extends to New Caledonia. Large numbers of wheel-like umbels of flowers develop, but low percentage set seed. Extremely sterile pollen.
<i>S. salignus</i> R. Br.	95	
<i>Telopea speciosissima</i> R. Br.	70	Small endemic genus with 30 species; marked variation of foliage, about 200 flowers per raceme; few follicles mature; less than 10% of flowers develop follicles. High sterility of pollen.
<i>Xylomelum pyriforme</i> Sm.	85	High sterility of pollen. Small endemic genus of four species. Two to three follicles per inflorescence of numerous flowers.
<i>Petrophila pulchella</i> R. Br.	75	Endemic genus of 35 species, mostly confined to Western Australia. Foliage very variable. Flowers abundant, few mature fruits and seeds. Pollen highly sterile.
<i>Isopogon anethifolius</i> R. Br.	50	Endemic genus of 30 species, leaves markedly variable. Flowers abundant in compact cone-like inflorescences and about 10% produce fruits. Pollen shows high degree of sterility.
<i>I. anemonifolius</i> R. Br.	85	
<i>Persoonia myrtilloides</i> Sieb.	35	Anomalous protean genus of 60 species, confined to Australia, excepting one species in New Zealand. Great variation in habit. Less than 20% flowers set seed. Fairly fertile pollen.

An investigation of the precise cause of that most important and characteristic feature of the types concerned, the markedly low output of fertile seeds, seems to the writer to provide the necessary additional support to his contention.

The accompanying table gives succinctly the results of studies of the mature pollen of the more important species of the Proteaceae.

THE MYRTACEAE. Plate xi.

As the introductory remarks to the Proteaceae, having a general bearing on the subject of hybridization, apply equally well to the Myrtaceae, a repetition of them here is unnecessary. It is well to emphasize, however, that among the genera of this Natural Order, forty-five are found in Australia and the majority of these are essentially endemic. Species of such important genera as *Eucalyptus*, *Angophora*, *Tristania*, *Syncarpia*, *Callistemon*, *Melaleuca*, *Kunzea*, *Leptospermum*, *Baeckea*, *Darwinia*, and others, constitute by far the predominant expressions of endemism in the Australian vegetation.

The possible rôle that hybridization plays in the evolution of the Myrtaceae, must therefore be carefully considered. In this connection, I propose to call attention to certain hybrid characteristics which are manifest in the pollen of several of these genera.

The accompanying table shows the percentage sterility of the pollen of important representatives of the Myrtaceae.

Table Showing Sterility of Pollen of the Myrtaceae.

Type.	Percentage of Sterile Pollen.	Remarks.
<i>Eucalyptus saligna</i> Sm.	85	Most important genus in Australian flora, to which it is practically confined.
<i>E. crebra</i> F.v.M.	85	
<i>E. globulus</i> Labill.	85	Systematists have found many difficulties in establishing sound criteria for classification and identification of species, as many closely related species occur.
<i>E. hemiphloia</i> F.v.M.	80	
<i>E. tereticornis</i> Sm.	75	Many species show marked tendency to vary in habit, foliage and fructification. Colour variation is apparent in flowers. Comparatively few flowers set seed, and the capsules contain many unfertile seeds. Bentham (1866) mentions this character, as well as the variability in the number of carpels forming the ovary in the same species.
<i>E. eugenioides</i> Sieb.	65	
<i>E. peltata</i> Benth.	60	
<i>E. calophylla</i> R. Br.	60	
<i>E. stellulata</i> Sieb.	50	
<i>E. siderophloia</i> Benth.	50	
<i>E. haemastoma</i> Sm.	50	
<i>E. piperita</i> Sm.	50	
<i>E. Flocktonae</i> Maiden	50	
<i>E. acmenioides</i> Schau.	45	
<i>E. corymbosa</i> Sm.	40	"The abortive seeds are generally numerous in the capsules and variously shaped, the several seeds of the same specimen often differing more from each other than the corresponding ones of different species."
<i>E. santalifolia</i> F.v.M.	35	
<i>E. pilularis</i> Sm.	35	

This infertility of the seeds and their abortive abnormalities are characteristic more or less of all species and, associated with various degrees of pollen sterility, suggest natural hybridization.

The percentage of sterility of pollen ranges from 35 to 85 in the species examined.

Table Showing Sterility of Pollen of the *Myrtaceae*.—Continued.

Type.	Percentage of Sterile Pollen.	Remarks.
<i>Angophora lanceolata</i> Cav.	65	Five species in genus, confined to Eastern Australia. Small percentage of flowers develop fruits. Many abortive seeds in capsules.
<i>A. cordifolia</i> Cav.	45	
<i>Syncarpia laurifolia</i>	30	Monotypic genus confined to Eastern Australia. Many abortive pollen grains.
<i>Tristania laurina</i> R. Br.	80	Small genus extending into New Caledonia and Malaya. Five endemic species. Capsules contain many sterile seeds; pollen very sterile, often adhering in groups.
<i>T. confertifolia</i> R. Br.	80	
<i>Callistemon linearis</i> DC.	95	Genus with about 18 species showing variability in colour of flowers, habit and foliage. Few capsules mature compared with flowers produced; many sterile seeds present. Pollen sterility ranges from 35% to 95%.
<i>C. punifolius</i> DC.	80	
<i>C. lanceolatus</i> DC.	30	
<i>Melaleuca nodosa</i> Sm.	75	Genus with 100 species, probably related to <i>Callistemon</i> . Varied in habit, foliage and colour of flowers. Capsules comparatively few in number, many abortive seeds present. Sterile pollen variable in size, some attaining size of fertile grains.
<i>Leptospermum stellatum</i> Cav. . .	80	Genus with 20 species, of which 18 are endemic and well distributed in Eastern Australia. Sometimes striking variations in colour and foliage. Several to many abortive seeds per capsule. Highly sterile pollen.
<i>Backhousia myrtifolia</i> Hook. & Harv.	70	Endemic genus of four species; many seeds abortive. Sterile pollen of small size and peculiar shapes.

CONCLUSION.

It is quite probable that within the Flora of Australia there are residuals of genera and species that, at one time, enjoyed a much wider range of geographical distribution. One would naturally expect to find examples of these in groups of such great antiquity as the Pteridophytes, Conifers and Cycads. Residuals, originating in this manner, thus become peculiar to this continent, and are, in the generally accepted definition of the term, endemic. Among the Angiosperms, however, we have no record of this kind of endemic. If such exist, their number is so small as to be negligible in comparison with the numerous genera and many hundreds of species whose peculiarity to this region is due to their having originated here. I have, therefore, not considered "residual endemics" as coming within the scope of the present enquiry.

The exceptionally large proportion of endemics present in the Australian Angiosperm Flora, may be rationally accounted for on the grounds: (1) that its evolution has not been interrupted by serious climatic changes, such as periodical glaciation, and (2) that it has not been influenced by the constant invasion from other floras, owing to its isolation for a long period of geological time. The Angiosperm life, evolving under these conditions, offers an exceptionally favourable field for the investigation of the origin of species; and there seems no reason whatever for assuming any essential difference in the origin of non-endemic and endemic species.

The hypothesis of the origin of species by infinitesimal variations developed by natural selection, is no longer entertained by leaders of evolutionary thought. As an alternative to this De Vries' Theory of the origin of species by mutation has been accepted and approved by many botanists and zoologists. De Vries founded his theory essentially upon the behaviour of cultures of *Oenothera lamarckiana*. He observed that from the progeny grown from the seed of this plant, there were several that showed remarkable variations from the parent type. As some of these bred true to type, he called them mutants and regarded them as initial species. He observed, however, that among these aberrant forms, or mutants, some were more or less sterile. This spontaneous appearance of mutations, observed by De Vries, constitutes the main support of his Mutation Theory.

The recent school of geneticists, however (including Rosenberg, Jeffrey, Bateson, Lotsy and many others), has demonstrated that, owing to the disturbance of the germ-plasm, represented in the chromosomes, variations and mutations are characteristic of hybrids. It has also been demonstrated, on very reasonable grounds, cytological and otherwise, that *Oenothera lamarckiana* and other species of this genus, are undoubtedly of hybrid origin. As this conclusion has been accepted by the majority of the leading geneticists, the De Vriesian hypothesis of the origin of species by unaccountable spontaneous mutations has been deprived of the foundation upon which it has rested.

On the zoological side, the Mutation Theory of De Vries has received enthusiastic support in America, by a school founded by Professor Morgan. The main foundation of this school of mutationists was laid upon the apparently spontaneous and rather remarkable mutations appearing in the dipterous insect, *Drosophila melanogaster*. But here again, the remarkable variations observed in this insect may be accounted for on the basis of hybridization. In his recent work on the cytology of the spermatogenesis of this insect, Jeffrey (1925) has revealed new and important facts which prove, beyond any reasonable doubt, that *Drosophila melanogaster* is a hybrid.

In view of the light of these recent genetic researches, I am obliged to interpret the characteristic features of the Proteaceae and Myrtaceae, especially those observed in sporogenesis and recorded in the condition of the pollen, as proof of their hybrid origin. As the types whose pollen has been described in the present paper cover such a wide range of genera and species of both these large families, which represent the predominant portion of the endemic Flora of Australia, it seems a reasonable hypothesis that hybridization has been of no uncommon occurrence in the evolution of these two great tribes. I am quite convinced that hybridization occurs whenever possible, and the possibilities, in these two tribes at least, are general.

Moreover, I am convinced that the great majority, if not all of the endemic species, of the Proteaceae and Myrtaceae examined by me are of hybrid origin. It seems safe to conclude that all such endemic species originated as hybrid mutations. The facts revealed in this investigation are in harmony with the general trend of progress made by contemporary geneticists in other fields of enquiry, and this progress is directed to the conclusion that hybridization, followed by Natural Selection, has been the main determining influence in the evolution of the Angiosperms. There is almost inexhaustible evidence of this in the Endemic Flora of Australia.

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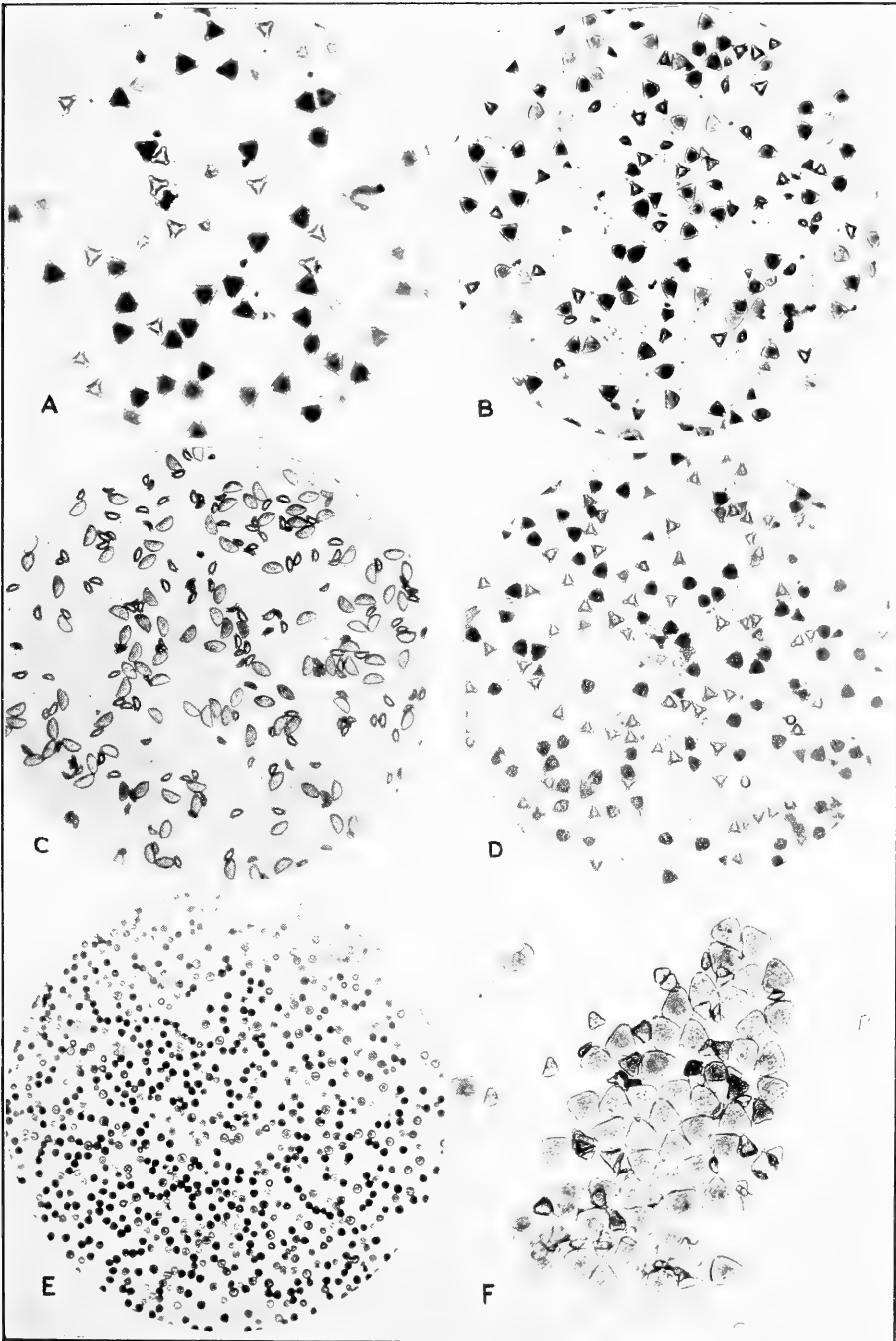
EXPLANATION OF PLATES X-XI.

Plate x.

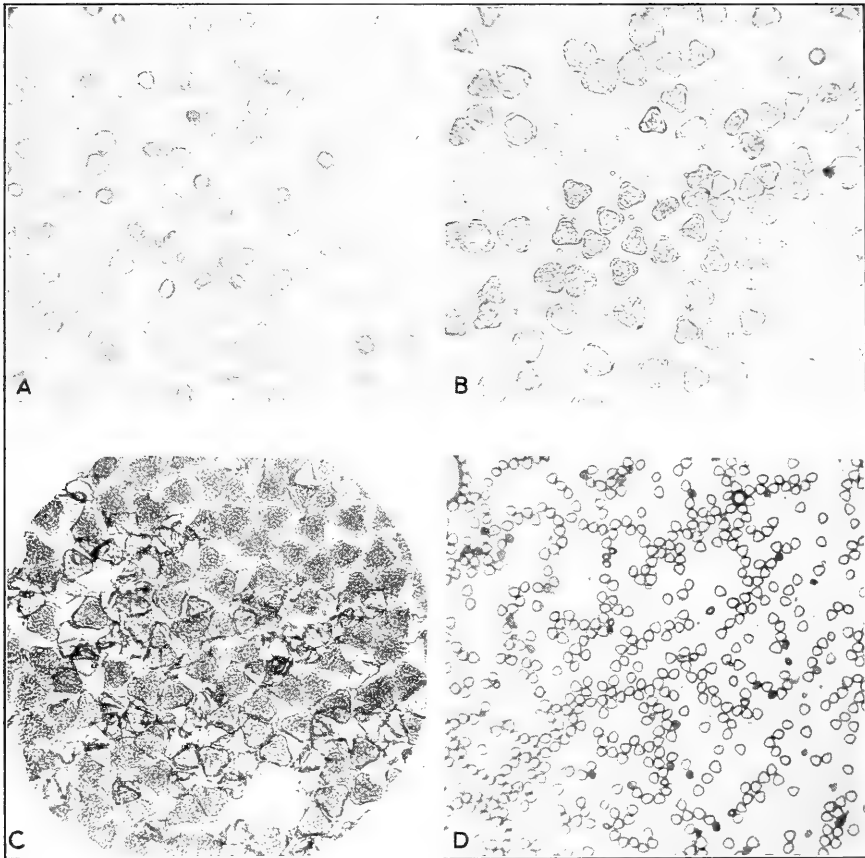
Mature pollen grains of Proteaceae; (A) *Grevillea buxifolia*, (B) *Grevillea robusta*, (C) *Dryandra floribunda*, (D) *Xylomelum pyriforme*, (E) *Isopogon anethifolius*, (F) *Telopea truncata*.

Plate xi.

Mature pollen grains of Myrtaceae: (A) *Eucalyptus hemiphloia*, (B) *Eucalyptus tereticornis*, (C) *Leptospermum lanigerum*, (D) *Syncarpia laurifolia*.



Mature pollen-grains of Proteaceae.



Mature pollen-grains of Myrtaceae.

GOULBURN—A VITAL POINT ON THE NEW SOUTH WALES HIGHLANDS.

By F. A. CRAFT, B.Sc., Linnean Macleay Fellow of the Society in Geography.

(Two Text-figures.)

[Read 27th August, 1930.]

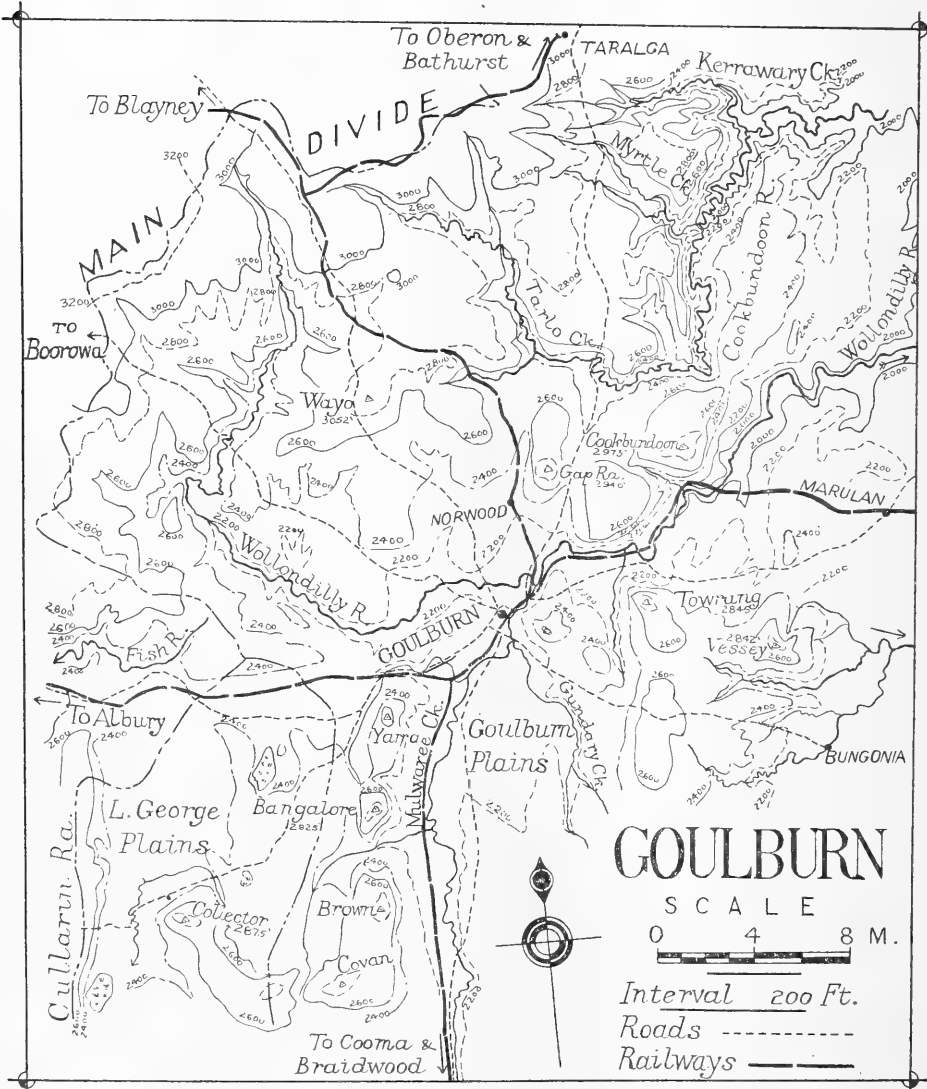
Introduction.—Goulburn, by reason of its geographical position and by virtue of the trade supremacy of Sydney, is the principal gateway to Eastern Riverina and one of the most important strategic centres in the State, commanding, as it does, the main route between Sydney and Melbourne. Discovered first by a white man (Meehan) in 1818, the site of Goulburn is a level plain beside the Wollondilly River and is remarkable as being the focus of numerous wide, easily-travelled valleys. The surrounding country varies in elevation from 2,000 to 3,000 feet above sea-level, but the upland slopes are gentle and the higher masses have been parted by wide, mature valleys. There is an easy slope westward forming the eastern part of Riverina, which includes the most productive sheep, wheat and cattle areas in New South Wales. South of the city rise the masses of the Kosciusko and associated tablelands, whilst to the north are slopes leading up to the Blue Mountain Plateau.

Position and Topography.—Between Moss Vale and Goulburn the main road and railway pass over a causeway of land somewhat similar to that used by the Western Railway at Mt. Victoria. To the north of this ridge are the deepening valleys and gorges of the Wollondilly and Cookbundoon Rivers; on the southern side is the profound canyon of the Shoalhaven, here 1,600 feet deep. Tributary valleys of these two systems head near Marulan (16 miles east-north-east of Goulburn), where the main road and railway are confined to a narrow watershed.

For thirty miles to the north and south of this point there are no roads of any importance across the highlands; the greater part of the canyon country is, indeed, almost impassable. Thus the main routes passing from Sydney to Goulburn are naturally defended in these directions by almost precipitous gorges which form a strategic line of great importance, limiting movement from the level tableland around Moss Vale to the downs country beyond Goulburn.

Around the city itself a varying topography is met with (Text-fig. 1). The plains on which Goulburn is situated are due to the erosion of an anticline in the prevailing Devonian strata, which strike approximately along the magnetic meridian and consist mainly of shales, slates and quartzites. Further south the softer rocks and weaker structures have been swept away to form the plains of Gundry and Mulwaree Creeks ("Goulburn Plains") and those of Lake George. The more resistant structures and rocks stand as conical monadnocks up to 800 feet above the plain. The glassy white quartzites which form or reinforce these residuals have been so greatly weathered through long ages that level valleys have been cut between them, giving easy routes for roads.

North of the Wollondilly near Goulburn a gently rising plain leads up to a higher tableland about the source of that river. Like the plains previously mentioned, this higher tableland forms part of the late Tertiary penepplain, but it is marked by extensive basalt flows. Its gentle southern warped slope has favoured the formation of mature valleys which offer no great obstacles to roads. On the other hand, its eastern edge consists of a steep bank parallel to the Cookbundoon River, being partly a fault-line scarp, but owing some of its height



Text-fig. 1.—Topography of the Goulburn district, County of Argyle. Note the convergence of valleys on Goulburn, and the position of that city as a focus of land routes.

to the resistant character of its rocks. This slope, combined with the steep gorge of the Cookbundoon, is a formidable natural barrier.

West of Goulburn the Bredalbane Plains lead to Fish River, the head of the Lachlan, an insignificant stream which has cut a gap through the Cullarin fault block, which is responsible for the existence of Lake George. The higher parts of this gap are used by the road and railway, but elsewhere the narrow horst provides a barrier which can, however, be readily enough surmounted, as erosion has yet had but little effect on it. This appears to be the most recently developed tectonic feature in the region.

Bredalbane Plains, divided into three sections, are shallow tectonic basins formed during the uplift and bending of the plateau surface. They have been filled with sediment and hill-wash which has almost obliterated the former lakes. Stormwater lying on the level expanse of the plains is readily evaporated.

Topographic features about Goulburn depend on the preservation of the Tertiary penplain or, where parts of this surface have been differentially uplifted, on the erosion of gentle, mature strike valleys down the warped slopes. Where the main streams have been affected by headward erosion following the uplift of the tableland, steep-sided gorges have been developed, forcing lines of communication to hold to the gentle upland country. This also applies to the Abercrombie River, 40 miles north-north-west of Goulburn.

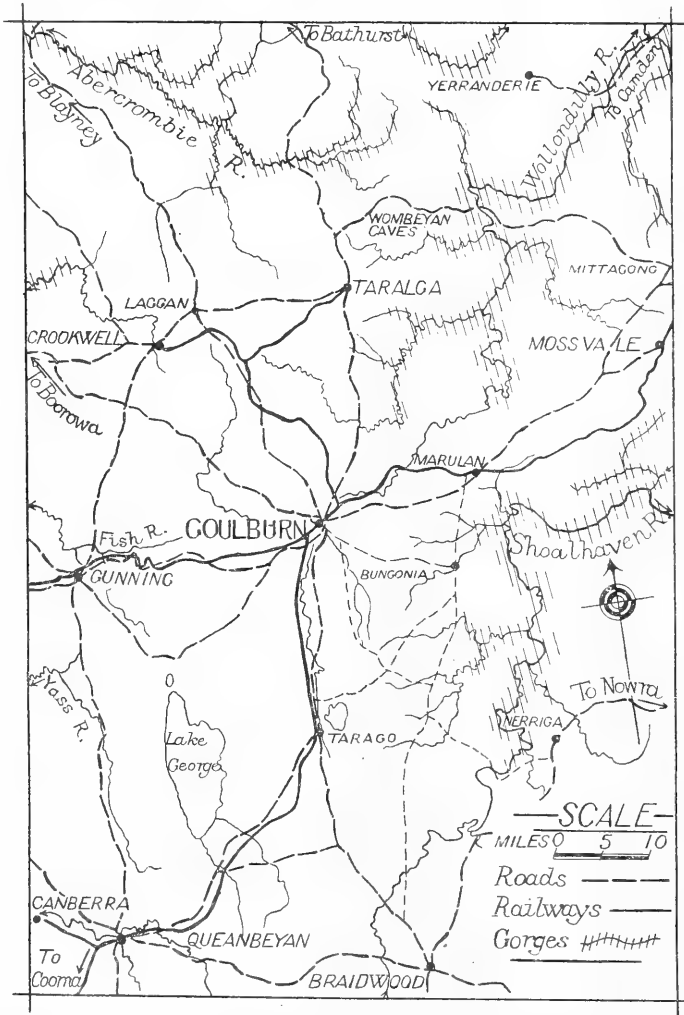
Communications (see Text-fig. 2).—The Blue Mountain Tableland, extending from the southern scarp of the Hunter River Valley to within 30 miles of Goulburn is, in general, very sparsely settled. A number of tourist resorts and coal-mining towns, including Katoomba and Lithgow, have grown up along the Great Western Railway, but elsewhere in this area there is only one large settlement, the silver-mining village of Yerranderie, near the Wollondilly River. We have, then, an almost uninhabited strip of tableland parallel to the coast with a length of 120 miles and a width varying from 60 miles in the north to 40 in the south. Owing to the infertile nature of its soil, which is derived largely from Triassic sandstones and partly from older metamorphic rocks, and to the steep canyons which intersect the surface, roads are not needed for purposes of settlement, nor are they practicable in most of this area at a reasonable cost.

Immediately to the west of this highland country, on the westward drainage of the upper Lachlan, Abercrombie and Macquarie Rivers, sparse settlement is possible. The land surface is still much dissected, especially by the powerful Abercrombie rising in the high tableland near Jenolan (4,200 feet), forty miles north of Goulburn. However, the raising of sheep and a few cattle is possible, and small crops of potatoes and oats are grown in isolated places. On the rich basalts of the Main Divide extending through Taralga and Crookwell, these crops are of more importance and cold-climate fruits are grown, but sheep-raising and some dairying are the main industries. Here there is more extensive settlement, requiring local means of communication.

Means of transport are provided by three main roads (Text-fig. 2), which extend north and north-west from Goulburn, in addition to branch railways to Crookwell and Taralga. Full advantage is taken of ancient (Tertiary) passes and of gentle valleys. The continuation of two of these roads to Bathurst, via Taralga and Laggan, involves the passage of the difficult Abercrombie gorges, but direct communication is provided with Bathurst, Blayney and Oberon and the Great Western Road and Railway. Another important road leads westward from

Goulburn to Boorowa in the wheat belt, after passing the early mature valley of the upper Wollondilly. The Great Southern Railway and Road give access to the Riverina, via Gunning and Yass, whilst roads and railways leading southward serve Canberra and the pastoral regions of the upper Shoalhaven and Snowy Rivers. These latter are the arteries for the whole of the Southern Tablelands of the State and take advantage of long, parallel meridional valleys, avoiding the high, barren ridges between the various rivers.

The sole eastward outlets from the upper Shoalhaven and Snowy are provided by rather steep roads leading from Braidwood, near that river, to the coast at Nowra, Bateman and Moruya. These are the only routes crossing the broken



Text-fig. 2.--The key position of Goulburn. Rugged topography limits communication to the east and north, whilst lesser dissection to the west and south favours the development of land routes.

coastal slopes in a length of 130 miles. Braidwood, controlling these and the level upper part of the Shoalhaven valley, resembles Goulburn, 47 miles to the north, but on a much smaller scale.

Conclusion.—The routes leading from Sydney to Melbourne, the Southern Tableland, the south-western slopes and the western slopes of part of the Blue Mountain Tableland diverge from Goulburn. They take advantage of favourable topography, which makes Goulburn the principal strategic centre in the south of New South Wales. A considerable fraction of the inland trade and transport of the State passes through the city, whose industrial and commercial importance is growing.

Reference.—For a more detailed description of the physiography of this district see—CRAFT, F. A., 1928.—The Physiography of the Wollondilly River Basin. *Proc. Linn. Soc. N.S.W.*, liii, Part 5, 618.

ON *GREVILLEA GAUDICHAUDII* R. BR., A SUPPOSED NATURAL
HYBRID BETWEEN *GREVILLEA LAURIFOLIA* SIEB.
AND *G. ACANTHIFOLIA* A.C.

PART I.—ANALYSIS OF THE HYBRID.

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(Plates xii-xv, and nineteen Text-figures.)

[Read 27th August, 1930.]

Historical.

Fletcher (1913) gave a short account of this natural hybrid and Fletcher and Musson (1927) amplified this account. A careful comparison of the hybrids with the putative parents was made, and the authors came to the conclusion that "the entire series known as *Grevillea Gaudichaudii* is a series of variable, naturally related forms explainable only as being hybrids between the two other species mentioned. That the two parent species are markedly contrasted in most of their morphological characters, in their habit of growth, etc." and that "*Grevillea Gaudichaudii* has no specific characters; being of mixed origin, the characters are inherited, being blends or mixtures of the parent-forms."

The occurrence of natural hybrids has attracted a great deal of attention within recent years. Cockayne, Allan, Simpson and Thomson have recorded about 290 groups of wild hybrids in the New Zealand flora, belonging to 42 families and 92 genera. The majority of these consist of polymorphic swarms, found abundantly in such genera as *Myrtus*, *Olearia*, *Celmisia*, *Nothofagus*, *Ranunculus*, etc. Interspecific hybrids are much more common than intergeneric hybrids.

The hybridizing species usually have the same growth-form although the New Zealand flora furnishes exceptions, e.g., the tree-form, *Plagianthus betulinus*, hybridizes with the bush-form, *Plagianthus divaricatus*, while the *Grevillea* hybrids dealt with here are the result of crossing of species with different growth forms, one being a prostrate shrub, the other a divaricating bushy form.

In *Nothofagus Cliffortioides* × *N. fusa* and in *Myrtus bullata* × *M. obcordata* the hybrid swarm shows every gradation from one species to another. Although many natural hybrids have been recorded, very few have been produced artificially, or have been studied intensively or cytologically.

The Problem.

In the present investigation the writer set out to place on record detailed observations on the *Grevillea* hybrids, to endeavour to produce them by artificial crossing and to investigate their cytological details, especially the character of the reduction spindle in the pollen-mother-cells.

The present communication gives a detailed analysis of the chief contrasting characters of the putative parents and demonstrates the relationships of the hybrid series to these parents. The coefficients of divergence of the hybrid forms from the two parents and from the midparent (hypothetical form in which the parental characters are perfectly blended) have been calculated and these coefficients have been plotted graphically about the midparent as a reference line. From the graphs of the two hybrid forms the degree of blending of the parental characters will be apparent, and it will be possible to compare these hybrids with others.

In regard to artificial production of the hybrids a considerable amount of work is in progress, and seedlings have been raised from the cross *Grevillea laurifolia* (female) and *G. acanthifolia* (male). Photograph 1 (Plate xii) shows two such seedlings, and it will readily be seen that these very closely resemble the H1 form analysed in this paper. The details of this experimental work will be published later.

The reduction spindles in the microspore-mother-cells have also been investigated and the typical irregular heterotypic spindle described by Rosenberg (1909) for the *Drosera longifolia* × *Drosera rotundifolia* hybrid, in which there is a lagging of unpaired chromosomes on the spindle, has been found. The cytological details of the hybrid spindle and of the parents will be published later.

ANALYSIS OF THE HYBRIDS IN RELATION TO THEIR DIVERGENCE FROM THE PARENTS.

The characters selected show distinct contrast in the two putative parent species.

Habit.

Grevillea laurifolia is a prostrate shrub, with a thick root-stock from which several long trailing branches develop. All branches are prostrate, flexible, and produce numerous short lateral branches bearing the leaves and large attractive spikes of red flowers. The main branches vary considerably in length, the mean length is 4.33 feet (30 measurements) while the number of branches per plant also varies, the mean for 30 counts being 7.25. The mean area occupied by a single plant is approximately 42.6 square feet. Photograph 2 (Plate xiii) shows part of a plant.

This species colonizes the dry sandstone habitat on the Blue Mountain Plateau, frequently growing beneath larger shrubs.

Grevillea acanthifolia is an erect compact shrub producing numerous branches from the thick root-stock. The mean number of main branches per plant is 4.33, while the mean length of the branches is 3.1 feet (the mean of 30 measurements).

In habitats near creeks or where there is soakage at the head of valleys in this locality, the height of some plants is sometimes as much as 7 to 8 feet, but in drier habitats this species does not grow so tall. The mean spread of this species is 14.23 square feet (10 measurements); it occurs in the same valley-heads as *G. laurifolia*, but while *G. acanthifolia* colonizes the lower slopes (where moist) and the valley floor, *G. laurifolia* invariably occupies the upper drier slopes. The flowering period lasts from September to March in both species; this fact and their frequent proximity provide the opportunity for natural hybridization. Photograph 3 (Plate xiii) shows part of a plant.

Grevillea Gaudichaudii, supposed hybrid between the putative parents *G. laurifolia* and *G. acanthifolia*, is represented by two distinct forms, which I

will refer to as H1 and H2. These forms have approximately the same frequency in this locality; H1 is represented by six individuals, and H2 by four individuals. H1 is a form about intermediate between the putative parents, approximating the midparent, while H2 is closer to *G. laurifolia* than *G. acanthifolia*; in other words, *laurifolia* appears prepotent in the general complex of the hybrid H2. The H1 form is typically prostrate in habit, with a tendency for the apices of the branches to become erect. The habit is definitely like that of the *laurifolia* parent, but the tendency to erect apices suggests the influence of *acanthifolia*. The mean number of branches per plant is approximately 3.5 (6 plants), while the mean length of each branch is 2.5 feet (20 measurements). Measurements were made from plants in open; branches of all forms are much longer when sheltered by taller shrubs. The mean area occupied by the whole plant is 18.0 square feet (6 plants). In general appearance this type is about midway between the two putative parents. The flowering period is slightly shorter than in the parents. Photograph 4 (Plate xiv) shows part of a plant.

The H2 form is also prostrate and approximates to the *laurifolia* parent very closely in general habit (and other characters which will be referred to later). It is a much more vigorous form than the H1 hybrid, and only close inspection will distinguish it from the *laurifolia* parent when they occur together. The mean length of the branches is 5.16 feet (measurements from plants in open; branches of all forms are much longer when sheltered by taller shrubs). The mean number of branches is 5, and the mean area 40 square feet. Photograph 5 (Plate xiv) shows part of a plant.

Table 1 shows the habit characters of the parents and of the hybrids, and the coefficients of divergence of the hybrids from the midparent and the parents.

TABLE 1.

Character.	<i>G. laurifolia</i> mean.	H1 mean.	H2 mean.	<i>G. acanthifolia</i> mean.	$\frac{M-H1}{l-a}$	$\frac{M-H2}{l-a}$
Branches per plant	7.25	3.5	5	4.33	+0.78	+0.27
Height above ground in feet . . .	0	0	0	3.1	—	—
Approximate area in square feet	42.6	18.0	40	14.23	+0.37	-0.41
Mean length of branches (feet) . .	4.33	2.5	5.16	3.1	+0.99	-1.18

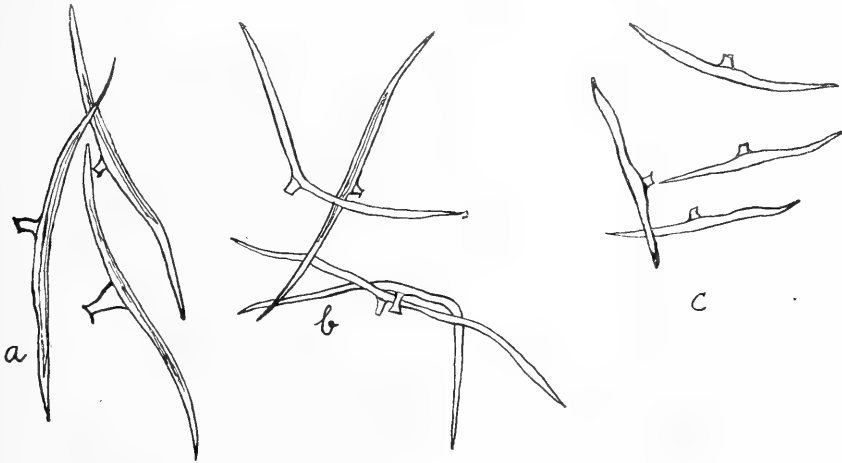
The last two columns give the coefficients of divergence of the hybrids from the midparent. The coefficient of divergence from the midparent, for the number of branches, of the H1 form (+ 0.78) is considerable and indicates that this type is much nearer to the *acanthifolia* parent than to the *laurifolia*. In the H2 form there is a closer approximation to the midparent, but the balance is shown in favour of the *acanthifolia* side. The *laurifolia* parent is obviously dominant in regard to the inheritance of the other characters referred to under habit, as the coefficients of divergence indicate.

Foliage.

The leaves of *G. laurifolia* are petiolate, entire, often with an apiculus (sometimes recurved), dark green on adaxial surface, whitish-tomentose on abaxial

surface. The size is variable, the greatest length is 111 mm., the greatest breadth 64 mm., the shortest length 35 mm., and the narrowest leaf 17 mm. across. The measurements give the greatest length and breadth. The length of the petiole varies between the limits 22 mm. and 4 mm.

The shape of the leaf varies, being lanceolate, broadly ovate, almost circular, or mucronate. The young leaves and shoot-apices are covered with a thick indumentum of white and ferruginous closely appressed hairs. The adaxial surface of old leaves becomes practically glabrous. The abaxial surface retains its covering of hairs. The venation is prominent, and there is a characteristic intra-marginal vein. In *acanthifolia* the leaves are considerably dissected, each segment being pungent-pointed. As in *laurifolia*, they vary in all dimensions, the mean length of the largest leaves is 50.8 mm., the mean breadth 40.6 mm., the mean length of the smallest adult leaves is 31.6 mm., and the mean breadth 22.2 mm. The number of lobes varies within wide limits (*vide* Photograph 6, Plate xv). There is no intra-marginal vein. The young apices and young leaves are covered with whitish hairs, but the adult leaves are glabrous. Text-figure 1 shows the type of foliar hairs for the parents and hybrids. The petiole is winged, the lowest segments of the lamina being decurrent with the edge of the petiole.



Text-fig. 1.—*a, b, c.* Foliar hairs of *laurifolia*, H2 and H1 respectively. Isolated hairs occur on the leaves of *acanthifolia*, very similar to those of the H1 forms. H2 has hairs approximating to those of *laurifolia*. In H1 there is a more or less perfect blending of the two parents. $\times 40$.

The H1 hybrid is represented by individuals, the leaves of which are pinna-sected; Photograph 7 (Plate xv) shows the degree of dissection of the leaf of one plant. The segments vary from 3 to 13 in number. Some of these may again be twice or thrice dissected. This latter character appears in some of the older basal leaves and seems to indicate the prepotency of the *acanthifolia* parent.

The hairy covering varies on different leaves, but all have appressed hairs on the abaxial surface. The adaxial surface is glabrous.

The H2 form shows a considerable range of leaf size and form, even in the one individual. The majority of the leaves are entire, but associated with them, and occurring in no definite sequence, are variously pinnasected leaves of the most variable shape and size. Photograph 8 (Plate xv) shows the range of dissection in leaves from a single plant, the number of segments varying from 2 to 5; a typical intramarginal vein is present in all leaves of this form. The proportion of entire to dissected leaves varies in different individuals, for example, as Fletcher and Musson (1927) have recorded, there are H2 individuals with a large majority of pinnasected leaves, and others with a smaller proportion of them.

The general texture, indumentum, colour and shape of leaf approximate to the *laurifolia* parent, and indicate its prepotency. The undivided leaves of the H2 form are usually longer and narrower than those of *laurifolia*.

Table 2 gives the means of the maximum length and maximum width of a number of the larger leaves of both parents and of the hybrid forms, and the length of the petioles. The divergence of the hybrids from the two putative parents and from the midparent is also shown.

TABLE 2.

Characters.	Plant.				Coefficients of Divergence.					
	<i>G.laurifolia</i>	H1	H2	<i>G.acanthifolia</i>	$\frac{l-H1}{l-a}$	$\frac{l-H2}{l-a}$	$\frac{M-H1}{l-a}$	$\frac{M-H2}{l-a}$	$\frac{a-H1}{l-a}$	$\frac{a-H2}{l-a}$
Length of leaf (mm.)	96	80.2	101.6	59.8	+0.44	-0.15	-0.07	-0.65	-0.56	-1.15
Width of leaf (mm.)	52	57	46.3	40.6	-0.44	+0.50	-0.94	+0	-1.44	-0.50
Ratio $\frac{W}{L}$ ($\times 1,000$) ..	542	712	456	679	+1.24	-0.63	+0.74	-1.13	+0.24	-1.62
Length of petiole (mm.)	14.2	8.4	9.8	9.8	+1.31	+1.00	+0.82	+0.50	+0.32	+0
Means of coefficients					+0.64	+0.18	+0.14	-0.32	-0.36	-0.82

From this table it is apparent that the absolute measurement of the leaf-width of the H1 form (57 mm.) is greater than that of either parent, while the leaf-width measurement of the H2 form (46.3 mm.) exactly coincides with the value for the midparent.

The absolute length of the leaf of the H2 form, 101.6 mm., is greater than that of either parent; as frequently happens in hybrids (Warren, 1929). In regard to the petiole, the absolute measurement of length (9.8 mm.) of the H2 form coincides with that of the *acanthifolia* parent, while the petiole of the H1 form is shorter than either parent, but nearer *acanthifolia*.

In the leaf-ratio, the H1 hybrid exceeds the ratio of either parent, but is only slightly greater than the ratio of the *acanthifolia* parent, while the ratio of the H2 form is less than either parent but is considerably nearer the *laurifolia* parent.

So far as the petiole is concerned, the prepotency of the *acanthifolia* parent is distinctly apparent in the tendency of the lowest segments of the lamina to become decurrent on the petiole and to produce the winged petiole of the parent in the H1 forms; and also in the mean of the absolute length.

If we consider the *mean* of the coefficients of divergence of the hybrids from the *laurifolia* parent, the midparent and the *acanthifolia* parent in Table 2, we find for the H1 form, +0.64, +0.14, -0.36, respectively when the sign is regarded, while for the H2 form the respective means are +0.18, -0.32, -0.82.

As the sign of the coefficient indicates the direction in which the individual diverges from the reference point and the mean of the coefficients with regard to the midparent "expresses the degree of inequality of balance of the sum total of the hereditary influences from the two parents" (Warren, 1929) it appears that the H1 form (+0.14) approximates more closely to the midparent than the H2 form (-0.32); this balance about the midparent being slightly weighted in favour of the *acanthifolia* parent in the former, and slightly more so in favour of the *laurifolia* parent in the latter.

There is also considerable inequality of balance about either parent in the H1 forms, but more so about the *laurifolia* parent (+0.64); in the H2 forms there is only slight inequality of balance about the *laurifolia* parent, but great inequality about the *acanthifolia* parent (-0.82).

As the mean of the coefficients gives the relative degree of general divergence of the hybrid from the parents when the sign is disregarded, we get for the H1 forms 0.86, 0.64 and 0.64, and for the H2 forms 0.57, 0.57, 0.82.

These means indicate that in the leaf characters under discussion the general divergence of the H1 form from *laurifolia* (0.86) is considerably greater than from *acanthifolia* (0.64) and from the midparent (0.65); that is, the *acanthifolia* parent is distinctly prepotent over *laurifolia*. In the H2 form the general divergence from the *acanthifolia* (0.82) is much greater than from the *laurifolia* parent, and therefore in the determination of its leaf characters the *laurifolia* parent is prepotent. In the H1 type the difference in the general divergence from the *acanthifolia* parent and the midparent is negligible; while in the H2 type the difference in the divergence from the *laurifolia* parent and the midparent is also negligible.

Very similar conclusions may be arrived at from the measurements of the smallest adult leaves of the plants.

Lobing of the Leaf.

As *laurifolia* has entire leaves, the presence of dissections of the lamina is a clear indication of the prepotency of the *acanthifolia* parent, but the number of lobes and their character vary, so that the H2 form clearly approaches the undivided *laurifolia* lamina, while the H1 form approaches the *acanthifolia* side.

In Table 3 the details of the lobing are indicated, and the coefficients of divergence of the hybrids from the parents and midparent calculated.

For the H1 hybrids the mean number of lobes is 7.53, for the H2 2.9, and for the *acanthifolia* parent 12.34; commonly there are 7 lobes in H1, 2 or 3 lobes in H2 and 11 lobes in *acanthifolia*. The coefficient of divergence of the H1 form from the *laurifolia* parent (+0.58) shows that there is considerable prepotency of the *acanthifolia* parent; the coefficient of divergence of the H2 form from the *laurifolia* parent is only +0.23, so that the potency of the *acanthifolia* parent is

approximately two and a half times less than in the H1 form. Moreover the coefficient of divergence of the H1 form from the midparent (+ 0.09) indicates a distinct balance round the midparent, while the coefficient of the H2 form (- 0.26) indicates considerable inequality of balance due to the hereditary effect of the *laurifolia* parent.

TABLE 3.

Plant.	Number of primary lobes per leaf.																Coefficients of divergence of hybrids.										
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	$\frac{l-H1}{l-a}$	$\frac{l-H2}{l-a}$	$\frac{M-H1}{l-a}$	$\frac{M-H2}{l-a}$	$\frac{a-H1}{l-a}$	$\frac{a-H2}{l-a}$	Means					
<i>G. laurifolia</i>	Leaves entire																										0
H1	1	1	2	4	25	4	10	1	1	1	1					+0.58		+0.09		-0.41		7.53					
H2	15	16	7	2													+0.23		-0.26		+0.76	2.90					
<i>G. acanthifolia</i>								4	7	3	5	3	3	1								12.34					

TABLE 4.

Characters.	Plant.				Coefficients of divergence of hybrids.					
	<i>G. laurifolia</i>	H1	H2	<i>G. acanthifolia</i>	$\frac{l-H1}{l-a}$	$\frac{l-H2}{l-a}$	$\frac{M-H1}{l-a}$	$\frac{M-H2}{l-a}$	$\frac{a-H1}{l-a}$	$\frac{a-H2}{l-a}$
Intramarginal vein	strongly developed	less strongly developed	strongly developed	Absent	--	--	--	--	--	--
Distance from margin (mm.)	2	0.7	1.5	0	+0.65	+0.25	+0.15	-0.25	-0.35	-0.75

Intramarginal Vein.

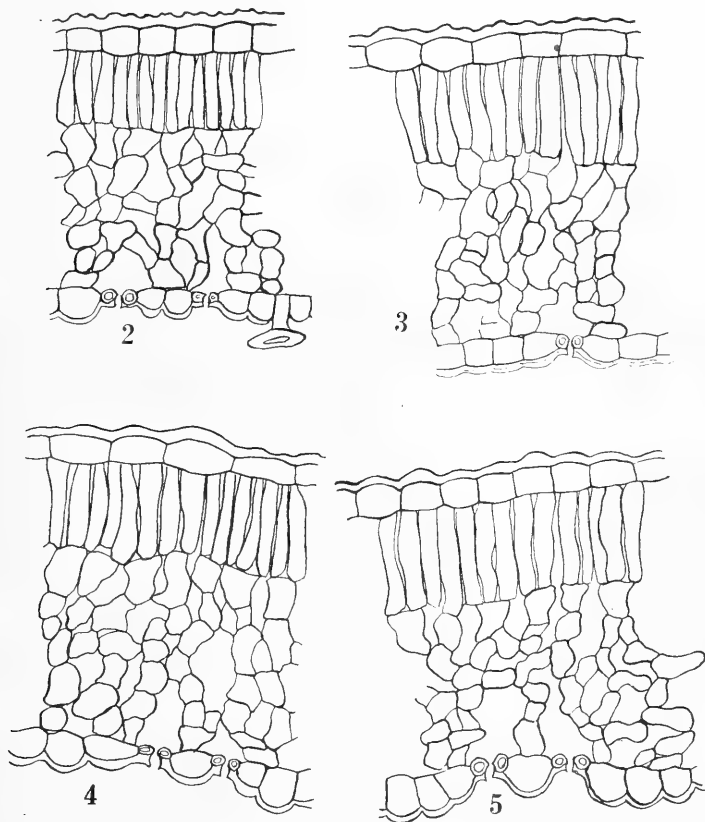
In *G. laurifolia* this vein is strongly defined, and at a mean distance of 2 mm. from the margin; in *G. acanthifolia* it is usually absent, although there is frequently a development of fibres where the margin rolls back towards the abaxial surface (thus simulating a vein in section). In both the H1 and H2 hybrids the vein is present, but is more strongly developed in the H2 forms. The mean distance from the margin in H2 is 1.5 mm., while in H1 it is 0.7 mm.

The prepotency of the *laurifolia* parent is clearly indicated in regard to the presence of this vein, but the weaker development in the H1 form which, from

previous evidence of leaf characters, is undoubtedly close to the midparent indicates the "inhibiting" effect of the *acanthifolia* factor.

The coefficient of divergence of the H1 form from the *laurifolia* parent (+ 0.65) indicates considerable deviation, but with regard to the midparent the H1 form shows considerable balance around this point. The H2 form shows less divergence from the *laurifolia* parent, and more from the midparent than is the case for the H1 forms.

Table 4 gives the coefficients of divergence of the H1 and H2 hybrids from the parents and the midparent in regard to the intramarginal vein development.



Text-figs. 2, 3, 4, 5.—Transverse sections of lamina of the two parents, *laurifolia* and *acanthifolia*, and of the H1 and H2 forms respectively. $\times 125$.

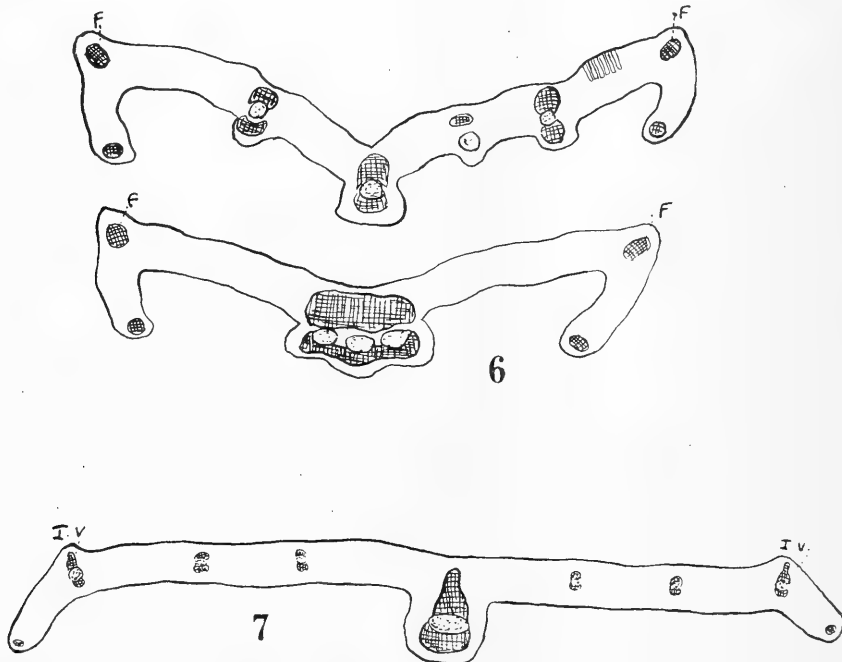
Thickness of Lamina.

Text-figures 2, 3, 4, 5 represent camera lucida drawings of transverse sections of the lamina of the two parents and of the H1 and H2 hybrids. The sections reveal small differences in thickness; but the H1 hybrid is slightly thicker than any of the others, i.e., thicker than either parent.

The *laurifolia* parent has strongly developed papillate epidermal cells on the abaxial surface. This is also strongly indicated in the H1 and H2 forms. The *acanthifolia* parent has no papillation of this epidermis.

The *acanthifolia* parent has a decidedly thicker palisade zone than the *laurifolia* parent and slightly thicker than the H1 and H2 hybrids; the H1 form approximates to the *acanthifolia* condition more nearly than the H2. Both hybrid forms have stalked hairs similar to those of the *laurifolia* parent (Text-fig. 1). All leaves are strongly cuticularized on the adaxial surface, but the tomentose abaxial surface of *laurifolia*, H1 and H2 are slightly less cuticularized than the glabrous *acanthifolia* leaf.

Text-figure 6 shows the general view of the section of the *acanthifolia* leaf; the recurved margin is plainly indicated, and the distribution of the vascular bundles and fibrous tissue. In H1 there is an occasional tendency to recurving of the leaf margin (Text-fig. 7).



Text-fig. 6.—Diagram of transverse section of leaf of *G. acanthifolia* showing the recurved margin and the mass of fibres (F) simulating the intra-marginal vein where leaf recurves. $\times 15$.

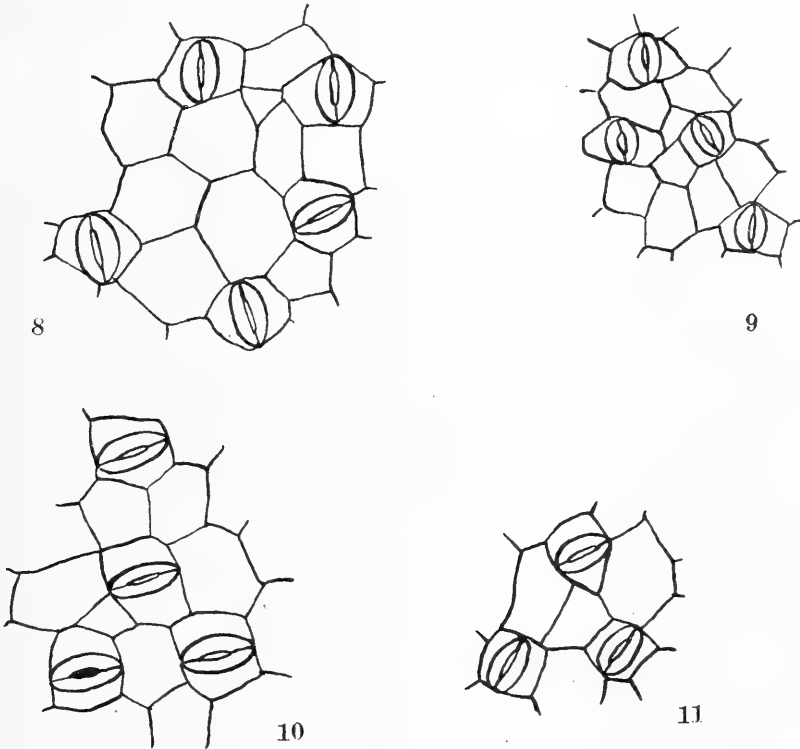
Text-fig. 7.—Diagram of transverse section of H1 lamina showing the intra-marginal vein (i.v.) and the slight tendency towards recurving of the leaf-margin. $\times 15$.

Stomata.

The mean number of stomata in the same field of the microscope for *laurifolia*, *acanthifolia*, H1 and H2 respectively is 46.3, 66, 49, 49.5. The large number in *acanthifolia*, compared with the other forms, is accompanied by a reduction in

size of the guard-cells. The width of the guard-cells of the forms is approximately the same. The longest guard-cells occur in the H1 form (310 μ), the shortest in *acanthifolia* (241 μ). In the *laurifolia* parent the mean length is 291 μ , while in the H2 form it is 267 μ .

Text-figures 8, 9, 10, 11 show the relative size of the stomata of the parents and of the hybrids; and it is readily seen that the guard-cells of the H1 form are larger than in either parent. Each stoma opens into an air space beneath the abaxial epidermis. Text-figure 12 (*a, b, c, d*) shows camera lucida drawings of these air-spaces as seen in section of the abaxial surface.



Text-figs. 8, 9, 10, 11.—Drawings of the abaxial epidermis of *laurifolia*, *acanthifolia*, H1, and H2, showing the stomata. The stomata of the hybrids approximate to the *laurifolia* character rather than *acanthifolia*.
× 225.

The H2 hybrid (which is most like the *laurifolia* parent in habit and general morphology) behaves unexpectedly in the matter of the palisade. Although it grows close to the *laurifolia* parent (often intertwined with it), under precisely the same degree of illumination, it yet develops a much thicker palisade layer—a layer, in fact, which is slightly thicker than in the exposed *acanthifolia* parent. Moreover, the ratio of spongy to palisade mesophyll in the H1 form is higher than in the other three forms.

The intercellular space system (as revealed in sections parallel to abaxial surface) of the *acanthifolia* parent is distinctly smaller on the whole than in the other leaves, the H1 and H2 hybrids approximating to the *laurifolia* structure (Text-figure 12, *a, b, c, d*).

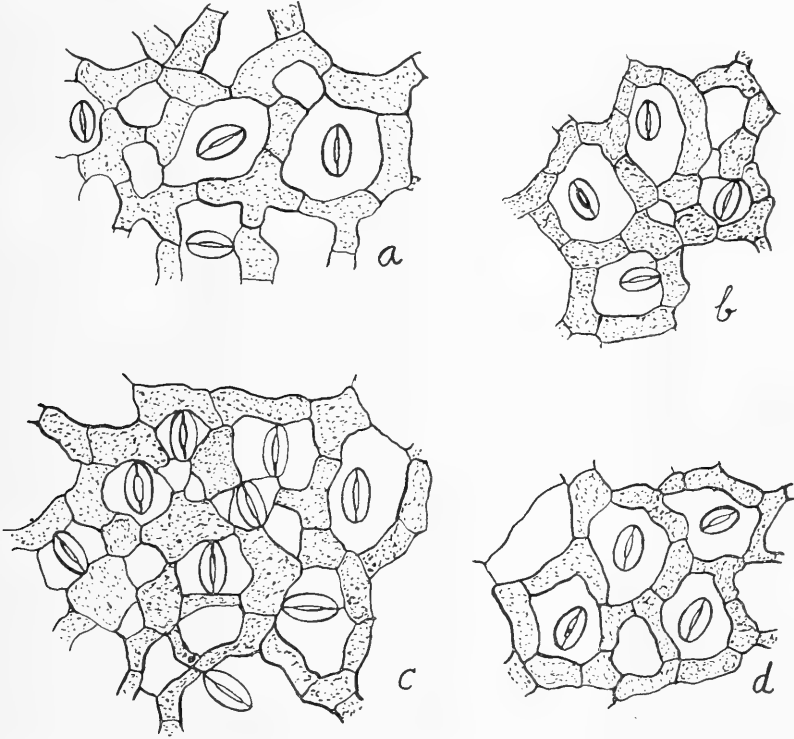
Table 5 gives the divergence of the hybrids from the parents and the mid-parent in relation to the chief histological characters of the leaf.

TABLE 5.

Leaf Character.	Plant.				Coefficients of Divergence.					
	<i>laurifolia</i>	H1	H2	<i>acanthifolia</i>	$\frac{l-H1}{l-a}$	$\frac{l-H2}{l-a}$	$\frac{M-H1}{l-a}$	$\frac{M-H2}{l-a}$	$\frac{a-H1}{l-a}$	$\frac{a-H2}{l-a}$
Mean length of guard-cells (μ) (20 measurements)	291	310	267	241	-0.38	+0.48	-0.88	-0.02	-1.40	-0.52
Mean number of stomata in equal areas	46.3	49	49.5	66	+0.14	+0.17	-0.37	-0.34	-0.86	-0.84
Thickness of palisade mesophyll (μ) (20 measurements) ..	600	672	848	800	+0.36	+1.24	-0.14	+0.74	-0.64	+0.24
Spongy mesophyll (μ) (20 measurements)	1,400	1,728	1,448	1,624	+1.40	+0.21	+0.93	-0.29	+0.46	-0.78
Ratio $\frac{\text{Spongy mesophyll}}{\text{Palisade mesophyll}}$..	2.3	2.57	1.7	2.03	-1.00	+2.20	-1.50	+1.70	-2.00	+1.2
Means of coefficients (sign regarded) .. .. .	..	..	..	..	+0.10	+0.86	-0.39	+0.36	-0.89	-0.14
Means of coefficients (sign ignored) .. .. .	..	..	..	..	0.65	0.86	0.76	0.62	1.07	0.71

The most important features revealed in this table are: (1) the mean size of the guard cells of the H1 hybrid (310 μ) is greater than in either parent; (2) the relative number of stomata in equal areas of leaf surface of the two hybrid forms deviates only very slightly from the *laurifolia* parent; (3) the *acanthifolia* parent has the largest number of stomata per unit area and also the smallest stomata; (4) the coefficient of divergence of the H1 hybrid from the midparent (-0.88) in regard to length of guard-cells is considerably weighted in favour of the *laurifolia* parent, while the coefficient of the H2 (-0.02) shows only a very slight divergence of this form from the midparent. Considering the means of the coefficients of divergence of the hybrids from *laurifolia*, the midparent, and *acanthifolia*, we find for the H1 form +0.10, -0.39 and -0.89 respectively (when sign is regarded), and for the H2 form, +0.86, +0.36 and -0.14 respectively; these coefficients indicate that the H1 form deviates very slightly from *laurifolia* in the sum-total of these foliar characters, but it deviates considerably from *acanthifolia*. The mean coefficient of divergence of the H2 form from *acanthifolia* is -0.14, thus indicating the dominance of the *acanthifolia* parent. If the sign of the coefficients is ignored we obtain the relative degree of the general divergence of the hybrids from the parents and mid-

parent; for H1 these means are 0.65, 0.76, and 1.07 from *laurifolia*, midparent, and *acanthifolia* respectively, and for the H2, 0.86, 0.62, and 0.71. Thus the general divergence of the H1 forms is much greater from *acanthifolia* than from *laurifolia* so far as the histology of the leaf is considered. The H2 form shows a slightly greater divergence from the *laurifolia* structure than from *acanthifolia*. The means of the coefficients with regard to the midparent are, for H1, 0.76 and, for H2, 0.62, indicating a fair degree of divergence from the midparent in both hybrid series.



Text-fig. 12.—a, b, c, d. Camera lucida drawings of the air-space system of *laurifolia*, *acanthifolia*, H1, and H2 respectively. A stoma is superimposed in relation to the main air-spaces. $\times 175$.

Inflorescence and Flowers.

Table 6 gives the coefficients of divergence of the hybrids from the parents and the midparents for the main characters of the inflorescence.

Considering the number of flowers per inflorescence the coefficients of divergence of the H1 form from *laurifolia* (+ 0.61) and from the midparent (+ 0.11) indicate a weighting of the balance in favour of the *acanthifolia* parent. The coefficients of divergence from the same points of reference for the H2 form are -0.11 and -0.61 respectively and the absolute number of flowers of the H2 form is lower than that of either parent, but is very near to the number for the *laurifolia* parent, thus indicating the dominance of the *laurifolia* parent in this character.

Considering the length of the inflorescence we see that *acanthifolia*, with 59.4 mm., is about twice the mean length of *laurifolia*. The H1 form (mean 41 mm.) shows the prepotency of the *acanthifolia* parent, the coefficient of divergence from the midparent being -0.06; i.e., the H1 form approaches very closely to the midparent in respect to this character. The H2 form diverges considerably from the midparent as its coefficient of divergence (-0.4) indicates; but it approaches the *laurifolia* condition closely (coefficient + 0.08).

TABLE 6.

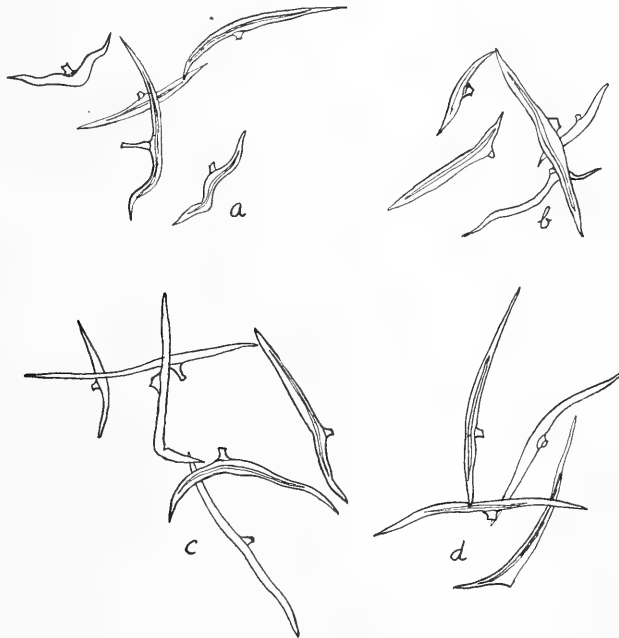
Plant.	Characters.									
	Mean length of Inflorescence (mm.).		Mean length of Peduncle (mm.).		Mean number of flowers in Inflorescence.		Mean length of Pedicel (mm.).		Mean length of Gynophore (mm.).	
<i>laurifolia</i>	26.3		19.3		26.7		2.57		3.1	
H1	41.0		19.1		39.3		2.08		2.1	
H2	29.0		17.5		24.5		2.48		2.66	
<i>acanthifolia</i> ..	59.4		11.1		47.4		1.92		2.01	
$\frac{l-H1}{l-a}$ | $\frac{l-H2}{l-a}$	+0.44	| +0.08	+0.02	| +0.22	+0.61	| -0.11	+0.75	| +0.14	+0.91	| +0.40
$\frac{M-H1}{l-a}$ | $\frac{M-H2}{l-a}$	-0.06	| -0.40	-0.47	| -0.30	+0.11	| -0.61	+0.24	| -0.37	+0.41	| -0.10
$\frac{a-H1}{l-a}$ | $\frac{a-H2}{l-a}$	-0.55	| -0.92	-0.97	| -0.80	-0.39	| -1.10	-0.25	| -0.86	-0.08	| -0.60

The H1 and H2 forms come nearer the *laurifolia* parent in the matter of length of peduncle, than to the *acanthifolia* parent. The midparent value is 15.2 mm.; both hybrid forms exceed this value as their coefficients of divergence, -0.47 and -0.30, indicate; the influence of the *laurifolia* parent is seen here. In regard to the length of the pedicel we see that the H2 form (2.48 mm.) comes very close to the *laurifolia* parent (2.57 mm.) and that its coefficient of divergence from the midparent is -0.37, thus showing the prepotency of the *laurifolia* parent. The H1 form (2.08) approaches closely to the *acanthifolia* side (1.92 mm.).

In regard to the gynophore, we find practically the same condition, the H1 form, with a mean length of 2.66 mm., approaching *laurifolia*, with mean length of 3.1 mm. Here, too, the H1 form shows the prepotency of the *acanthifolia* parent. The coefficient of divergence from the midparent is +0.41, i.e., in favour of *acanthifolia*.

From a consideration of these characters of the inflorescence it is apparent that the characters of the two parents blend in a remarkably peculiar fashion; one parent being prepotent in one character, the other in some other one; while in yet another, one or both of the hybrids show a more or less true blending of the parental characters.

The means of the coefficients of divergence of the H1 forms from *laurifolia*, the midparent, and *acanthifolia* in these characters of the inflorescence and flowers are +0.55, +0.05, and -0.45 respectively, when sign is considered, and for the H2 hybrid the corresponding means are respectively +0.15, -0.36, and -0.86. For the H1 hybrid the balance about the midparent is very definite, but slightly weighted on the *acanthifolia* side (+0.05). The inequality of balance about *laurifolia* (+0.55) and *acanthifolia* (-0.45) is considerable and similar. In the H2 form the means show great dissimilarity, and that the balance is greatest about the *laurifolia* parent.



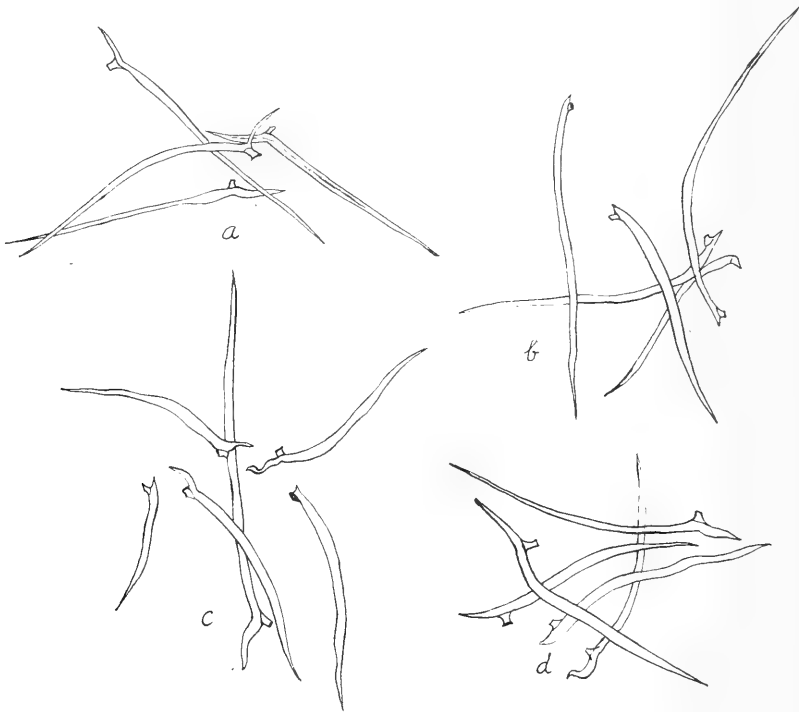
Text-fig. 13.—a, b, c, d. Hairs from the corolla of the four forms; in the hybrids the hairs are generally longer than in the two parents and tend towards slight asymmetry—an *acanthifolia* character. $\times 30$.

When the signs of the coefficients are disregarded, the means of these coefficients give the relative degree of the general divergence of the hybrids from the parents and from the midparent. These means are, for the H1 hybrid, 0.55, 0.26, and 0.45 respectively, and, for the H2 hybrid, 0.19, 0.36, and 0.86 respectively. Thus the general divergence of the H1 form from the *laurifolia* (0.55) is slightly greater than from the *acanthifolia* (0.45), while the H2 form shows very little divergence from the *laurifolia* parent (0.19), but a very considerable divergence from the *acanthifolia* parent (0.86). The two parents are almost equally balanced in the H1 hybrid, but the *laurifolia* parent is dominant in these characters in the H2 hybrid.

Pilosity of the Inflorescence and Flowers.

In Table 7 the chief characters of the pilosity of the inflorescence of the parents and hybrids are enumerated.

From the data recorded in Table 7 it also seems that there is a fortuitous blending of the parental influences in the matter of hair-colour and hair-structure; for example, the ovary and gynophore have red and white hairs in *laurifolia*, white only in *acanthifolia*, and a mixture of white and yellowish-brown or white and ferruginous in the H1 and H2 forms respectively, thus suggesting a blending of the two parents. In the corolla, *laurifolia* has red or ferruginous hairs, *acanthifolia* chiefly white, few greenish-brown, while the hybrids are chiefly ferruginous, clearly indicating the dominance of the *laurifolia* parent. The same conclusion may be drawn from the hair-colour of the bracts and of the inflorescence axis.



Text-fig. 14.—a, b, c, d. Drawings of the hairs from the ovary and gynophore of *laurifolia*, *acanthifolia*, H2, and H1 respectively. The influence of *acanthifolia* is seen in the asymmetrical position of the stalk in the hybrids. $\times 30$.

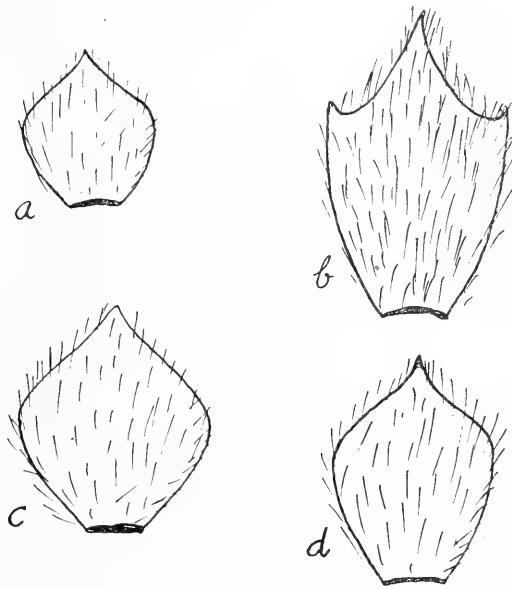
In regard to hair-structure, the *laurifolia* parent has symmetrically stalked hairs, while the *acanthifolia* parent is decidedly asymmetric in this respect; the H1 form has chiefly asymmetrically stalked hairs, but less so than the *acanthifolia* parent, while the H2 form has hairs which are almost symmetric. Clearly the prepotency of the *laurifolia* parent is revealed in this character of the H2, while the two parents are more or less equally represented in this character in the H1 hybrids. The other parts of the inflorescence or flower reveal similar features of hair-structure.

Text-figure 13 (*a, b, c, d*) demonstrates the structure of the hairs from the corolla and Text-figure 14 (*a, b, c, d*) shows the structure of the hairs from the ovary and the gynophore.

Bracts of the Inflorescence.

Text-figure 15 depicts the floral bracts of all four forms; it is clear that the shape of the H1 and H2 bracts is affected by the *laurifolia* parent, for they are almost like enlargements of the bracts of this parent.

Table 8 gives the means of the maximum length and maximum breadth of the bracts and the coefficients of divergence of the hybrids from the parents and the midparent in regard to these characters.



Text-fig. 15.—*a, b, c, d.* Drawings of bracts of *laurifolia*, *acanthifolia*, H1, and H2. The effect of the *laurifolia* parent is seen in the general appearance of the bracts of the hybrids. $\times 15$.

From this table it appears that the mean length of the bracts of *acanthifolia* is more than twice that of the *laurifolia* bracts, while the hybrids come between the parents. The midparental mean is 3.85. The H1 form shows a coefficient of divergence of -0.14 from the midparental value; in the H2 form the coefficient of divergence from the midparent is -0.26 , so that the influence of the *laurifolia* parent is greater than in the H1 form. There is slight predominance of the *laurifolia* influence in this bract-character. Considering the mean of the width of the bracts, we find that in the H1 form the mean is greater than for either parent, while the H2 form lies between the parental values. The midparental value is 2.92; the coefficient of divergence of H1 from the midparent is $+1$, while the H2 form has a coefficient of divergence of -1.57 ; both forms therefore show considerable divergence from the midparent in opposite directions.

TABLE 7.

Organ.	Plant.			
	<i>laurifolia</i>	H1	H2	<i>acanthifolia</i>
Inflorescence Axis.	hairs red or ferruginous, short, symmetrical.	hairs ferruginous, few white, short, mostly asymmetrical.	hairs ferruginous, almost symmetrical.	greenish-brown, white, longer than in <i>laurifolia</i> , asymmetrical.
Bracts ..	red or ferruginous, short, resembling hairs of corolla, symmetrical; purple patches present.	few white, chiefly ferruginous, generally asymmetrical; no purple patches.	mainly ferruginous, stalk generally symmetrical; purple patches present.	few greenish-brown, chiefly white, stalk symmetrical; no purple patches.
Ovary and Gynophore.	red and white in proportion 1 to 6; stalk generally somewhat asymmetrical.	chiefly white, few greenish-brown, asymmetrical.	chiefly white, occasional ferruginous hair present, asymmetrical generally.	all white, long, very asymmetrical.
Corolla ..	red or ferruginous, latter more abundant, stalk slightly asymmetrical.	chiefly ferruginous, few white, asymmetrical generally.	mainly ferruginous, few white, stalk slightly asymmetrical.	chiefly white, few greenish-brown, short, less asymmetrical than in ovary.

TABLE 8.

Plant.	Character of Bracts.			Means of Coefficients (sign regarded).		Means of Coefficients (sign ignored).	
	Mean length.	Mean breadth.	$\frac{L}{W} (\times 1,000)$	H1	H2	H1	H2
	(mm.).	(mm.).					
<i>G. laurifolia</i> ..	2.40	2.75	873				
H1	3.44	3.27	1,052				
H2	3.10	2.37	1,308				
<i>G. acanthifolia</i> ..	5.30	3.10	1,709				
Coefficients of divergence of hybrids from parents and midparent.							
$\frac{l-H1}{l-a} : \frac{l-H2}{l-a}$	+0.36 ; +0.24	+1.50 ; -1.10	+0.21 ; +0.52	+0.69	-0.11	0.69	0.62
$\frac{M-H1}{l-a} : \frac{M-H2}{l-a}$	-0.14 ; -0.26	+1.00 ; -1.57	-0.28 ; +0.02	+0.19	-0.60	0.49	0.62
$\frac{a-H1}{l-a} : \frac{a-H2}{l-a}$	-0.64 ; -0.76	+0.50 ; -2.10	-0.78 ; -0.48	-0.31	-1.11	0.64	1.11

The column giving the ratio of length to width of bracts shows that the hybrids fall between the two parents in this character, but the coefficient of divergence from the midparent indicates that the H1 form (-0.28) deviates considerably from this point of reference in favour of the *laurifolia* parent, while the H2 form (coefficient of divergence $+0.02$) approximates much more closely to the midparent. The prepotency of the *laurifolia* parent in regard to this character is suggested in the H1 form and the camera lucida drawings of the bracts (Text-fig. 15, *a, b, c, d*) also demonstrate this conclusion.

The means of the coefficients of divergence of the H1 hybrids from *laurifolia*, the midparent, and *acanthifolia* in regard to the characters of the bracts are $+0.69$, $+0.19$, and -0.31 respectively, when sign is considered; and for the H2 hybrids -0.11 , -0.60 , and -1.11 respectively. In regard to the H1 form, the mean of the coefficients of divergence from the midparent, $+0.19$, shows a greater approximation of this hybrid to the midparent than is the case in the H2 form; in other words there seems to be a more perfect blending of the characters of the two parents in the bract-structure; there is a slight dominance of the *acanthifolia* parent, as the sign indicates. The means of the coefficients of divergence from the parents show considerable inequality of balance ($+0.69$ from *laurifolia* and -0.31 from *acanthifolia*) and are distinctly dissimilar.

If we consider the means of the coefficients for the H2 forms, there is apparent a very considerable inequality of balance about the midparent (-0.60) and about the *acanthifolia* parent also (-1.11). The balance about the *laurifolia* parent is very definite. In the H2 form it is apparent that all the means of the coefficients of divergence (-0.11 , -0.60 , and -1.11) are on the *laurifolia* side, thus indicating the dominance of this parent.

If we consider the relative degree of divergence of the hybrids from their respective parents and midparent, we obtain an indication of the effect of either parent. The means of the coefficients of divergence from the usual points of reference, when sign is disregarded, give the relative effect of either parent in the constitution of the hybrids. The means of these coefficients are 0.69 , 0.47 , and 0.64 respectively for the H1 hybrids and for the H2 hybrids 0.62 , 0.62 , and 1.11 respectively. In the H1 form the general divergence from *laurifolia* (0.69) approximates closely to that from *acanthifolia* (0.64), but is considerably greater than the divergence from the midparent; thus *acanthifolia* is slightly dominant.

In the H2 form the general divergence from the *laurifolia* parent (0.62) is equal to that from the midparent (0.62) and only about half the divergence from the *acanthifolia* parent. Thus in the constitution of this form the *laurifolia* parent is strongly prepotent in the bract characters.

Pollen.

Table 9 sets out the colour, the dimensions, and the percentage of small and sterile pollen grains of parents and hybrids.

The colour of the H1 pollen is about intermediate between that of the parents, while the H2 form shows a different degree of blending of parental colours.

In size, the grains of the *acanthifolia* parent are larger than those of *laurifolia* and of the hybrids. The H1 form shows a coefficient of divergence from the midparent of -0.33 , while the H2 form has a coefficient of -0.84 . The latter diverges considerably from the mean of the parents and indicates the

TABLE 9.

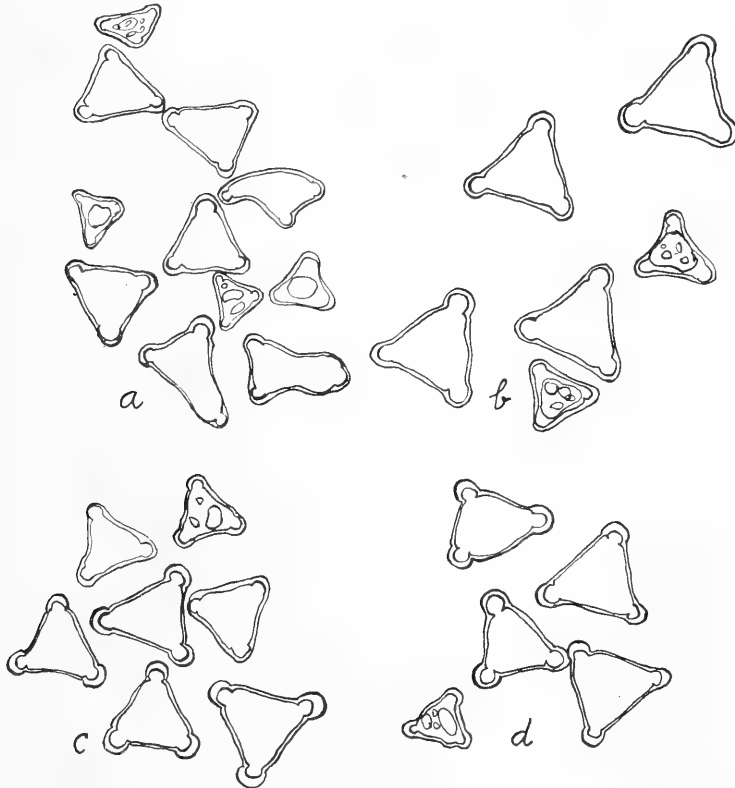
Character.	Plant.				Coefficients of divergence.					
	<i>laurifolia</i>	H1	H2	<i>acanthifolia</i>	$\frac{l-H1}{l-a}$	$\frac{l-H2}{l-a}$	$\frac{M-H1}{l-a}$	$\frac{M-H2}{l-a}$	$\frac{a-H1}{l-a}$	$\frac{a-H2}{l-a}$
Colour ..	bright-yellow	greenish-yellow	brownish-red	dark-red						
Size of largest grains ..	548	564	514	646	+0.16	-0.34	-0.33	-0.84	-0.83	-1.34
Size of small grains ..	360	390	400	400	+0.75	+1.00	+0.25	+0.50	-0.25	0
Percentage of sterile and small grains	3.7	13.4	8.17	23.6	+0.48	+0.22	-0.01	-0.27	-0.51	-0.77

dominance of the *laurifolia* parent in this character. On the contrary, in regard to the small sterile grains the hybrids approximate more closely to the *acanthifolia* side. The parents and hybrids show a most remarkable variation in the percentage of these small and usually sterile grains which invariably appear abnormal in their contents (which appear as large globular oily masses, absent from the larger and normal grains). (See Text-figure 16, *a*, *b*, *c*, *d*.)

A common property of most hybrids is a high degree of pollen and ovule sterility. But from numerous counts of sterile and normal pollen-grains of all four forms, I find that the *acanthifolia* parent has far more small, undeveloped and sterile grains than the hybrids, e.g., *laurifolia* has 3.7% sterile, *acanthifolia* 23.7%, H1 and H2 have 13.4% and 8.17% respectively. This character was so unexpected that I made numerous check counts at intervals, always with the same result, namely, that the hybrid pollen is much more consistently normal than the *acanthifolia* pollen, although in the H1 form it is four times more sterile than *laurifolia* pollen, and in the H2 approximately twice as sterile.

The accompanying Table 10 sets out the coefficients of divergence of the hybrids from the two parents and from the midparent for the chief characters discussed in the text; the coefficients being arranged in order of magnitude. These coefficients of divergence have been plotted as a graph taking the midparent as the reference line and plotting horizontally from it in a vertical series the appropriate coefficients recorded in the table. In the graphs (Text-figs. 17, 18) the horizontal distance between the *laurifolia* and the *acanthifolia* reference lines shows graphically the range of the coefficients of divergence of the characters where the values of the hybrids come within the limits of the two parents. Identity with one or other parent is obviously indicated if the coefficient of divergence of the hybrid from the midparent is ± 0.5 . In such a graph the relationship of the hybrids as a whole to the parents is presented in a manner which makes it possible to compare one hybrid with another, for the sum of the coefficients of divergence from any reference line is represented by the area

between the graph and any of the three vertical reference lines. The numerical value of this sum of the coefficients of divergence (neglecting the sign) is, for the H1 form, 0.67, 0.46, 0.64 respectively and, for the H2, 0.53, 0.49, and 0.84 respectively. In the former it is seen that the effect of the two parents is nearly balanced, neither having any distinct dominance in regard to the hybrid's constitution, but in the H2 form there is a striking difference in the potency of the parents in its make-up, the *aurifolia* parent being more predominant than the

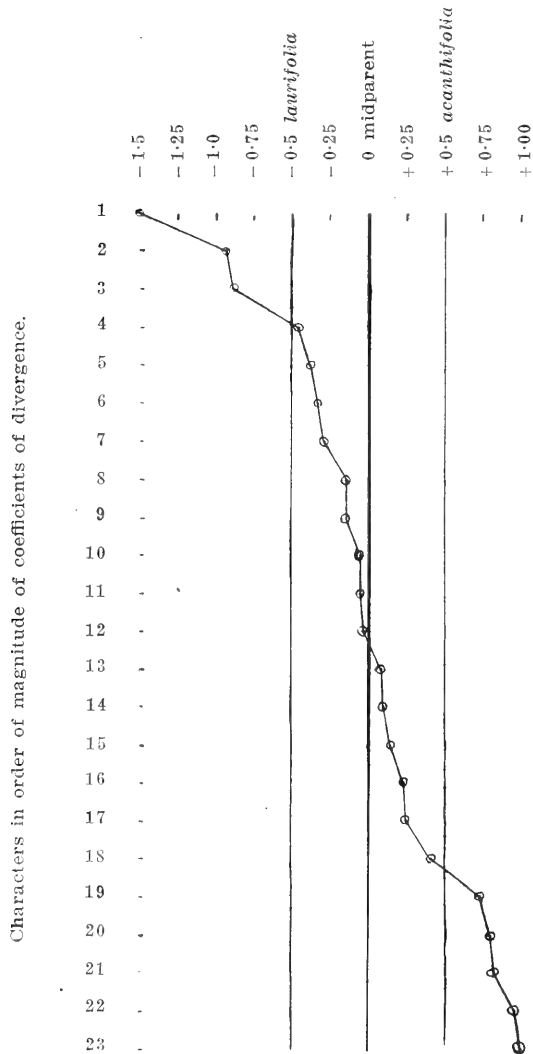


Text-fig. 16.—Drawings of pollen grains of *aurifolia*, H1, H2, and *acanthifolia*, showing the relative size of the grains, and some of the small sterile ones. The contents in the latter show disorganization, while the others have a uniform distribution of the contents. $\times 150$.

acanthifolia parent. This is also suggested in the graphs plotting the coefficients of divergence of the hybrid from the midparent (Text-figs. 17, 18). There is no strong tendency for the graph to approximate to the midparental line (as may be expected, since the mean coefficient of divergence from the midparent is 0.55), but there is a very large proportion of the graph on the *aurifolia* side, and the curve is decidedly asymmetric. The graph for the H1 form, however, displays considerable symmetry about the midparental line and is thus strikingly different from the graph for the H2 hybrid, so far as balance about this reference line is considered.

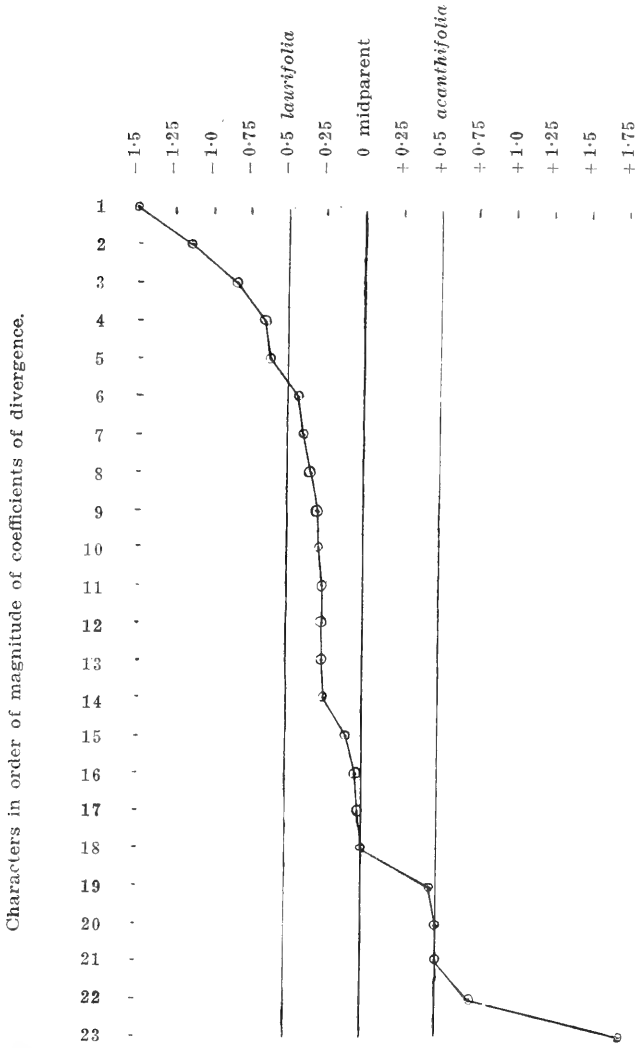
The balance of the graph about the midparental line may also be expressed numerically (Warren, 1929). The sum of the negative coefficients of divergence from the midparent (i.e., on the *laurifolia* side) for H1 is -5.19, the sum of the positive coefficients (*acanthifolia* side) is +5.52, giving a difference of +0.33, or a mean difference per character of +0.01. Thus in the constitution of the H1 form the *acanthifolia* parent is slightly dominant.

Considering the H2 form, we find the negative coefficients (*laurifolia* side) total -7.93, while the sum of the positive coefficients totals +3.71, giving a difference of -4.22, or a mean difference per character of -0.17. Thus the



Text-fig. 17.—H1 Hybrid.

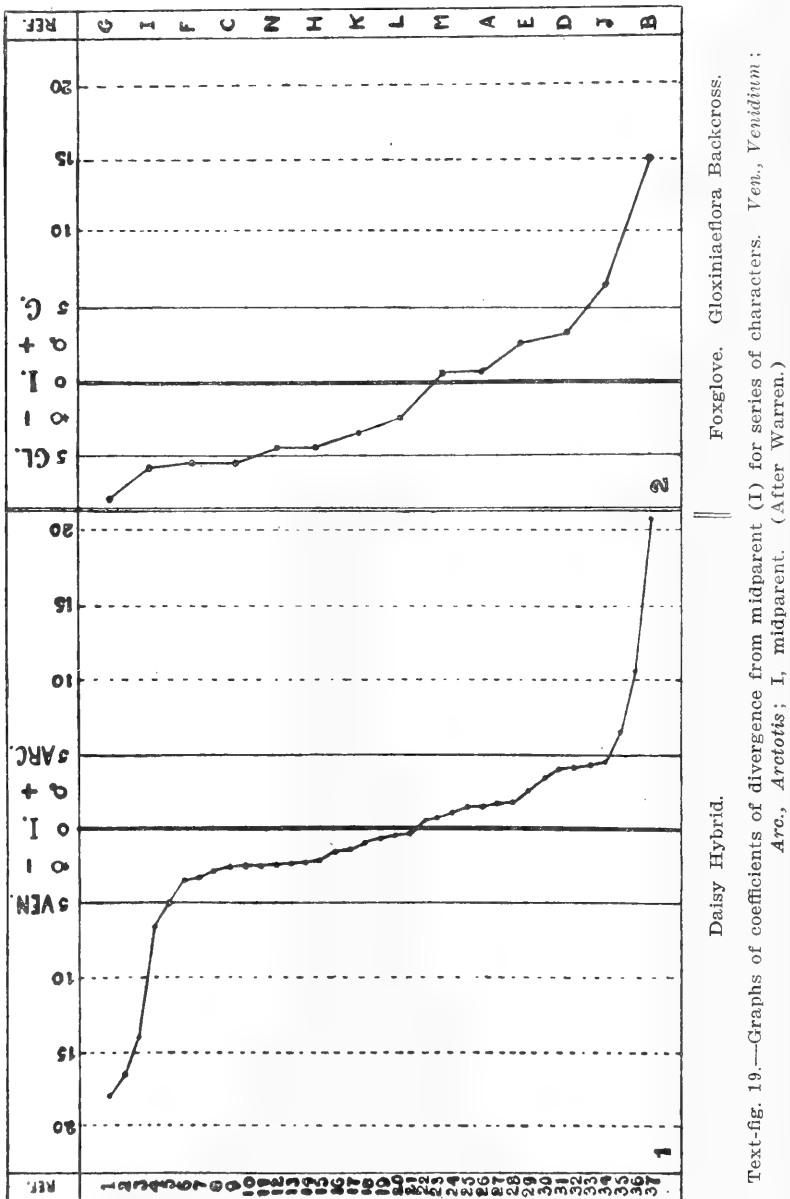
constitution of the H2 hybrid is largely determined by the *laurifolia* parent, and the graphs of the two forms confirm these conclusions. Text-figure 19 is a reproduction of the graph representing the generic hybrid between *Venidium* and *Arctotis* studied by Warren (1929). A comparison of this graph with Text-figures 17 and 18 above, for the specific hybrids analysed in this paper, will show clearly the similarity of the curves, and the symmetrical arrangement about the mid-parental line. From the graph of the *Venidium* × *Arctotis* hybrid and the graphs of the *G. laurifolia* × *G. acanthifolia* hybrids, it is apparent that most of the hybrid



Text-fig. 18.—H2 Hybrid.

characters fall within the limits of the characters for the two parents; but it is also apparent that the means of some of the characters of the hybrids are outside the means of the parents.

Table 10, *a*, *b*, gives the coefficients of divergence of the H1 and H2 hybrids from the parents and midparent in respect to the characters discussed in the text; the coefficients are arranged in order of magnitude.



Text-fig. 19.—Graphs of coefficients of divergence from midparent (I) for series of characters. *Ven.*, *Venidium*; *Arc.*, *Arctotis*; I, midparent. (After Warren.)

TABLE 10 a.

Character.	H1		
	Coefficients of Divergence.		
	$\frac{l-H1}{l-a}$	$\frac{M-H1}{l-a}$	$\frac{a-H1}{l-a}$
1. Spongy Mesophyll ($\times 1,000$)	-1.00	-1.50	-2.00
Palisade Mesophyll			
2. Width of Leaf	-0.44	-0.94	-1.44
3. Length of Guard-Cells	-0.38	-0.88	-1.40
4. Length of Peduncle	+0.02	-0.47	-0.97
5. Stomata per Unit Area	+0.14	-0.37	-0.86
6. Size of Largest Pollen-Grains	+0.16	-0.33	-0.83
7. Ratio of Bract $\left\{ \frac{W}{L} \times 1,000 \right\}$	+0.21	-0.28	-0.78
8. Length of Bract.. .. .	+0.36	-0.14	-0.64
9. Thickness of Palisade	+0.36	-0.14	-0.64
10. Length of Lamina	+0.44	-0.07	-0.56
11. Length of Inflorescence	+0.44	-0.06	-0.55
12. Percentage of Small Grains	+0.48	-0.01	-0.51
13. Lobes of Lamina	+0.58	+0.09	-0.41
14. Flowers per Inflorescence	+0.61	+0.11	-0.39
15. Distance of Marginal Vein	+0.65	+0.15	-0.35
16. Length of Pedicel	+0.75	+0.24	-0.25
17. Size of Small Pollen-Grains	+0.75	+0.25	-0.25
18. Length of Gynophore	+0.91	+0.41	-0.08
19. Leaf Ratio $\left\{ \frac{W}{L} \times 1,000 \right\}$	+1.24	+0.74	+0.24
20. Main Branches per Plant	+1.30	+0.78	+0.30
21. Length of Petiole	+1.31	+0.82	+0.32
22. Thickness of Spongy Mesophyll	+1.40	+0.93	+0.46
23. Breadth of Bract	+1.50	+1.00	+0.50
Means (signs ignored).. .. .	0.67	0.46	0.64
Means (signs considered)	+0.51	+0.01	-0.48

TABLE 10 b.

Character.	H2		
	Coefficients of Divergence.		
	$\frac{l-H2}{l-a}$	$\frac{M-H2}{l-a}$	$\frac{a-H2}{l-a}$
1. Breadth of Bract	-1.10	-1.57	-2.10
2. Leaf Ratio $\left\{ \frac{W}{L} \times 1,000 \right\}$	-0.63	-1.13	-1.62
3. Size of Largest Pollen	-0.34	-0.84	-1.34
4. Length of Leaf	-0.15	-0.65	-1.15
5. Flowers per Inflorescence	-0.11	-0.61	-1.10
6. Length of Inflorescence	+0.08	-0.42	-0.92
7. Length of Pedicel	+0.14	-0.37	-0.86
8. Stomata per Unit Area	+0.17	-0.34	-0.84
9. Length of Peduncle	+0.22	-0.30	-0.80
10. Thickness of Spongy Mesophyll	+0.21	-0.29	-0.78
11. Percentage of Small Grains	+0.22	-0.27	-0.77
12. Length of Bract.. .. .	+0.24	-0.26	-0.76
13. Lobes of Lamina	+0.23	-0.26	-0.76
14. Distance of Marginal Vein	+0.25	-0.25	-0.76
15. Length of Gynophore	+0.40	-0.10	-0.60
16. Length of Guard-Cells	+0.48	-0.02	-0.52
17. Ratio of Bract $\left\{ \frac{W}{L} \times 1,000 \right\}$	+0.52	-0.02	-0.48
18. Width of Leaf	+0.50	0	-0.50
19. Branches per Plant	+0.80	+0.27	-0.23
20. Length of Petiole	+1.00	+0.50	0
21. Size of Smallest Pollen-Grains	+1.00	+0.50	0
22. Thickness of Palisade	+1.24	+0.74	+0.24
23. $\frac{\text{Spongy Mesophyll}}{\text{Palisade Mesophyll}} (\times 1,000)$	+2.20	+1.70	+1.20
Means (signs ignored).. .. .	0.53	0.49	0.84
Means (signs considered)	+0.33	-0.17	-0.67

SUMMARY.

1. A detailed analysis of the natural specific hybrids *Grevillea laurifolia* × *G. acanthifolia* is made, and the opinion of Fletcher and Musson (These PROCEEDINGS, 1927) as to their probable hybrid origin is confirmed.

2. The most important contrasting characters of the putative parents and hybrids have been investigated, their coefficients of divergence from the parents and from the midparent calculated and plotted graphically about the midparental reference line.

3. There are two distinct hybrid series or swarms, H1 and H2; in the former, as the graph shows, there is an almost equal blending of the characters of the two parents, but a slight predominance of the *acanthifolia* parental complex; in the latter the graph shows that the *laurifolia* parent is strongly predominant. This conclusion is further confirmed by means of the coefficients of divergence for the H1 and H2 hybrids, which are respectively +0.01 and -0.17.

4. The mean of the H1 form exceeds the means of the parents in the following eight characters: ratio of spongy mesophyll to palisade mesophyll, width of leaf, length of guard-cells, leaf-ratio (width/length), main branches per plant, length of petiole, thickness of spongy mesophyll, and breadth of bracts. The H2 hybrid exceeds the means of the parents in the following seven characters: ratio of spongy mesophyll to palisade mesophyll, leaf-ratio (width/length), length of leaf, size of largest pollen-grains, flowers per inflorescence, thickness of palisade mesophyll, breadth of bract. In the remaining characters the means of the hybrids fall between the means of the parents, and therefore the effect of both parents is discernible.

The H1 forms approach the *laurifolia* parent in twelve characters and the *acanthifolia* parent in eleven, so that the effect of the two parents is almost evenly balanced.

In the H2 hybrids the *laurifolia* effect appears in seventeen characters and the *acanthifolia* in five, thus demonstrating the dominance of the former parent.

5. The graphs sum up the data available from an analysis of the H1 and H2 hybrids of *Grevillea*, and indicate the relationship of the hybrids as a whole to the two parents. The graph for the H1 form is sigmoid, and resembles that obtained by Warren for the *Venidium* and *Arctotis* hybrid. The graph for the H2 hybrids is not so symmetrical about the midparental line as that of the H1 form; indeed most of the graph is on the *laurifolia* side, thus graphically representing the dominance of the *laurifolia* parent in the constitution of this form. The graph, moreover, strongly resembles that of the *Gloxiniaeflora* backcross in the Foxglove hybrids, reproduced by Warren (1929), and indicates that the H2 hybrids may probably be a backcross, H1 (male) and *laurifolia* (female). This aspect is being investigated.

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EXPLANATION OF PLATES XII-XV.

Plate xii.

Photograph I.—Seedlings of the H1 hybrid raised by crossing *Grevillea laurifolia* (ovule parent) and *G. acanthifolia* (pollen parent).

Plate xiii.

Photograph II.—Portion of the *laurifolia* parent.

Photograph III.—Portion of the *acanthifolia* parent.

Plate xiv.

Photograph IV.—Part of the H1 hybrid.

Photograph V.—Part of the H2 hybrid.

Plate xv.

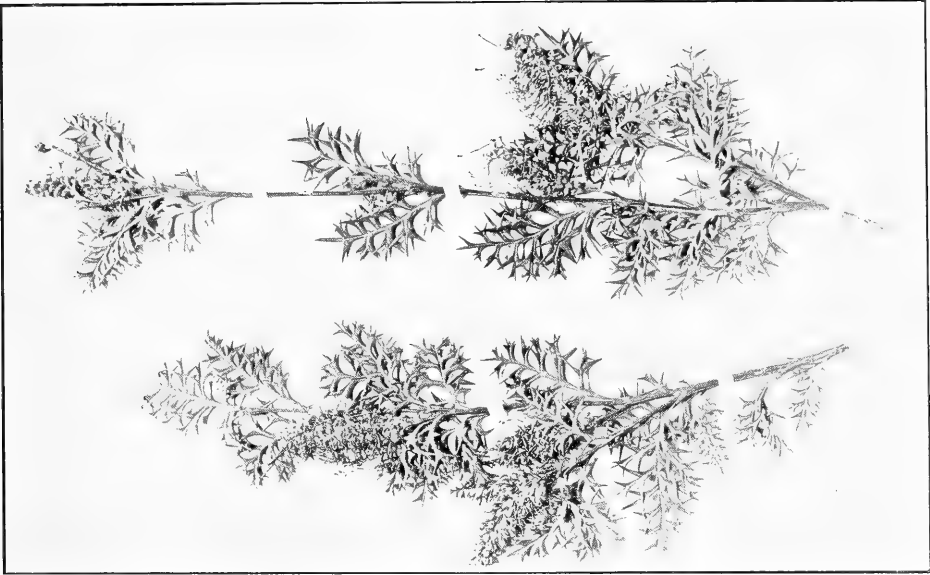
Photograph VI.—Leaf-lobing of *acanthifolia*.

Photograph VII.—Dissection of the lamina of H1 hybrid.

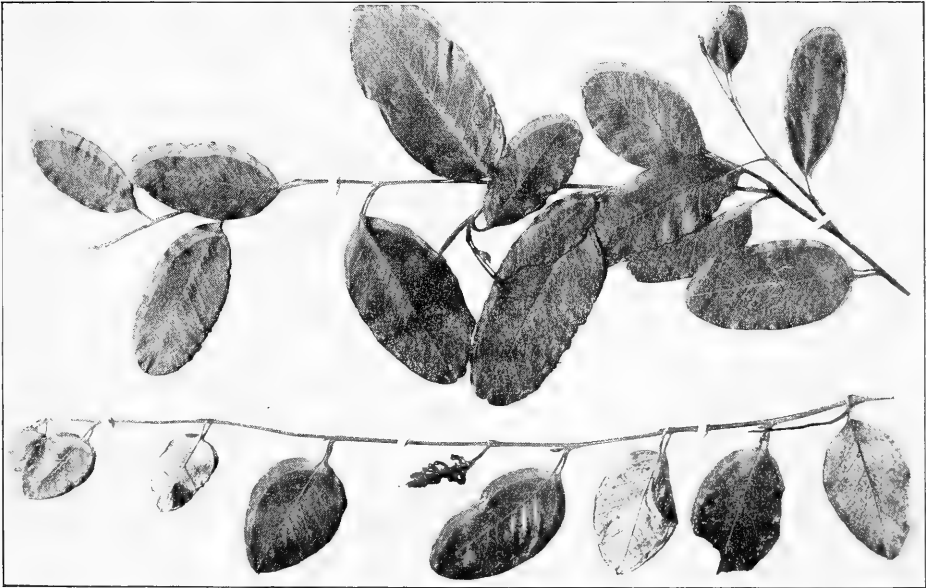
Photograph VIII.—Dissection of the lamina of the H2 hybrid.



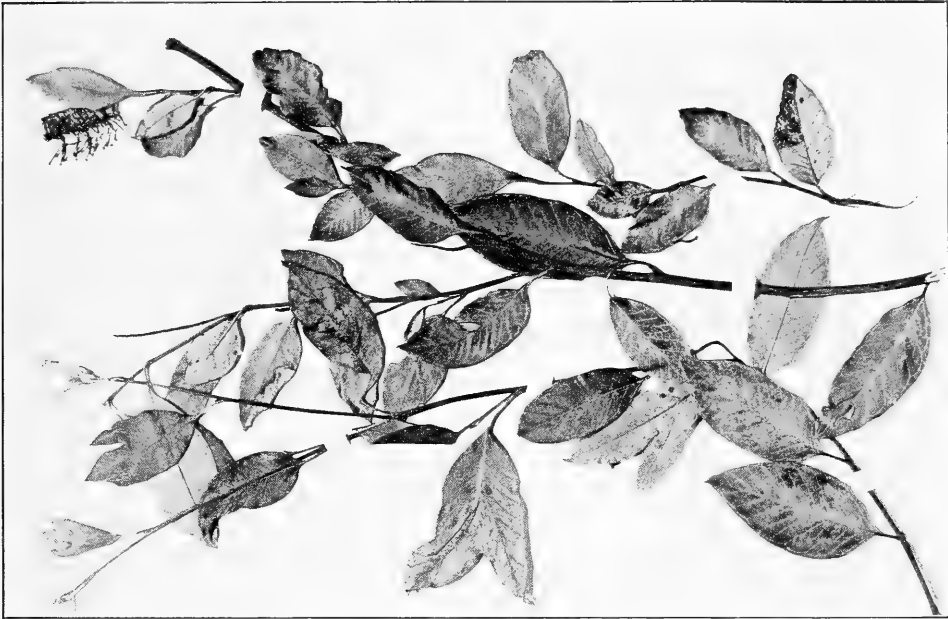
1. Seedlings of H1 hybrid, *Grevillea laurifolia* × *G. acanthifolia*.



3. Portion of *acanthifolia* parent.



2. Portion of *lanrifolia* parent.



5. Part of the H2 hybrid.



4. Part of the H1 hybrid.



6. Leaf-lobing in *G. acanthifolia*. 7. 8. Dissection of lamina in H1 and H2 hybrids.

NOTES ON THE AUTUMN ORCHIDS OF THE SOUTH MAITLAND
COALFIELDS, N.S.W.

WITH DESCRIPTION OF A NEW SPECIES OF PTEROSTYLIS.

By the REV. H. M. R. RUPP, B.A.

(Three Text-figures.)

[Read 30th July, 1930.]

The season 1930 has been most favourable for the growth and development of the autumn-flowering orchids in the above area. The following species have been in abundance far greater than I have seen in any other district: *Prasophyllum nigricans* R. Br., *Pterostylis ophioglossa* R. Br., *Pt. concinna* R. Br., *Pt. revoluta* R. Br., *Pt. reflexa* R. Br., and *Pt. truncata* Fitzg. These are closely followed in numbers by *Pterostylis acuminata* R. Br., *Pt. obtusa* R. Br., *Acianthus esertus* R. Br., *A. fornicatus* R. Br., and *Eriochilus cucullatus* Reichb. f. Less common are the following: *Prasophyllum acuminatum* Rogers, *Pterostylis*, n. sp., *Pt. parviflora* R. Br. and *Chiloglottis reflexa* (Lab.) Cheel.

Pterostylis concinna and *Acianthus fornicatus* belong rather to the winter than to the autumn months, but as they flowered in early May they may be included here. *Prasophyllum nigricans* has been extremely abundant; *P. acuminatum* seems to be rare. Single specimens of two doubtful *Prasophylls* of the same section have been found, but are omitted as of uncertain identity.

The most interesting orchids in the list are the nine Greenhoods (*Pterostylis*) and *Acianthus esertus*, and notes on these ten plants will be found below. Among the Greenhoods is a new species of which fifteen flowers have been obtained, and which I have named *P. furcillata*, from the diminutive forking of the apex of the labellum (Fig. 3).

Pterostylis ophioglossa R. Br.—Flowering stems vary in height from 6 to almost 24 cm. Colour ranges from greyish-green through bright green to a pale reddish tint, while flowers out in the open are sometimes nearly white. The angle formed by the forking of the labellum varies considerably, occasionally approaching that of *P. concinna*; in such cases the flowers are usually small, suggesting hybridization between the two species. Two remarkable abnormal plants were found side by side on one occasion, both being robust and well developed. One has two flowers on a common "double" ovary, facing each other, both normal except for the lateral sepals; on one side the sepal of each flower is quite free to the base, on the other the sepal of one flower is united to that of the other, forming a sinus similar to that between the paired sepals of the typical flower. The other plant has two perfect flowers, the second rising on a peduncle 10 cm. long from the base of the bract subtending the first flower. Miss D. Watson of Weston has obtained a similar specimen with a shorter peduncle, but the second flower lacks a labellum.

For some years I have been disposed to regard *P. ophioglossa* as having originated by hybridization between *P. truncata* and *P. concinna*. The chief reason against this has been my inability to secure any evidence of these two species being in flower concurrently, but I now have flowers of both before me. Figure 1 shows the close resemblance between the galea-segments of *P. truncata* and those of *P. ophioglossa*. The general form and habit of the latter and of *P. concinna* are much alike, while the similarity in outline of the flowers of *P. truncata* and *P. ophioglossa* is very obvious, even in dried specimens. A cross between *P. truncata* and *P. concinna* might well produce an intermediate-sized flower with a deeply-cleft labellum.

Pterostylis concinna R. Br.—Very abundant; often very tall, up to 24 cm., otherwise typical.

Pterostylis acuminata R. Br.—Much less restricted to the vicinity of water-courses and gullies than any of the others (*P. parviflora* excepted). Often tall, reaching 30 cm., but short stems are common.

Pterostylis revoluta R. Br. and *Pterostylis reflexa* R. Br. (Text-fig. 2).—The resemblances between these species are obvious, but are far more apparent in dried specimens than in the living state, and I am more and more convinced that Robert Brown was right in separating them. I have examined at least several hundred specimens of each, but have failed to find anything which could be regarded as an intermediate form. In the dried plants the labella are not dissimilar, but in the living plants that of *P. reflexa* is consistently darker and narrower except in one form, which I think is a hybrid, but not with *P. revoluta*. The most outstanding difference (apart from dimensions) in the living plants is in the curvature of the flower, the curve of *P. reflexa* beginning almost from the base. When a dorsal sepal is pressed flat and dried, it is almost impossible to imagine it forming the curve natural to it; this is because in its natural condition the whole segment forms a curve. It is quite different with *P. revoluta*, where there is a comparatively long upright portion of the flower from the base upward, before the forward curve develops. In the field this distinction gives the two flowers quite a different appearance, which is not nearly so marked in many herbarium specimens. In my experience *P. reflexa* is always found in colonies, while *P. revoluta*, though sometimes grouped, is scattered indiscriminately over the area where it occurs. In its larger forms this species is undoubtedly one of the handsomest of all our Greenhoods.

Pterostylis truncata Fitzg.—Hitherto I have only found, in two other districts, occasional groups of this species. In the neighbourhood of Weston it is in great abundance. Fitzgerald's specimens came from Mittagong; the tall one depicted by him must have been exceptional in height, and cannot be regarded as typical. The outstanding characteristic of *P. truncata*, as seen on the western slopes of New England, in the Paterson Valley, and about Weston, is the abnormally short stem for so large a flower. Victorian plants from Sunshine and the You Yangs agree in this respect. The red tints in the flower make it very attractive, but the shortness of the stem, which is often only 3 or 4 cm., gives it the semblance of a dwarf. Mr. E. Minchell and I have found at Weston three plants with two flowers; in one the second flower is 4 cm. above the first, in the other two the flowers are level with each other, on separate peduncles.

Pterostylis obtusa R. Br.—This vivid-green flower is fairly plentiful. The stem-leaves vary greatly, and are sometimes very broad. There is also much

variation in the length of the sepals, particularly the dorsal, which is occasionally produced into a moderately long filament. In most New South Wales localities the galea is shortly-pointed, but I have Tambourine Mountain (Queensland) specimens matching those of Weston.

Pterostylis parviflora R. Br.—Plentiful among the low shrubby growths. Very slender, not tall, whole plant bright green, flowers rarely tinged with red. The remarkable development of the stigmatic plate in this tiny flower is worth noticing.

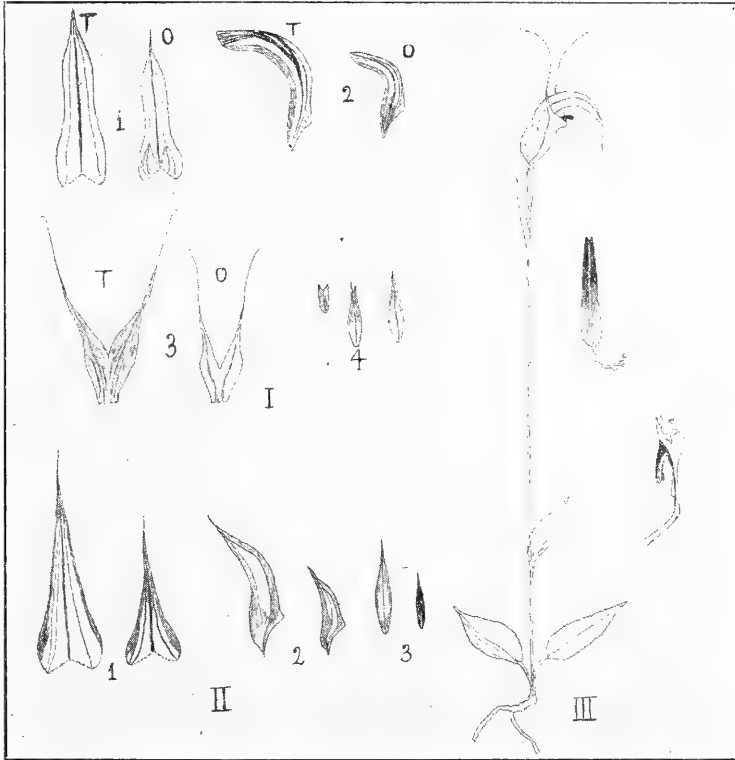


Fig. 1.—Comparison of *P. truncata*, *P. ophioglossa* and *P. concinna*.

1. Dorsal sepal of *P. truncata* (T) and *P. ophioglossa* (O).

2. Petal of the same. 3. Lateral sepals of the same.

4. Labellum of *P. concinna*, *P. ophioglossa*, and *P. truncata*.

Fig. 2.—Comparison of *P. revoluta* (large) and *P. reflexa* (small).

1. Dorsal sepal. 2. Petal. 3. Labellum.

Fig. 3.—*Pterostylis furcillata*, n. sp., showing enlarged labellum and column.

PTEROSTYLIS FURCILLATA, n. sp. Text-figure 3.

Planta gracillima 12–20 cm. alta. Folia ad basem fere duo, petiolata, latissime lanceolata, cum marginibus crispis. Bractea similis sub medium caulem, tanto base amplexans. Bractea appressa sub florem. Ovarium 10–18 mm. longum. Flos solitarius, a base ad galeae apicem 4–5 cm., summe viridis. Sepala lateral

ad sinum latum tumida, abhinc galeam magnopere excedenta. Galea curvissima, supra petala 8-10 mm. deflexa. Labellum 15 mm. longum, ad apicem bifidum cum cuspidibus obtusis, summe fuscum sed ad basem pallidum. Columna gracillima, circiter 13 mm. longa, lobi inferiores vix ciliati. Stigma angusta, prominens.

A very slender plant from 12 to 20 cm. high. Basal leaves usually two only in flowering plants; two plants were found with one leaf, and one with three, while some non-flowering plants close by had four. The rule, however, seems to be two. Leaves petiolate, broadly lanceolate or in one or two cases nearly ovate, acuminate, with crisped edges. One bract similar to the leaves on the lower part of the stem, clasping only at its base, and a more appressed bract subtending the long ovary. Flower solitary, 4-5 cm. from base to tip of galea, vivid-green. Lateral sepals forming a protruding lip (less marked than in *P. obtusa*) at the broad sinus, thence prolonged into filaments far beyond the galea. Galea much curved, deflexed, extending 8-10 mm. beyond the petals. Labellum 15 mm. long, shortly bifid at the apex, with obtuse points, very dark but paler at the base. Column very slender, a little shorter than the labellum, the lower wing-lobes obtuse and scarcely ciliate. Stigma narrow, prominent. Fl. April-May.

This orchid was found in *Melaleuca* scrub not very far from the Kurri Kurri Hospital grounds.* Its affinities seem to be largely with *P. obtusa*, and it may have originated by hybridization between that and *P. ophioglossa* or *P. concinna*; but as 15 flowers were obtained, all true to the type described (except for shorter sepals in one), it may fairly claim recognition as a species. The cleft in the labellum, though very small like that of the southern *P. Toveyana*, is quite definite in every flower. Young plants without flowers were seen close by, agreeing in the character of the leaves, and no other species was noticed within about twenty yards. The foliage is quite unlike that of *P. obtusa*. In general appearance the flower resembles that of *P. decurva*. As stated above, some of the non-flowering plants had four leaves; those with two only might easily have been mistaken for leaves of *Chiloglottis*.

Acianthus exsertus R. Br.—This usually insignificant plant will acquire new interest from the remarkable forms assumed by it in this district. The typical form is not uncommon, but a most abnormally robust form occurs in large colonies near Weston. The plants reach a height of 21 cm., with a stem-width of 2 mm. Sepals 8 mm. long, labellum 6 mm., column 4 mm. across the curve. These measurements were from one of the largest flowers. A whole colony of this robust form (not quite so tall) was found, in which every plant except three had a perfect flower at the point where the leaf is attached to the stem, far below the flowering-raceme. This flower is on a short peduncle connate to the stem itself. These interesting forms were brought under my notice by Mrs. P. Watson and her daughter, of Weston.

* Subsequently found three miles away, near Abermain.

THE TOPOGRAPHY AND WATER SUPPLY OF COX'S RIVER, N.S.W.

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Society in Geography.

(Four Text-figures.)

[Read 27th August, 1930.]

Position and Rainfall.—Cox's River drains some 1,300 square miles of plateau country to the west of Sydney, and its water falls into the Nepean-Hawkesbury system. The river basin is situated on the eastern slope of the highlands and is open to south-east and easterly winds, which bring considerable rain at all seasons. The actual rainfall varies directly with elevation and inversely with distance from the sea. The effect of elevation gives a steadily increasing annual rainfall from Penrith (elevation 89 feet; rainfall 28·92 inches) to Katoomba (elevation 3,336 feet; rainfall 55·80 inches). Further inland, a decreasing gradient of the highland surface corresponds with a markedly decreased rainfall. Distribution through the year is indicated by figures referring to precipitation along the Great Western Railway, as there are no recording stations elsewhere in the area apart from that line of settlement.

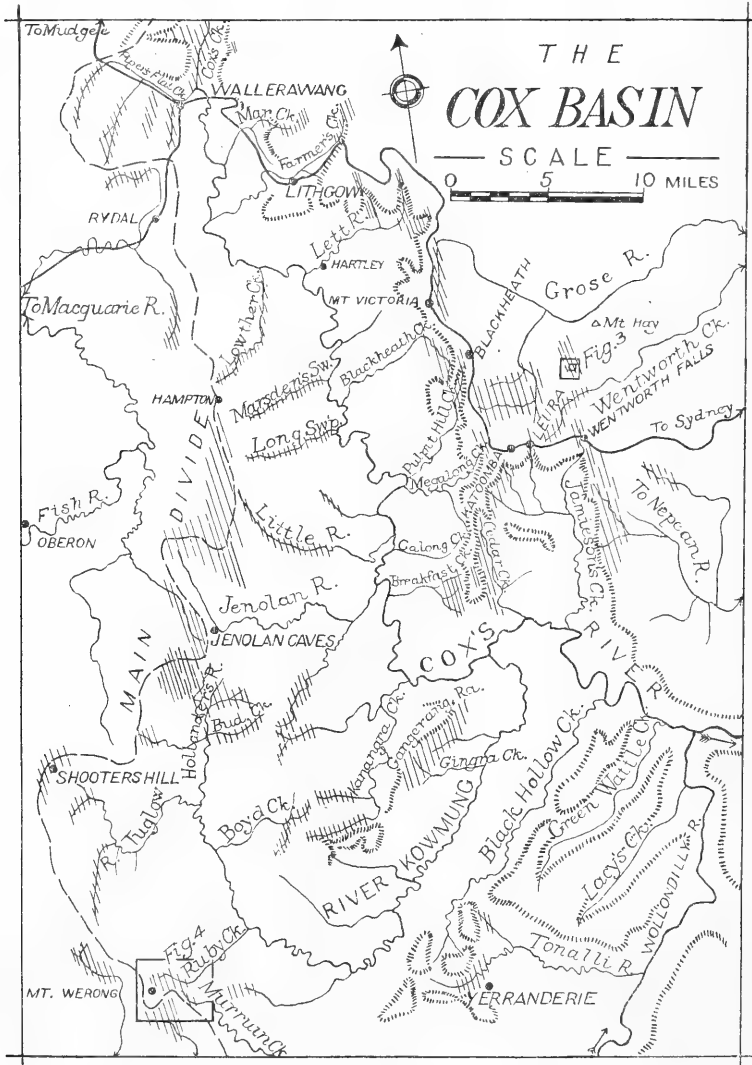
Average Monthly Rainfall (in Inches) for the Central Tableland, to 1928.

Station.	Years of Record.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.	April to October.
Lithgow ..	39	3·4	2·7	3·3	2·6	2·5	3·2	3·4	2·3	2·2	2·3	2·6	3·0	33·3	18·5
Mount Victoria	56	3·6	4·0	3·8	3·1	2·9	3·2	3·2	2·2	2·3	2·4	2·8	3·4	36·9	19·3
Blackheath ..	31	4·3	3·8	4·0	3·8	3·6	3·2	3·7	2·5	2·4	2·6	2·9	4·3	40·9	21·8
Katoomba ..	43	6·2	6·0	6·5	5·0	4·0	4·5	4·6	3·3	2·8	3·0	3·7	5·3	54·8	27·1
Lawson ..	33	5·0	4·9	4·7	4·5	3·8	3·5	4·5	2·9	2·5	2·8	3·5	5·0	47·6	24·5
Springwood ..	41	4·3	4·2	5·1	3·7	2·9	2·8	2·9	2·1	2·3	2·4	3·2	3·8	39·5	19·0
Penrith ..	32	2·8	2·5	2·9	2·7	2·3	2·0	3·1	1·7	1·5	1·9	2·3	3·2	28·9	15·2
Sydney ..	70	3·7	4·2	5·0	5·5	5·2	4·8	4·8	3·0	2·8	2·8	2·8	2·8	47·4	28·9

(After N.S.W. Statistical Register, 1927-1928.)

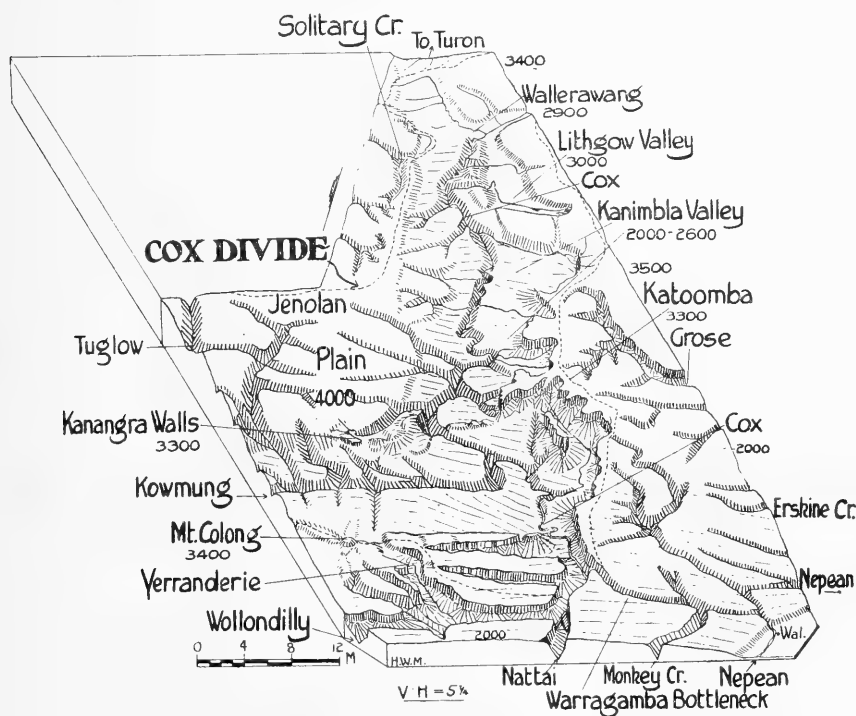
As far as the tablelands are concerned, these figures are probably representative enough, but the wide meridional valleys of the Cox and Kowmung have a topographic form and position which is suggestive of lower rainfall. Winds blowing from the west, south and south-east into these valleys tend to deliver their rain on the high tableland edges where a maximum updraught is created,

and to form areas of local high pressure and corresponding dryness in the leeward parts of the valleys. In the wide valleys of Kanimbla and Megalong, on the central section of Cox's River and 1,200 feet below the plateau, it is quite usual to experience fine weather whilst rain is falling on the high, exposed tableland less than ten miles distant. This is particularly the case during summer, when the valleys are hot on account of their relatively low elevation and the fact that they are enclosed by much higher land.



Text-fig. 1.—Locality map, showing names used in the text. The principal areas for stream water supply are hatched.

Thus there are reasons for suspecting some local variations of rainfall which are not disclosed by existing meteorological observations, and which would tend to lessen the supply of water given to the drainage system by the wide, deep valleys. On the other hand the high tableland (about 4,200 feet) around Jenolan Caves is in a favourable position for intercepting moisture as it is bounded, especially on the eastern side, by fairly steep slopes, and rises from 1,200 to 2,000 feet above its surroundings. Its contribution towards the streams might, therefore, be considerable. In point of fact the streams flowing from this high mass are the most reliable of the region, a circumstance which is not wholly due to high rainfall.



Text-fig. 2.—Block Diagram of the Cox River Basin, showing the principal topographic features and divisions.

Topography and Geology (Text-fig. 2).—An account of the physiography of this area has already been given by the writer (1928); consequently, a summary of the topographical and geological conditions will be sufficient for the purposes of this paper.

The valleys of Cox's River and its principal tributary, the Kowmung, form a line of demarcation between the newer Permian and Triassic strata to the south and east and the older Silurian and Devonian beds on the west. Thus that part of the tableland forming the eastern watershed of Cox's River, together with the mass lying six miles east of the Kowmung has a surface of Hawkesbury Sandstone. That series of wide, mature valleys which includes the levels at

Lithgow and Wallerawang (3,100 feet), Kanimbla and Megalong Valleys (2,200 feet), and the higher-level valleys of Kowmung River and Jamieson's Creek (between 400 and 2,800 feet) has a surface covering of Upper Marine (Permian) sandstone and conglomerate in part, but a great deal is carved out of intrusive granites and porphyries and highly inclined metamorphic strata.

The wide surfaces of these valleys are trenched by deep gorges cut in the underlying intrusives and metamorphics. That of the Cox in southern Megalong is 1,900 feet deep, and its sides slope at angles of 40 degrees and more. Similar gorges up to 3,000 feet in depth extend into the high tableland about Jenolan Caves, on whose edges small outliers of Permian littoral sediments rest unconformably on the prevailing older rocks.

Thus the Cox River area comprises a high metamorphic tableland about Jenolan which is separated from the lower sandstone plateau to the north and east by a series of upland valleys of varying elevations, and with a width which varies from six miles on the upper Cox to twelve miles in Kanimbla-Megalong and eight miles in the main Kowmung valley. Despite recent erosion there are considerable areas of undissected land in these valleys. The catchment of the Cox waters presents a variety of geological structures, mineral characters and topography, all of which would be expected to have great influence on the volume and permanency of the streams.

Evaporation.—The rainfall, as has already been indicated, is spread fairly through the year with a rather dry season in spring. In winter, with the prevailing high pressure and westerly winds, there is a tendency towards evaporation which is effectively checked by uniformly low temperatures in the highlands. Snow is experienced at intervals above 3,000 feet; frosts are of common occurrence, and ground, in places which are not exposed to the direct rays of the sun, may remain frozen for a week during frosty weather. In the valleys and on the

Highland (Shade) Temperatures, 1928.

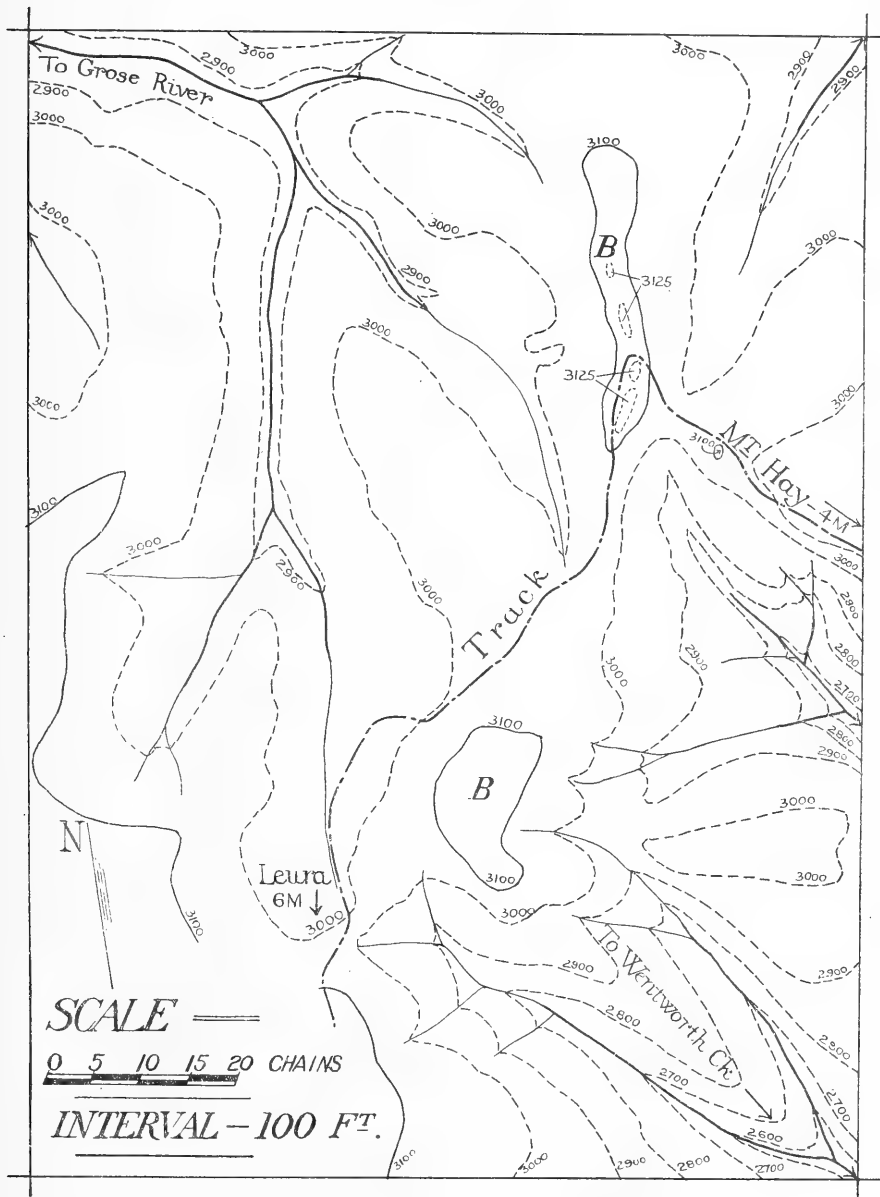
Station.	Altitude.	Annual Mean.	Means.		Extremes.		Extremes, 1923-1928.	
			Max.	Min.	Max.	Min.	Max.	Min.
Katoomba	3,349 ft.	55.2	63.3	47.1	88.0	31.0	98.0	28.0
Mount Victoria ..	3,490 ft.	53.6	61.2	46.0	87.0	29.0	94.0	26.0

Temperatures in degrees F.
(After N.S.W. Statistical Register, 1927-1928).

lower parts of the plateaus conditions are warmer but, given anything close to the average rainfall month by month, soil remains moist throughout the winter.

During the warmer months (October to April) the daily temperature is fairly high, although it is subject to such great occasional variation that snow has fallen on the higher tablelands upon Christmas Day. This is an exceptional circumstance, the opposite extreme being attained during those summers when hot westerly winds prevail for some weeks during January and February and bring inland conditions almost to the eastern coast.

In general, the summer conditions are warm or hot during the day, whilst the nights are much cooler. Evaporation is much greater than in winter and, with the uniform rainfall experienced, the natural stream flow diminishes with



Text-fig. 3.—Portion of the Blue Mountain Plateau near Leura. Note the level, B, of Tertiary basalt (3,100 feet, represented here by silicified grit) dissected by modern gorges (east) and older valleys containing swamps (west). The uplands are typical water-bearing country.

the approach of summer, and is generally at a minimum in March. The greatest sustained flow in the streams is observed between June and August owing to sustained rainfall and a low evaporation.

Sources of the Stream Water.—With a large catchment area existing under the conditions outlined, it might be thought that the main stream and its principal tributaries would, normally, carry a large volume of water. This would be the case if the whole area contributed a regular supply, but actually most of it is quite unreliable. In the evaluation of the land surface as a catchment area it may be considered in sections according to the broad divisions of geology and topography. These, as already indicated, are four in number.

a. *The Sandstone Tableland* (Text-fig. 3).—As Carne pointed out (1908), the Hawkesbury sandstones are essentially a non-waterbearing formation. He instances various borings undertaken in the Sydney Basin and the shafts of the Balmain Colliery (Sydney), the former being quite dry and the latter yielding a little water, mainly through a fissure. An examination of the base of the Triassic sandstones—namely, the Narrabeen beds, which underlie the Hawkesbury Sandstone series—shows that the seepage from those rocks in the Cox River area is inconsiderable. Adits driven into the coal measures immediately below the Narrabeen beds in Megalong Valley (near Blackheath), Nelly's Glen and Narrow Neck (Katoomba), and the old Gladstone colliery (near Leura), show very little seepage and in most cases are quite dry, even where loose talus slopes above could act as gathering grounds for water. When the strongly jointed character of the sandstones is remembered in addition, the absence of a considerable flow of water is all the more remarkable.

The generally impervious character of the sandstones is the result of a combination of factors. In the first place, the tableland surface is carved principally out of the top beds of the Hawkesbury series which consist, as Carne notes, of a ferruginous quartz-pebble conglomerate underlain by a coarse grit, in which there are numerous bands and concretionary structures of iron oxide. These latter are almost impervious and, as they have been developed by local concentration after the original deposition or, in some cases at least, as the result of more recent weathering, their jointing does not necessarily correspond with that of the surrounding beds. Where such bands are exposed in the upland valleys, as between Lawson and Blackheath, they frequently mark the upper edges of swamps, and water issuing from above them carries iron oxide in solution, which is re-deposited in the swamp areas as a chromatic scum.

As a general rule the sandstones are very compact and tightly cemented. They form good storage ground, as the water supply reservoirs at Lithgow (Coerwull Brook), Blackheath and Katoomba (small tributaries of Grose River), Wentworth Falls and the coastal storage areas for the water supply of Sydney testify.

The run-off from such an impervious catchment immediately after rain is a considerable proportion of the rainfall received. During, and immediately after rainstorms, the streams are greatly swollen, but quickly resume their normal appearance upon the return of dry conditions, when the entire water supply is drawn from relatively small areas.

Carne recognized upland swamps as forming "the gathering ground and starting point of the drainage", a thesis which is essentially true. In these level, ancient valleys special facilities have been provided for the storage and

gradual release of water. Surface weathering by frost and the alternations of heat and cold, together with the deeper action of plants and moisture, gradually break up rocks on the gentle slopes, giving a thickness of soil up to five feet on the uplands by the Western Railway, although in the more dissected country on either side of this watershed much less soil is noticed. Some of this material is washed into the upland valleys where it accumulates, giving sandy beds which store up a considerable quantity of water and which may favour the growth of water-loving plants.

On the higher hillsides rock degradation is a progressive factor, resulting in the cracking-up of rock masses and the development of joint and bedding planes into weathered bands. Weathering of the surface rock is accompanied by increasing porosity, which is shown well in many of the upland railway cuttings. The result of this weathering is to allow the freer penetration of rainwater, which percolates downward until it reaches an impervious stratum which is followed to the surface of the ground below the point of intake.

The horizontal line or outlet so formed represents the upper level of the resultant moist surface or swamp.

We have, therefore, to keep two actions in mind—the process of weathering and the storage of meteoric water for stream supply. When the former action is carried to completion on a surface subject to swift erosion of small ultimate magnitude, the result is seen in the formation of “monuments”. These are seen on the high ground around the more ancient valleys, and a line of them extends from the head of Cox’s River along the southern edge of the valley past Lithgow to Mt. Victoria, being found again on the cliffs above Megalong Creek, near Katoomba, and around the head of Grose Valley near Mt. Victoria. The monuments rise to thirty feet above their surroundings and are almost square in plan, tapering upwards. An edge of the base may be up to forty feet, and the prevailing strongly jointed grit is suitable for their formation.

As regards water supply, the derivation of stream water is well illustrated at Wentworth Falls, about a half mile south-south-east of the main waterfall. Here the slopes of an ancient valley overlooking the modern gorge are wet and boggy. A shallow well, deriving water from the soil and humus on the surface, is always full. Nearby, and lower down the slope, a deeper well has been cut at least ten feet in the sandstone. The top has been carefully drained so that no surface water may enter, and no other water has done so, although there are swamps both above and below.

Continuing south-east from this latter point, an extensive series of gentle swampy valleys is found draining westward to Jamieson’s Creek (to Cox’s River), whilst similar slopes drain eastward to the Nepean. In these cases good storage ground is provided by a spongy morass composed of sandy soil, humus and masses of water-loving plants, the swamps being fed in the first place by water percolating from the weathered sandstone above. The storage capacity of such an area is greatly increased by the accumulation of humus and plants.

The effect of providing artificial drains is well shown above Katoomba Falls, where such drains have been successful in collecting the water seeping from soil above the ironstone bands and delivering it quickly into the stream, thus militating against a continued permanent flow.

Streams which depend for their water supply upon swamps and shallow valleys incised in the plateau include Marangaroo Creek, Farmer’s Creek

(Cooerwull Brook), Lett River, Megalong and Jamieson's Creek and all the heads and main tributaries of Grose River. The head of Cox's River is made of two branches—tributaries of Piper's Flat Creek coming from broad, alluviated valleys to the north of Mt. Lambie, whilst Cox's Creek rises in swamps above the coal-measure shales. In this latter case, the water is derived from the monument country and weathered slopes, but the swamps themselves are in mature valleys incised 300 feet in the plateau. On leaving the higher areas the streams plunge over cliffs into another series of valleys, or flow into juvenile gorges. In either case they receive but little water from their lower courses.

b. The Older Valleys.—One series, that extending around Wallerawang and Lithgow, and carved in a varying surface of shales, sandstones, conglomerates and metamorphic strata, has already been mentioned as the gathering ground of Cox's River. Going downstream, the lower levels of Kanimbla and Megalong Valleys are met from 1,800 to 2,600 feet (average 2,200 feet). Their main extent is to the east of the river, and their surface consists of granite about the river with Permian (Upper Marine) sandstone on the eastern periphery. The talus slopes from the tableland scarps lie at angles varying from 14 to 20 degrees. On account of this slope and the coarsely fragmental nature of the scree, they are of little importance for the storage of water.

The granites of the main valley weather into a gravelly soil which gives free passage to rainwater, whilst the underlying rock is almost impervious. The small streams originating on the floors of these valleys flow only after heavy rain, and dry up quickly. On the exposed surface of Upper Marine sandstone there are level areas of porous weathered material which, aided in some cases by neighbouring weathered granite, provide storage for the water supply of Blackheath, Galong and Breakfast Creeks. The latter drains several square miles of tea-tree flats about 2,000 feet above sea-level, and is by far the largest of the three.

On the western side of Cox's River in this area, the weathered granite is deeply cut into by mature valleys, which are occupied by small, swampy creeks, including Lowther Creek, Marsden's Swamp, and Long Swamp. Compared with the area of their gathering grounds these streams are small. From the point of view of permanent water supply, the great areas of Megalong and Kanimbla Valleys cannot be compared with the restricted swamp and mature valley areas of the tablelands.

In this latter respect the valley of the Kowmung is still more striking. A great trench, twenty miles long and eight miles wide, and sloping from 2,800 feet in the south to 400 feet in the north, has been carved in the plateau. It continues still further north to form Jamieson's Valley at a rising elevation. Its floor is occupied by Kowmung River, flowing in a deep gorge, and by Black Hollow Creek. The latter receives half of the drainage, but is almost invariably dry. Partly owing to this fact its depth of entrenchment is not great, but the northern section of the Kowmung, fed by streams from the higher tableland further west, has incised a trench up to 2,000 feet deep. To the east, the parallel valley of Green Wattle Creek exists in a similar state of aridity to Black Hollow Creek, gathering water from its own level floor.

c. The Canyons.—The deep gorges which trench the older valleys and are attacking the higher (Jenolan) tableland are incised principally in granites, slates and quartzites. These newly-dissected rocks are naturally impervious, and

water falling on the steep sides of the gorges, which slope from 25 to 45 degrees, runs off quickly, except in a few special instances.

In the valley of Little River there are areas of dense forest, due to a richer soil from weathering slates and claystones and a sheltered easterly aspect. These have the effect of storing up water, thus minimizing floods and giving a good flow even in seasons of drought. This valley, with its luxuriant vegetation and level, fern-covered sidings near the stream, contrasts with the sterile slopes and rocky bottoms of the turbulent and variable Cox and Kowmung. Other forest areas are found along the head gullies of Jenolan and Kanangra Rivers, and on the eastern side of Gangerang Range overlooking the Kowmung River. The forests and brush of Gangerang are developed from 1,500 to 3,300 feet above sea-level on slates facing eastward. The section appears to receive a heavy rainfall as it faces eastward and presents a high, bold slope. The forests act the part of a sponge and feed Gingra Creek. The lower course of this Kowmung tributary is in a characteristically sterile gorge.

Jamieson's Valley and its southern extension to the Kowmung Valley beyond Cox's River have areas of forest on eastern and southern slopes, between 1,300 and 2,600 feet. These act as storage grounds but the westward slopes, subject to cold winter gales, are only sparsely forested.

The canyon sides, then, contribute little to the normal water supply of the streams. This applies with equal force to the gorges dissecting ancient valleys and those cutting back into the higher tableland.

d. The High (Jenolan) Plateau.—Rising from 3,300 to 4,400 feet, the essentially level plain which forms this part of the tableland has a surface comprised of weathered metamorphics, granite and Tertiary basalt, with a few small outliers of Permian rocks. Considerable areas have not yet been subject to dissection, but preserve the mature features developed both prior and subsequent to the extrusion of Tertiary basalts. The water supply comes from three principal sources—forest lands, swamps and basaltic residuals, a special case of the second being provided by certain Tertiary wash.

Considering these in order, we find that there are areas of forest along the high ridge which passes from Rydal, through Hampton, immediately to the west of Jenolan Caves and thence to Kanangra Walls, a distance of 35 miles. The forests grow on level, deeply-weathered country with an extent up to two miles on either side of this ridge. The soil, while generally of a clayey nature, is able to retain much moisture where it supports forests and has the associated humus. The heads of valleys in this area are marked by clear, boggy patches in the forest. This high ridge gives water to Fish River (Macquarie system), and to tributaries of the Cox and the Kowmung. The head stream of the latter—Hollander's River—derives much water from this source, the forest lands sloping gently into the upper valleys of the stream. This also applies to the southern head of Tuglow River, ten miles south-west of Jenolan Caves.

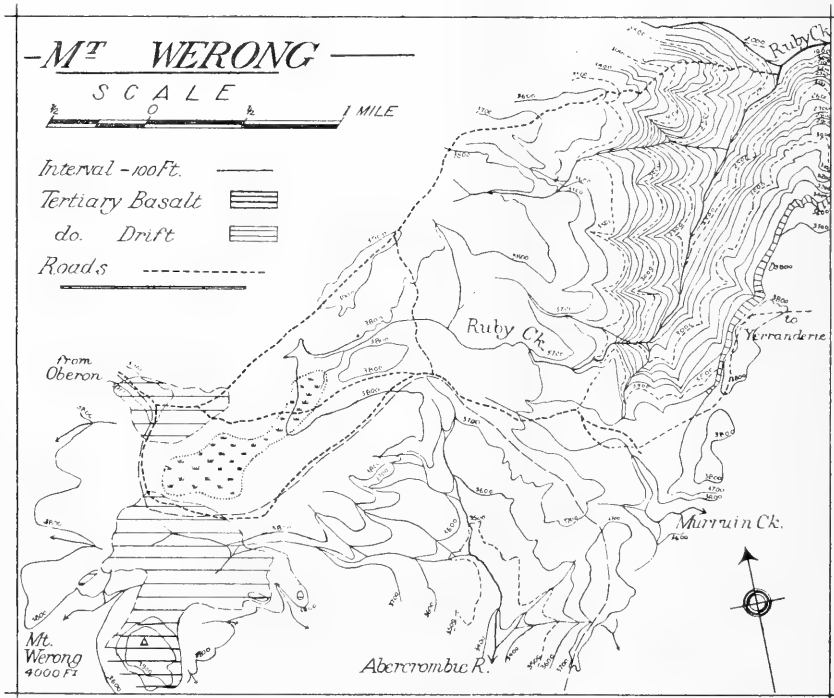
Of the purely swamp areas, three are most notable, at the heads of Boyd, Kanangra and Werong (or Ruby) Creeks. Of these, the first two are only a mile apart in places, but the third is on the Main Divide between the Kowmung and Abercrombie Rivers.

Boyd Creek rises in granitic country about 3,600 feet above sea-level. The northern branch is in a level tea-tree swamp, whilst the more permanent southern head is in a morass two miles long, both occurring in broad, mature valleys incised

300 feet in the tableland surface. Granite here is deeply weathered, and the valleys have been partly filled with hill wash which makes a fine storage ground. Swamp plants grow in profusion in the morass, giving a spongy surface. A similar effect is achieved by tea-tree in the other branch. The water table corresponds with the upper limit of unweathered granite and, where the surface deposits have been removed on the downstream side by recent erosion, this fresh surface is revealed.

Further east, the heads of Kanangra Creek are found in swampy valleys beginning on the face of a steep eastward slope leading from 3,900 to 3,300 feet. The edge of the Upper Coal-Measures and Upper Marine Series is represented at, and below, the lower level by shore line agglomerates, conglomerate, grit and carbonaceous shale containing a coal seam. These strata rest on, and against, Devonian quartzites and slates, the surface having been weathered to produce the soil necessary for water storage. As with the head of Boyd Creek, tea-tree and other water-loving plants have taken possession of the moist areas, greatly increasing the natural water storage capacity. Such streams as Boyd and Kanangra Creeks have a constant, permanent flow, the swamps distributing their water gradually and uniformly.

The third area quoted above, at the head of Ruby or Werong Creek, owes its origin to a slightly different circumstance. There are beds of Tertiary wash (Text-fig. 4) resting on slate and intrusive quartz-felsite and quartz-porphyrity. The



Text-fig. 4.—Water-bearing upland country at Mt. Werong. The tableland is swampy or forested. The gorge of Ruby Creek is typical of the deep canyons, and its sides give no permanent contribution to the stream.

sediments are overlain, in a small portion, by Tertiary basalt, which has hardened and crystallized some of the sands. Mature valleys up to 150 feet deep have been carved in the surface with their heads encroaching on the drift, which has been partly redistributed by streams radiating from the basalt knob of Mt. Werong. The presence of a thick layer of soil in the valleys and on the hillsides, together with water-bearing drift, has resulted in the formation of swamps, which give a permanent water supply to Ruby and Murruin Creeks, the latter draining eastward to the Wollondilly River. Apart from these areas the gentle, deeply-weathered and forested slopes on the west of the Main Divide provide water to the head of the Abercrombie River.

The two basalt areas worthy of note are at Shooter's Hill and at the head of Budthingeroo Creek, the latter being between Jenolan Caves and Kanangra Walls. Tuglow River heads in a broad, mature valley near Shooter's Hill. The valley itself is at 3,800 feet, whilst the basalt mass of the hill, which is reported to overlie gem-bearing Tertiary wash, rises 300 feet higher. Underlying strata weather to give a stiff clay soil almost impervious to water. Thus Shooter's Hill resembles the other basalt masses of the tableland in that the basalt, although itself impervious, is notably cracked and broken. Water can thus penetrate some distance below the surface—in many cases right to the base of the flow—and, being gradually given up, it provides a permanent flow to nearby valleys. The gradual removal of soluble matter tends to form cavities in the basalt, giving increased facilities for water storage.

In a similar area on Budthingeroo Creek at 3,950 feet, the basalt itself is crossed by gentle, swampy valleys some 300 feet below the surface of the tableland. Again water supply depends upon accumulation of soil in gentle valleys and the presence of much-cracked and broken rocks.

The canyons which penetrate this high region have the normal characteristics of fresh rock-slopes, namely, generally sparse forest and a very quick run-off. They are marked by considerable roughness and depth, the deepest, that of Kanangra Creek, being incised 3,100 feet in the tableland.

Upland Valleys.—The occurrence of valleys such as those shown in Text-figures 3 and 4 is of considerable physiographic interest. In the former case a broad, swampy valley 200 feet deep has been incised in Hawkesbury sandstone below the southward continuation of the Mt. Hay basaltic level. In the latter case the mature valley of Ruby Creek has been eroded to a lesser depth in slate and intrusive porphyries, but again the time relation of the upland valleys to the Tertiary drift and basalt is clear. Upland valleys indicated in these two figures share one point in common with Lithgow and Kanimbla Valleys—all are of post-basaltic age. These shallow upland valleys represent a period of erosion—probably a continuation of the cycle begun before the outpouring of the basalts—definitely ante-dating the modern "canyon cycle". It is not suggested that these basalts are all of similar age, but the broad agreement of physiographic resemblances certainly calls for remark, and is typical of such areas in the Central Tableland.

Conservation of Water Supply.—Cox's River and its tributaries depend upon limited areas existing under special conditions for their normal water supply. In order to maintain the permanency of the streams it is necessary to protect their sources of supply—the swamp areas and the upland forests. The artificial draining of the swamps and the deforestation of the highlands will result in

the drying up of stream sources, in increased erosion and sterility of the tablelands, and in the further development of those features characteristic of streams in semi-arid regions namely, violent floods alternating with periods of little or no flow and the complete silting of their courses. These streams are bound to be of greater importance in the future for purposes of water supply and the generation of electric power for the mining of coal and metallic minerals, so their preservation and the checking of erosion resulting from indiscriminate settlement and deforestation are of great importance.

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NOTES ON AUSTRALIAN DIPTERA. XXV.

By J. R. MALLOCH.

(Communicated by Dr. G. A. Waterhouse.)

(Eighteen Text-figures.)

[Read 30th July, 1930.]

The present paper contains, besides some additional data on four families that have been already dealt with to some extent in this series, a revision of the species of the calliphorid subfamily Metopiinae, and some notes on Empididae.

I have to a large extent recently neglected the smaller forms from Australia, of which I still have many submitted to me by the late Dr. E. W. Ferguson and others, but, in view of the greater amount of interest generally evinced in the Tachinidae and similar families, I have deferred working up the many species of such families as Chloropidae that are yet before me.

Family ORTALIDAE.

Subfamily PLATYSTOMINAE.

I am as yet not in possession of sufficient material to present a synoptic key to the genera of this subfamily; in fact I am not in possession of a sufficient number of the genera of the family to give a generic key for any other subfamily of it.

Genus POGONORTALIS Hendel.

POGONORTALIS DOCLEA Walker.

Some specimens named by Coquillett *Rivellia doclea* Walker, in the United States National Museum, are identical with *barbifera* Hendel and are evidently correctly named. The species will, therefore, be known as *Pogonortalis doclea* (Walker). It may be noted that Hendel uses the name *barbata* in his generic key for the genotype, but in the text he uses *barbifera*. The above synonymy prevents any question being raised as to which of Hendel's names ought to be used.

Genus EUPROSOPHA Macquart.

EUPROSOPHA CONJUNCTA Hendel.

In connection with the separation of this species from *separata* Hendel in my key, it must be noted that the character of the scale-like hairs of the abdominal tergites applies to the males only, the females in both species having the apex of the first visible tergite only with scale-like yellow hairs. It would appear worth noting that, in addition to the character of the connected apical and preapical dark marks on the wing, the present species has the tegular process produced forward at least as far as the base of the posterior notopleural bristle, while *separata* has it produced only to the hind margin of the mesopleura.

Three females, Kuranda, Qld., no other data (F. P. Dodd).

EUPROSOPIA MACROTEGULARIA Malloch.

Eight specimens including both sexes, Mt. Molloy, Qld. (F. H. Taylor).

EUPROSOPIA PUNCTIFACIES Malloch.

One female, Kuranda, Qld. (F. P. Dodd).

The tegulae are very short, extending to pleural suture as in *separata*. The species was described from the male only.

A striking feature of this species is the presence of four vertical bristles, all the other Australian species known to me except *miliaria* Hendel having but two verticals. The fourth visible tergite in the female is similar to the third in colour and texture, and there is no indication of a pair of dorsal subapical spiracles on the dorsum, in contradistinction to *biarmata* Malloch, *conjuncta* Hendel, and *separata* Hendel, in which there is a white-fringed spiracle on each side close to apex of dorsum. In *scatophaga* Malloch this pair of spiracles is much closer together and clear of the hind margin of the tergite.

EUPROSOPIA MACULIPENNIS Guérin.

I included this species in my first key to the species of this genus on the basis of the record by Hendel and his figure of the wing. I have now before me two examples and desire to add some notes on the species.

Hendel's figure of the wing, although photographic, does not show the apical markings as distinctly as is the case in my material, both of the latter specimens having a distinct, though not conspicuous, fuscous fascia over the outer cross-vein which is to a greater or lesser extent broken by pale marks in its field, especially in the marginal cell where it is represented by three or four small spots. It will thus be necessary to qualify my statement in the key in which I state that there is no fascia beyond the middle of the wing, the series of dark markings being possible of acceptance as a fascia in the more fully marked examples. However, the other characters are correct and no doubt the key will serve its purpose until I get sufficient material to enable me to draw up a more reliable one based upon a knowledge of the variations in this and other species.

Hendel was in error in stating that there are but six scutellar bristles, as in the male and female before me there are eight. The abdomen in the female has pale lanceolate hairs at apices of first and second visible tergites, the male has such hairs at apices of first to third and on disc of third and fourth tergites. The facial carina is granulose. Tegulae almost unproduced forward in either sex.

Locality: Brisbane, Qld., 2.12.1913 (H. Hacker). Baker collection, United States National Museum.

EUPROSOPIA TENUICORNIS Macquart.

Although I included this species, which is the genotype, in my synoptic key to the species, I did not record it as amongst the available species. It has now come to hand from Mr. F. H. Taylor, but only the female is represented in the series of six examples.

Structure of tegular process as in *conjuncta*, arista bare at base, scutellum without any indication of an apical central sulcus, evenly rounded and with six bristles, lateral portions of apices of first to third visible tergites with pale yellow lanceolate hairs, least noticeable on third tergite.

Locality, Sydney, N.S.W., February, 1928 (F. H. Taylor).

No more definite record has been published for this species than Australia up to the present. Macquart's record for Tasmania is undoubtedly an error.

EUPROSOPIA BIARMATA Malloch.

Fortunately a female of this species has been submitted by Mr. Taylor, so that at least one specimen will be available for comparison in some Australian museum. This example is identical in all respects with the type specimen which has to be returned to the Deutsches Entomologisches Museum.

As indicated in my original description, the species will not run into either of the two divisions of my synoptic key, because of the very slight apical sulcus and dark brown glossy lateral areas of the scutellum. It finds its closest affinities in the *separata* group, as none of the other species now known to me has the scutellum glossy laterally at apex, all having very distinct and dense greyish dust on the entire surface.

Locality: Tully, Qld., October, 1925 (F. H. Taylor).

EUPROSOPIA SCATOPHAGA, n. sp.

♀. A smaller species than *macrotegularia*, but resembling it in the marking of the wings, except that they are more evenly reticulated at bases and the fascia over the other cross-vein is broader and more intersected on costa with pale marks so that it resembles a broad-limbed V.

Head clay-yellow, frons fulvous yellow, with irregular dark dots and small marks centrally and in front and the upper lateral margins dark, the upper orbits overlain with pale dust; face with a dark mark from middle of each antennal fovea to mouth-margin, labrum with a dark mark on each side; palpi fuscous, yellow at bases and apices; antennae brownish testaceous. Thorax as in *macrotegularia*, dorsum with dark-brown vittae which are much interrupted, three dark marks at base of scutellum; pleura without dark dots, but shaded with dark-brown on parts. Abdomen with the tergites blackish-brown, sides of anterior half of first visible tergite and two rather indistinct central anterior marks on third pale-grey dusted. Legs fuscous, basal half or more of each tibia fulvous yellow, basal segment of each tarsus, except the extreme apex, white. Wings rather evenly marked with fuscous streaks and spots, the most conspicuous being a fascia over inner cross-vein which is darkest on costa and tapers off behind, and a V-shaped fascia over outer cross-vein which is not connected with the apical spot, the latter with a pale mark at centre, and numerous small dark marks between the fasciae and basal of the one over inner cross-vein. Halteres yellowish-brown. Mesonotum with dark hairs except on posterior margin, scutellum pale haired except at base, pleural hairs partly pale and partly dark.

Arista bare; third antennal segment extending to below middle of face; facial carina microscopically transversely striate. Scutellum with a slight apical central depression or sulcus and six bristles, not glossy on sides. Abdomen with scale-like yellow hairs on apex of first visible and sparsely over entire surface of second, third and fourth tergites. Legs normal. Tegular process short, extending to suture, lower process lacking or minute.

Length, 7-8 mm., exclusive of ovipositor.

Type and six paratypes, Eungella, via Mackay, Qld., altitude 2,300 feet, March 1, 1929, on horse dung (F. H. Taylor).

This species is another one which does not fall into either of the two initial segregates in my key, having a distinct apical sulcus and no glossy lateral areas on the scutellum.

Genus LAMPROGASTER Macquart.

In a recent paper on Australian species of this genus I believe I mis-identified one of van der Wulp's species and below offer a few notes to clear up the situation.

LAMPROGASTER ELONGATA van der Wulp.

I identified as this species two examples from Cairns, N. Queensland. These agree very closely with the description of *elongata* and, were it not for the fact that I am now in possession of a series of specimens which differ in a few essential features while agreeing in the main with the Australian specimens, I would still be of the opinion that the latter represented van der Wulp's species. The new material is from Papua, the original locality of the species, and the weight of evidence appears to justify my decision that these, and not the Cairns examples, represent the true *elongata*.

It is opportune that I present a few additional characters which modify my key in the paper just referred to. The changes are embodied in the following paragraphs.

3. Mesonotum with a well developed pair of prescutellar acrostichals; humeral bristle present; general colour of thorax and abdomen rufous, with a conspicuous metallic-blue tinge, the mesonotal hairs and bristles black; scutellum slightly sulcate in centre at apex; fourth wing-vein not conspicuously curved forward at outer cross-vein, practically straight on its apical section, the first posterior cell slightly and gradually narrowed from outer cross-vein to apex *pseudelongata*, n. sp.
- Mesonotum without a distinguishable pair of prescutellar acrostichal bristles, the other characters not as in above combination; fourth wing-vein always very noticeably bent forward at outer cross-vein, the first posterior cell much narrowed from there to short of middle of apical section of fourth vein, and practically parallel-sided from there to apex 4
4. Humeral bristle well developed; general colour of thorax and abdomen deep metallic violet-blue; face testaceous, with a dark streak on each side from antennal fovea to mouth; mesonotum with the hairs and bristles dark; mid tibia with one or two strong black apical ventral spurs; ventral surface of scutellum much paler than dorsal, yellowish; second vein of wing not at all undulated apically *xanthoptera* Hendel
- Humeral bristle lacking; face testaceous, without well defined dark lateral streaks; ventral surface of scutellum not paler than dorsal, scutellum either all blue or yellowish; second wing-vein distinctly undulated apically 4a
- 4a. Thorax and abdomen metallic violet-blue, dark haired; mid tibia with a strong black apical ventral spur *elongata* van der Wulp
- Thorax and abdomen testaceous yellow, with a more or less evident blue or violet suffusion, the hairs on both yellow; mid tibia with the apical ventral spur yellow or pale-brown *zelotypa* Hendel

There are so few characters for the distinction of the above species outside of those included in the diagnosis that descriptions may be dispensed with.

Locality: Papua (F. P. Dodd). Ten specimens, including both sexes.

LAMPROGASTER PSEUDELONGATA, n. sp.

♀. This species agrees very closely with the preceding one, differing in being less intensely violet blue, the thorax and abdomen showing a brownish ground colour through the metallic suffusion, while in *elongata* this is rarely evident

except on the thorax. The structures mentioned in the synopsis, by means of which I am distinguishing the species, are not mentioned in Hendel's paper. I figure the apical portions of the wings of the two species to demonstrate more clearly the differences in venation (Figs. 1 and 2). The apex of the scutellum

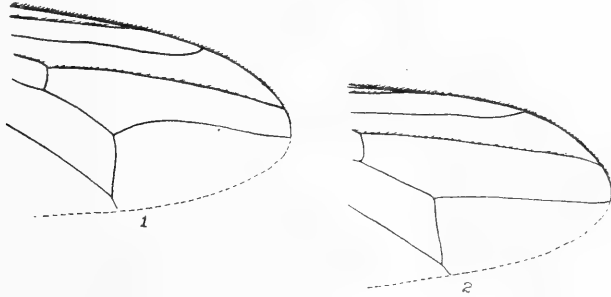


Fig. 1.—*Lamprogaster elongata*. Apex of wing.

Fig. 2.—*Lamprogaster pseudelongata*. Apex of wing.

in the new species has a rather evident but shallow depression or sulcus in centre between the apical bristles, which is not distinguishable in *elongata*.

Type and one paratype, Cairns, N. Qld., 1907 (Coll. Lichtwardt). Type in Deutsches Entomologisches Museum, Berlin-Dahlem, paratype deposited in Australian Museum by the author, on authority from Dr. Walther Horn.

I have no additional data on the other species listed in the key above.

LAMPROGASTER FUSCIBASIS, n. sp.

♂, ♀. General colour tawny or pale-brownish testaceous, with variable subcutaneous dark dots on face and thorax, which may not be normal, frons variably darkened centrally, thoracic dorsum with traces of four dark vittae which are not at all clearly defined, the scutellum sometimes darkened in part on disc, abdomen paler than thorax, without dark markings, sometimes with a bluish or violaceous lustre that is not very distinct. Legs pale. Wings yellowish, with a brownish or fuscous cloud at bases, which extends over costal half or more and to the apices of the basal cells, and is most distinct over the veins closing the latter, the costa yellowish, most intensely so, in the stigmal region, inner cross-vein quite distinctly clouded with brown. Calyptres yellowish-brown, margin of upper one darker; halteres yellowish-brown.

Head of the same type as that of *viola* Malloch, adhering rather closely to the anterior margin of thorax, and without a deep concavity on upper occiput; frons half of the head-width, with the usual four vertical bristles; arista short-haired on basal half; genal bristle pale and short. Thorax with bristling as in *pseudelongata*, but the scutellum is without fine hairs and has usually ten marginal bristles. Abdomen broadly ovate, the first visible tergite adhering quite closely to metanotum and with a deep rounded excavation in front, which is defined by a sharp edge. Legs normal, the mid tibia with two or three black apical ventral spurs. Wing-venation similar to that of *pseudelongata*, except that the second vein is almost straight.

Length, 13 mm.

Locality: Kuranda, Qld., no other data (F. P. Dodd). Type, male, allotype, female.

This is the most robust species of the genus known to me and, unless it has lost some of its usual colour, the dullest-coloured one. In Hendel's key to the species of the genus it runs fairly well to *basalis* Walker, but an examination of the description of that species shows clearly that it is distinct from it both in colour, and in the bare scutellum and less densely haired thorax and abdomen. In my key it will run to Caption 9, but it does not fit in either of the segregates there defined.

Family SAPROMYZIDAE.

Genus SAPROMYZA Fallen.

SAPROMYZA LICHTWARDTI, n. sp.

♀. Head clay-yellow, frons dark-brown, opaque, shining and yellow on a narrow line on each side and the orbital stripes; upper half of occiput dull-brown; face without dark marks; antennae and aristae black; palpi yellow. Thorax clay-yellow, mesonotum, scutellum, and metanotum fuscous brown, the first-mentioned with slight pale-grey dusting. Abdomen yellowish-brown, the tergites possibly variable in depth of colour. Legs yellow, fore pair black from basad of middle of femora to apices of tarsi, mid and hind pairs with apices of femora and tibiae deep-black, bases of tibiae and apical two or three segments of tarsi darkened. Wings hyaline. Halteres yellow.

Frons nearly one and a half times as long as wide; ocellars short and fine; longest hairs on arista about twice as long as its basal width; general structure as in *alboatra* Malloch. Thorax as in that species; intradorsocentral hairs in about eight series; anterior sternopleural undeveloped; prosternum with a few hairs. Mid tibia with one long apical ventral bristle; hind femur without apical anteroventral bristles; fore femur without an anteroventral comb. Inner cross-vein close to middle of discal cell; ultimate section of fourth vein but little longer than penultimate section.

Length, 7.5 mm.

Type, Herberton, N. Qld., 3,700 feet, January, 1911 (Dodd).

Type in Deutsches Entomologisches Museum, Berlin-Dahlem, Germany.

This species will run down to Caption 23 in my recently published key to the species of this genus, but will require a new segregate, because the frons is neither entirely black, nor entirely yellow, being brown with pale orbital stripes. The black palpi distinguish the species from *alboatra* Malloch and *brevicornis* Malloch, the two species in the section with black frons. In the published key, *mariae* is used at the second segregate of Caption 24 instead of *brevicornis* Malloch, an error which I am unable to account for, as the species are not at all similar and *mariae* occurs subsequently in the key at its proper place.

Family CLUSIOIDIDAE.

The family Clusioididae is the same as Heteroneuridae and Clusiidae of authors. Only one species is as yet recorded from Australia, to which I now add a second one.

Genus HETEROMERINGIA Czerny.

The new species may be distinguished from the one already described by means of the following characters:

- A. Wing with a faint fuscous cloud which extends from costa to a little beyond fourth vein on slightly less than the apical half; halteres black *imitans*, n. sp.
- AA. Wing with three quite conspicuous blackish fasciae, the basal one narrow and extending entirely across wing, the second one broader and enclosing the two cross-veins, connecting with a broader apical fascia along costa, and less distinctly so with it along hind margin of wing; halteres with yellow knobs
..... *australiae* Malloch

HETEROMERINGIA IMITANS, n. sp.

♀. Almost identical with *australiae* in colour and markings, the principal distinctions lying in the features listed in the above synopsis, and in its having black palpi, and the fore femur with a smaller dark apical spot. Structurally the two species are very similar, both of them having the ocellars very small, a character which distinguishes them from *nigrimana* Loew of Europe, to which *imitans* is very similar in other respects. The yellow coxae and femora, and faintly marked wings should readily distinguish the species from the European form.

Length, 3.5 mm.

Type, Cairns, N. Qld., 1907 (Coll. Lichtwardt, Deutsches Entomologisches Museum).

The type specimen is the only one available and it must be returned to the museum to which it belongs. I consider, however, that there will be no trouble experienced in distinguishing it when it is again collected. As already pointed out, the species may frequently be found upon fallen tree-trunks in shade and, wherever the insects are present, patient and careful collecting will disclose that they are not as rare as their infrequent occurrence in collections would appear to denote.

Family NEOTTIPHILIDAE.

Genus TAPEIGASTER Macquart.

I have recently received from Dr. Walther Horn, examples of two species of this genus, previously unknown to me, and below I present a key for the identification of the species. It should be noted that the upper mouth margin (epistome) in *marginifrons* is quite prominently produced, contrary to Bezzi's statement in his key, and that this species is more closely related to *argyrosipila* than to the other species.

Key to the Species.

- 1. Hind femora not noticeably stouter than mid pair; epistome transverse, or almost so, but little produced beyond vibrissal angle 2
- Hind femora distinctly stouter than mid pair; epistome produced centrally well beyond level of vibrissal angle 4
- 2. Mid and hind femora slender, about equally thick, fore pair quite noticeably stouter than either pair, fore and mid pairs with two series of rather short black spines on less than the apical half, one on the anteroventral and the other on the posteroventral surface; femora with black mark at apices, none on central portion; tibiae without long hairs; hypopygium of male without any dorsal process *fulva* Malloch
- Mid femora distinctly stouter than hind pair, all pairs with a median dark mark or ring; second hypopygial segment of male with a pair of processes 3
- 3. Tibiae of at least the mid and hind legs with dark basal annulus; processes of second hypopygial segment prominent, pointed, and slightly curved
..... *annulipes* Macquart
- Tibiae all lacking a dark basal annulus; processes of second hypopygial segment short and blunt *luteipennis* Bezzi

4. Antennae black or fuscous; rather slender species, testaceous brown in colour, with a broad central grey-dusted vitta on the mesonotum, which may be more or less divided by longitudinal dark lines; abdomen grey-dusted, each tergite with a more or less evident brownish spot on each side of anterior half
 *marginifrons* Bezzi
 Antennae fulvous yellow, but slightly darkened; species fulvous yellow in colour, mesonotum greyish-dusted; abdomen shining fulvous yellow, with a black dorsal mark over apical half of second, all of third and fourth visible tergites
 *argyrosbila* Bezzi

TAPEIGASTER ANNULIPES Macquart.

One male, Katoomba, Blue Mts., N.S.W., 3,400 feet, 1912 (Dodd). Lichtwardt collection.

TAPEIGASTER MARGINIFRONS Bezzi.

This is apparently the commonest species of the genus, judging from the number of specimens that I have examined.

Sunbury, Vict., and specimens with same locality and date as the preceding species. Lichtwardt collection. Thirteen specimens.

TAPEIGASTER ARGYROSPILA Bezzi.

This species is considerably stouter than any of the others and more brightly coloured, the dark dorsal mark on the abdomen standing out quite conspicuously. It may be noted that the epistome is not always bituberculate, as one of the specimens before me now has the tubercles almost undeveloped.

Male and female, Sunbury, Vict., Lichtwardt collection.

Bezzi had only the male before him when he described the species, and this is the only subsequent record of the species.

TAPEIGASTER FULVA Malloch.

I have seen only the original material of this species.

TAPEIGASTER LUTEIPENNIS Bezzi.

This species is yet unknown to me.

Family CALLIPHORIDAE.

Subfamily METOPIINAE.

The family Calliphoridae, which I have dealt with to some extent in a previous paper in this series, is distinguished from Tachinidae by the lack of a prominently rounded postscutellum, and the exposed second abdominal sternite, the latter overlying the lateral edges of the second tergite.

The Metopiinae are readily distinguished from most Calliphoridae by the bare or microscopically pubescent arista, in which respect they agree with most Tachinidae, but there are many genera of Calliphoridae outside of this subfamily, which have the arista bare or almost so, and it is difficult to distinguish metopiine species from such genera. Up to the present, I have seen no genus from Australia that could be the cause of doubt as to its position either in Calliphorinae, Sarcophaginae, or the present subfamily, though it is quite possible that such may exist. The situation, therefore, is not as difficult here as in America where a number of rather doubtful forms occur, and for present purposes one may accept as belonging to Metopiinae all species having hypopleural bristles, that lack a

well developed postscutellum, have the second abdominal sternite overlying the edges of its tergite, the arista bare or almost so, the stem-vein of the wing bare on its basal section above, the lower calypter bare, the occiput dusted on each side of upper half, and the notopleural bristles usually two in number. It is worth mention that the prosternum and postalar declivity in all Australian species known to me are bare, the palpi are always present, the first posterior cell of the wing is always open and ends at some distance before apex of wing, the abdomen has always bristles on dorsum, sometimes reduced to those at apex of third visible tergite, and the lower calypter is widened behind, and more or less bulged up basally.

So far as we know at present, the females are viviparous, and the larvae live in the nests of Hymenoptera-Aculeata, generally in those of fossorial forms, the habits of the flies in pursuing their prey-laden hosts being the basis for many interesting notes in various entomological journals.

In attempting to make use of the generic key given below, it must be distinctly understood that it is applicable to only the Australian material available to me at this time. In North America there are some species referred to one or more of the included genera, which would not run out at the proper position in the key, but these are exceptional and need not interfere with the use of the key for the purpose of identifying native species. It may be pertinent to note that the region I refer to as the "notopleural triangle" is the slightly depressed and more or less triangular region at each side of the transverse suture, the lateral margin of which supports the notopleural bristles. The presence of numerous hairs on this region in the Australian species of the genus *Protomiltogramma* Townsend has caused me to retain this as a valid genus, though it is very closely similar to *Senotainia* Macquart, and may yet be united with it.

Key to the Genera.

1. Propleura haired in centre 2
 Propleura bare in centre 3
2. One or both of the notopleural bristles duplicated, the adjacent hairs long and strong; fore tibia with two subequal preapical dorsal bristles; frontal orbits with two or more series of lateral hairs, and no strong proclinate outer bristles *Austrometopia*, n. gen.
 Neither of the notopleural bristles duplicated, the triangle otherwise bare; fore tibia with one outstanding preapical dorsal bristle; frontal orbits almost bare outside of the inner marginal bristles, except for two or three strong proclinate bristles *Chaetometopia*, n. gen.
3. Parafacials each with a single series of quite long bristles near anterior margin extending to below middle of face; facial ridges with a few bristles above vibrissae of about the same length as those on the parafacials and extending upward almost, or quite, to the lowermost of the latter; first and third wing-veins partly setulose above *Opsidiopsis* Townsend
 Parafacials bare, or with microscopic hairs, if rather strongly setulose their entire width above is armed and not only the anterior margin; first wing-vein bare, third setulose at base 4
4. No outstanding bristle at vibrissal angle, the series quite regular
 *Miltogramma* Meigen
 One of the bristles at vibrissal angle much longer than the others in the series on facial ridges 5
5. Parafacials with strong black bristly hairs which are distinctly lengthened near anterior margin, especially below, the longest fully as long as width of parafacial at level of its base; postsutural dorsocentral bristles in three pairs and quite long; first posterior cell of wing much narrowed at apex, sometimes practically closed *Aenigmatopia*, n. gen.

- Parafacials with very inconspicuous hairs, or bare; postsutural dorsocentral bristles in four pairs, the two or three anterior pairs short and weak, almost, or quite, indistinguishable from the adjacent hairs; first posterior cell of wing always quite distinctly open 6
6. Frontal orbits with one or two series of strong black hairs laterad of the inner marginal series of bristles; vibrissae separated from each other by a much greater distance than either is from eye-margin, and situated at less than the length of second antennal segment from mouth-margin
 *Pachyophthalmus* Brauer & Bergenstamm
- Frontal orbits without series of noticeable hairs laterad of the inner marginal bristles, usually with two or more strong proclinate outer bristles on upper half; vibrissae separated from each other by a distance equal to, or shorter than, that of either from eye *Protomiltogramma* Townsend

Genus AUSTROMETOPIA, n. gen.

This genus is very similar in most respects to *Pachyophthalmus*, but is readily distinguished from it and all other genera of the subfamily known to me except one, by the haired central anterior portion of the propleura. The strongly haired notopleural triangle is characteristic of these two genera, though most of the Australian species of the subfamily have hairs present there and, like *Pachyophthalmus*, it has one or two series of quite well developed black hairs on each frontal orbit laterad of the inner marginal bristles. For other characters see description of the genotype.

Genotype, the following species.

AUSTROMETOPIA BURNSI, n. sp.

♂. Head black, occiput grey-dusted, postocular orbits, cheeks, face, and frontal orbits yellow-dusted, sometimes almost golden; antennae, aristae, palpi, and cephalic hairs black. Thorax and abdomen black, with grey dusting, the former with three broad shining black vittae which are traceable over the scutellum, abdomen with three shining black subtriangular marks on each tergite, less distinct on the first and fourth. Legs black. Wings greyish hyaline. Calyptrae yellowish-white. Halteres brown.

Eyes subnude, with the facets of the central anterior portion enlarged; frons at vertex about half as wide as either eye, interfrontalia complete, about as wide as either orbit above, narrowed below, each orbit with a series of incurved inner marginal bristles, laterad of these two or more series of rather strong black hairs, one strong recurved bristle near upper extremity, and the hairs continued slightly below bases of antennae; parafacials generally bare; outer pair of vertical bristles much shorter than inner pair; ocellars and postverticals practically undeveloped; profile as Figure 3; aristae subnude; vibrissae situated slightly above epistome, separated by a distance about one and a half times as great as that of either from eye; palpi normal. Thorax with only the posterior presutural and two posterior pairs of postsutural dorsocentrals well developed; prealar of moderate length; sternopleurals variable, sometimes one or two below both the anterior and posterior bristles; sides of scutellum quite densely haired on basal half or more. Abdomen subcylindrical, slightly tapered to apex, first to fourth visible tergites each with quite strong apical central bristles. Tarsal claws and pulvilli moderately large, no exceptional tarsal armature on any of the legs; fore tibiae without noticeable ventral setulae, with two posterior bristles, and the anterodorsal setulae fine; mid tibia with one anterodorsal, one ventral, and two posterior bristles; hind tibia with rather irregular anterodorsal and

posterodorsal bristles, and one anteroventral bristle. Inner cross-vein of wing distinctly proximad of apex of first vein; first posterior cell open, ending in costa before tip of wing.

Length, 6.5-7 mm.

Type, and three paratypes, Meringa, N. Qld., 28.6.1926, "Parasitic on Eumenid" (A. N. Burns). Named in honour of the collector.

Genus PACHYOPHTHALMUS Brauer & Bergenstamm.

This genus is found in North America and Europe, the species living, in the larval stages, in the nests of various genera of solitary wasps. In my present material there is but one example of the genus, a female in rather poor condition which I am unwilling to identify specifically. It does, however, closely resemble *signatus* Meigen, the genotype, which occurs in Europe and North America. Pending receipt of more and better preserved examples of both sexes, I leave the matter of specific identity unsettled, though it appears possible the species is *signatus*.

Locality: Gordonvale, N. Qld., ex. mud wasp.

Genus OPSIDIOPSIS Townsend.

I am placing in this genus one Australian species which does not agree in all particulars with the genotype, *oblata* Townsend, a North American species. There is, however, a very close resemblance between the species and the characters in which they do not agree are not in every case considered as of generic import.

The peculiar armature of the parafacials is similar to that of *Metopia* Meigen, a genus not so far known to me from Australia, but one which may be expected to occur. The principal distinguishing character, by means of which it may be separated, is the setulose upper surface of the first wing-vein, *Metopia* having this vein bare. In the genotype of *Opsidiopsis* the first vein is setulose on the basal half above, while in the Australian species it is setulose on the apical half, and while in the latter the parafacials are practically bare except for the anterior marginal bristles, in *oblata* there are fine short hairs on almost their entire extent. In other respects the two agree very well.

Nothing is known of the larval habits of the genotype, and the new species has no indication on the label other than the locality and date.

OPSIDIOPSIS NUDIBASIS, n. sp.

♀. Black, thorax and abdomen slightly shining. Interfrontalia black, vertex grey-dusted behind the ocelli; frontal orbits, face including the parafacials, cheeks, and postocular orbits densely silvery-white-dusted, occiput grey-dusted; antennae and arista black, palpi fuscous. Thorax with grey dust, the mesonotum with four narrow incomplete black vittae, the submedian pair present only in front of suture, the sublateral pair interrupted at suture; sides of scutellum darker than disc. Second to fourth visible tergites of abdomen each with a rather broad fascia of grey dust near base, which is interrupted centrally. Legs black. Wings greyish hyaline. Calyptrae yellowish-white. Halteres brown.

Eyes bare, facets very slightly enlarged centrally in front; frons at vertex about one and a half times as wide as either eye, interfrontalia in front of ocelli twice as wide as either orbit, slightly narrowed anteriorly. All four verticals long, postverticals short; vertex rather sharp, ocelli as far from vertex as they

are from each other, ocellar bristles long, proclinate, and divergent; each orbit with about eight inner marginal bristles, all but the upper one incurved, the upper reclinate, and laterad of these on the upper half two sets of two bristles, the inner pair recurved, the outer pair proclinate and slightly lower placed, a few fine black hairs laterad of the bristles, the lowermost descending to level of apex of second antennal segment; profile as Figure 4; frontal lunule distinctly haired; face not widened below; vibrissae close to epistome, separated by about three times as great a distance as either is from eye. Thorax with two plus three pairs of strong dorsocentrals, notopleural triangle without fine hairs; apical scutellar bristles shorter than the two pairs of laterals and cruciate, sternopleurals one plus one. Abdomen tapered to apex, second and third visible tergites with a pair of strong apical central bristles, fourth with a series of such bristles. Fore tarsi slender; fore tibia with one posterior submedian bristle and a series of minute anterodorsal setulae; mid tibia with one anterodorsal bristle, about four short posterior bristles, and no ventral bristle; hind tibia with about four anteroventral, posterodorsal, and anterodorsal bristles, one of the latter much longer than the others. Inner cross-vein proximad of apex of first vein; outer cross-vein at about one and a half times its own length from the bend of fourth vein, the latter angular, apical section of the vein arcuate, first posterior cell ending well before apex of wing, rather narrowly open, apical section of fifth vein about half as long as preapical section; first wing-vein setulose on about its apical third, third vein setulose above from its base to well beyond inner cross-vein and with about three short setulae at base below.

Length, 6 mm.

Type, Eidsvold, January 23, no other data. Submitted by Dr. I. M. Mackerras, and to be returned to him.

Unless my placing of this species is erroneous, the male ought to correspond closely with the female in cephalic characters and the above description should suffice for its recognition. In all probability the species occurs on sand and flies low over it, resembling certain Hymenoptera-Aculeata that occur with it.

It would appear to be worth noting, in connection with my doubt as to the generic position of the above species, that the arrangement of the fronto-orbital bristles in it is similar to that in *Metopia* and quite different from that found in the genotype of *Opsidiopsis*. In the latter, there are many short hairs on the orbits, amongst which there are two proclinate outer bristles on the upper half and one reclinate bristle which appears to belong to the inner series, but there are no intermediate reclinate bristles such as occur in *nudibasis*.

Genus MILTOGRAMMA Meigen.

This genus occurs in Europe but is lacking in North America and, while the character upon which it is separated from its allies in the key may appear at first sight a rather trivial one, it is usually sufficiently well marked to distinguish the species readily, the vibrissae in all the other genera always standing out as well differentiated bristles in the series which runs from the lower margin of cheek to a greater or lesser distance above the vibrissal angle, the latter being in all cases quite well defined. In all the Australian species the ocellar bristles are very weak, almost erect, and divergent, and the frontal orbits have outer proclinate bristles which are not as strong as in most of the other genera.

The Australian species now before me may be distinguished as in the following key. Unfortunately the species are poorly represented, and males are

almost lacking, so that good characters for their distinction are difficult to assemble.

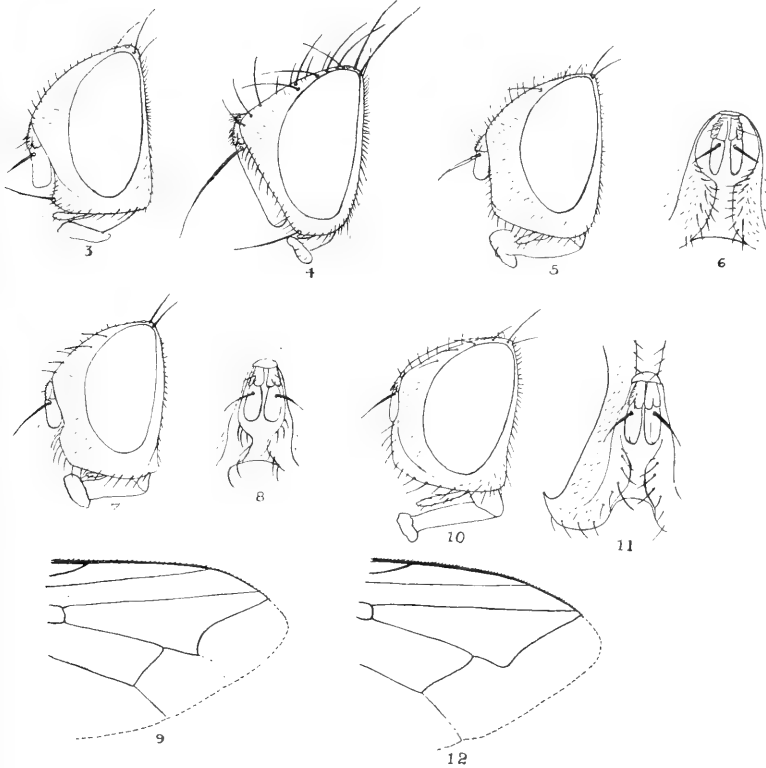


Fig. 3.—*Austrometopia burnsi*. Head from the side.
 Fig. 4.—*Opsidiopsis nudibasis*. Head from the side.
 Fig. 5.—*Miltogramma rex*. Head from the side.
 Fig. 6.—*Miltogramma rex*. Face.
 Fig. 7.—*Miltogramma rectangularis*. Head from the side.
 Fig. 8.—*Miltogramma rectangularis*. Face.
 Fig. 9.—*Miltogramma rectangularis*. Apex of wing.
 Fig. 10.—*Miltogramma normalis*. Head from the side.
 Fig. 11.—*Miltogramma normalis*. Face.
 Fig. 12.—*Miltogramma normalis*. Apex of wing.

Key to the Species.

1. Thoracic dorsum with five distinct black presutural vittae 2
- Thoracic dorsum with but four distinct black presutural vittae, the central one lacking 3
2. Vibrissal bristles in more than one series *rex*, n. sp.
- Vibrissal bristles in a single series *regina*, n. sp.
3. Fourth vein very conspicuously bent beyond the preapical angle, the latter a distinct right angle; inner cross-vein slightly but distinctly proximal of middle of discal cell *rectangularis*, n. sp.
- Fourth vein not very conspicuously bent beyond the preapical angle, the latter not a right angle; inner cross-vein slightly but distinctly beyond middle of discal cell *normalis*, n. sp.

MILTOGRAMMA REX, n. sp.

♂. Head testaceous yellow, interfrontalia brownish-red, frontal orbits, face including the parafacials, and cheeks yellow-dusted; occiput fuscous, yellowish-grey-dusted; antennae orange-yellow, third segment slightly darkened above; arista black; palpi orange-yellow; frontal hairs and bristles black, those on lateral margins of frontal orbits anteriorly, on parafacials and cheeks yellow, occipital hairs black. Thorax black, slightly shining and with rather dense grey dust, the mesonotum with five black vittae anteriorly, the submedian pair discontinued slightly behind suture, the others complete, the sublateral pair evident on sides of the scutellum, but the central one not evident there, the scutellum slightly yellowish apically. Abdomen testaceous yellow, darkened above, with a quite uniform and rather broad dorsocentral vitta and apices to tergites 2 to 4 brownish-black and slightly shining, first tergite entirely dark, the paler portions of the tergites yellowish-grey-dusted and dull, fifth tergite with the dark markings smaller than on the other tergites. Legs black, femora grey-dusted. Wings greyish hyaline. Calyptrae yellowish-white. Halteres dark-brown.

Frons at vertex about one-fifth of the head-width, interfrontalia of uniform width throughout its length, at middle more than one and a half times as wide as either orbit, all four vertical bristles well developed, ocellar and postvertical bristles very small, each orbit with a rather closely placed series of hair-like inner marginal bristles, incurved below, almost erect on posterior third, one recurved stronger bristle at the upper extremity of series, and three to five proclinate outer bristles, the outer portions of orbits with fine hairs which are continued to lower level of eyes on the parafacials; frontal lunule bare; profile as Figure 5; armature of face as in Figure 6; anterior central facets of eyes slightly enlarged. Thorax with only the posterior pair of the presutural and postsutural dorsocentral bristles well distinguished from the surrounding hairs; notopleural triangle quite copiously furnished with long erect hairs; sternopleurals one or two plus three or four; scutellum with about ten marginal bristles of rather unequal lengths. Abdomen subcylindrical, tapered apically, sixth tergite with only fine apical hairs, no bristles. Fore tarsi without exceptional armature; fore tibia with about six or seven ventral setulae at middle forming the usual comb; mid tibia with one long ventral, one or two short posterior, and three or four longer anterodorsal bristles; hind tibia with a quite regular series of rather closely placed fine bristles on anterodorsal and posterodorsal surfaces, and two to four anteroventral bristles. Inner cross-vein of wing close to middle of discal cell, apical section of fourth vein distinctly arcuate.

Length, 10 mm.

Type, King George's Sound, W.A.; no other data (Australian Museum).

MILTOGRAMMA REGINA, n. sp.

♀. A darker species than the preceding one, without trace of yellow on the scutellum, and dorsal exposure of abdomen. In other respects very similarly coloured and marked.

Structurally distinguished by the uniseriate vibrissal series of bristles. The frons is also narrower, but this is a character of the female of most of the species in this subfamily. The apical section of fourth vein is also more pronouncedly bent than in *rex*.

Length, 8.5 mm.

Type, Eidsvold, Qld. (Bancroft).

It is possible, but hardly probable, that this is the female of *rex*.

MILTOGRAMMA RECTANGULARIS, n. sp.

♀. Very similar in colour to the preceding species, but the dusting is more yellowish or brownish, the mesonotum lacks the central black vitta before the suture, the others are not so sharply defined, and the markings of the abdomen are more diffuse, the apical black fascia being rounded in front on each side and rather changeable when viewed from different angles. Knob of halteres yellowish.

Frons at vertex fully one-fourth of the head-width; interfrontalia at middle about one and a half times as wide as either orbit, the inner marginal bristles stronger than usual in the genus; profile as Figure 7; vibrissal series of bristles much stronger than in the next species (Figure 8). Thorax as in the preceding species, scutellum not at all yellowish at apex and with eight marginal bristles, including the basal one which is situated above the margin. Abdomen tapered apically, the apical bristles on tergites three and four short. Fore tarsus very slightly widened, mid tibia with one long and one short ventral bristle, the legs otherwise as in *regina*. Venation of wings as stated in the specific key, apical section as Figure 9.

Length, 7.5 mm.

Type, Sydney, N.S.W., 4.2.1924 (Health Dept).

MILTOGRAMMA NORMALIS, n. sp. ●

♀. Similar to the preceding species, but the dark thoracic vittae are rather bronzy, and the abdominal markings are more extensive.

Structurally distinguished by the characters listed in the key and the weaker series of bristles on the vibrissal region (Figures 10-12).

Length, 7.5 mm.

Type and one paratype, Kalgoorlie, Southern Cross, W.A., 13.11.1924 (Nicholson).

Genus CHAETOMETOPIA, n. gen.

This genus is very similar in general characters to *Senotainia* Macquart, and *Protomiltogramma* Townsend, but it differs from both of these in having some strong black hairs in centre of the propleura, a character which is possessed by only one other genus of the subfamily known to me and described in the present paper. This character alone will readily distinguish the genus from its allies, though it is not improbable that others as yet unknown to me may possess a similar character.

Genotype, the following species.

CHAETOMETOPIA CINEREA, n. sp.

♂. Head testaceous, occiput fuscous, entirely whitish-grey-dusted, the interfrontalia fuscous, and when viewed from behind without white dusting; antennae black, base of third segment narrowly reddish; palpi testaceous yellow. Thorax and abdomen black, densely grey-dusted, the former with five presutural black vittae on mesonotum, the submedian pair disappearing a little behind suture, the sides of the scutellum blackish; abdomen with the usual five series of black tergal spots, but in the type specimen they are sharply margined only when seen

from behind, the submedian spots narrow, extending the entire length of tergites. Legs black. Wings hyaline. Calyptrae white. Halteres yellow.

Frons at vertex a little less than one-fourth of the head-width, parallel-sided, orbits a little narrower than interfrontalia, each with two strong forwardly-directed outer bristles, an inner series of incurved bristles, and one upper recurved bristle, as well as some microscopic lateral hairs; outer pair of verticals not half as long as inner pair; postverticals minute; ocellars of moderate length; parafacials with a few weak black hairs; profile as Figure 13; face as Figure 14; eyes with the anterior central facets slightly enlarged. Thorax with two plus three pairs of dorsocentrals, and one plus one pairs of acrostichals; two strong and three weak bristles on the presutural lateral area, no hairs on notopleural triangle; sternopleurals one plus one; scutellars six; stigmatal region with three bristles, the lower one very short and weak. Abdomen cylindrical, tapered to apex, first visible tergite without apical central bristles, second with a short pair, third and fourth each with a strong pair. Fore tarsi without exceptional armature; fore tibia with two posterior median bristles; mid tibia with one ventral, one anterodorsal, and two short posterior bristles; hind tibia with one anteroventral, and two or more anterodorsal and posterodorsal bristles; tarsal claws rather long. Third vein with a few weak setulae at base; inner cross-vein at middle of discal cell; apical section of fourth vein arcuate near angle.

Length, 4 mm.

Type, Darwin, Qld. (G. F. Hill).

I have before me what appears to be a second species of this genus from North Borneo, but am not dealing with it at this time, as I intend to make a report on the collection of which it forms a part in another magazine.

Genus PROTOMILTOGRAMMA Townsend.

As already indicated in the foregoing pages, I have some doubts as to the propriety of retaining this as a good genus, the only character of note for its separation from *Senotainia* being the haired notopleural triangle, and some of the North American species of *Senotainia* have a few hairs on that portion of the thorax. There is, however, no species in Australia which appears to be intermediate and it is not really essential that the status be definitely decided at this time.

Some of the species have males in which there is a peculiar tufted appearance to the apex of the abdomen owing to the presence of numerous backwardly-directed bristles on the incurved lateral portions of the fourth visible tergite, but this is not a character that can be used as a generic criterion.

I give below a key for the separation of the species at present available.

Key to the Species.

1. Third antennal segment at least twice as long as the distance from its apex to mouth-margin 2
- Third antennal segment much less than twice as long as the distance from its apex to mouth-margin 5
2. Males 3
- Females 4
3. Wings entirely clear apically and posteriorly, quite conspicuously browned at bases on costal half, the dark colour fading out at or just beyond apex of first vein; neither frontal orbit at level of anterior forwardly directed outer orbital bristle as wide as interfrontal stripe; parafacial at middle not noticeably wider than third antennal segment *cincta* Townsend

- Wings clear, almost whitish at bases, browned on apical half, more noticeably so along the courses of the longitudinal veins; either frontal orbit at level of anterior forwardly-directed outer orbital bristle quite distinctly wider than the interfrontal stripe; parafacial at middle much wider than third antennal segment *laticeps*, n. sp.
4. Frons at vertex not more than one-fourth of the head-width *cincta* Townsend
 Frons at vertex one-third of the head-width *laticeps*, n. sp.
5. Male; wings entirely hyaline; frons more than one-fourth of the head-width
 *plebeia*, n. sp.
- Female; frons at vertex less than one-third of the head-width; central dark thoracic vitta not distinguishable over disc of scutellum *plebeia*, n. sp.

PROTOMILTOGRAMMA CINCTA Townsend.

No mention is made in the original description of the dark bases to the wings of the male. I have examined the type material in the collection of the United States National Museum and the specimens now before me agree in all respects with it.

Localities: Eidsvold, Qld., December, 1922; Sydney, N.S.W., 8.1.1923 (Health Dept.); Glenreagh, N.S.W., 1.2.1923 (Health Dept.); Blue Mts., 21.3.1922 (Health Dept.). Four specimens, two of each sex.

PROTOMILTOGRAMMA LATICEPS, n. sp.

♂. Very similar to the preceding species in general coloration, but for the information of students I give a fairly full description, *cincta* having been described in a Canadian magazine in 1916.

Head testaceous yellow; orbits, face, and cheeks densely white-dusted, not silvery, occiput fuscous except on a quadrate area behind vertex, the dark part, including the postocular orbits, densely white-dusted; antennae and palpi testaceous yellow; aristae black. Thorax black, densely grey-dusted, especially on pleura, the mesonotum with five blackish vittae, the central three narrower, the one on each side of central one discontinued a little behind suture, the central one rather faint on its hind portion, scutellum largely black, all the dark portions of dorsum with a bronzy tinge. Abdomen black, sides of segments of basal half more yellowish, apices of tergites narrowly yellowish and with whitish dust, bases of tergites quite broadly whitish-dusted, the yellowish colour showing through on second and third visible tergites, and the black colour usually carried forward to anterior margins centrally, the basal tergite black on exposed dorsal surface. Legs black. Wings hyaline, distinctly browned on apical halves, most noticeably so along the courses of the veins and costally. Calyptrae white. Halteres yellow.

Frons at vertex about one-third of the head-width, outer orbitals consisting of an upper backwardly-curved and two forwardly-directed bristles; inner margin of each orbit with about a dozen fine bristles, the upper three or four sloping backward, the others slightly inward and forward; head in profile as Figure 15, the slender part of arista much shorter than in *cincta*; face as Figure 16. Thorax with only one presutural and two postsutural pairs of dorsocentrals distinct from the surface hairs; sternopleurals one plus three. Abdomen cylindrical, slightly tapered to apex, second visible tergite without strong apical central bristles, third with the apical bristles weaker and less closely placed than in *cincta*, the fourth tergite without apical bristles; anal tuft not as prominent as in *cincta*. Fore tibia with the ventral series of setulae inconspicuous, mid tibia with a strong ventral bristle; hind femur with one rather long preapical anteroventral bristle.

two similar bristles near base on ventral surface, and some shorter and finer bristles opposite the latter on posterior surface, no fine hair-like bristles beyond the ventral pair; hind tibia with three or four anteroventral bristles, and some irregular anterodorsal and posterodorsal bristles.

♀. Similar to the male in most respects, differing mainly in the broader abdomen with more pointed apex.

In both sexes the parafacial hairs are pale and microscopic, very difficult to distinguish without the aid of a very strong lens.

Length, 6 mm.

Type, male, Sydney, N.S.W., 24.10.1923; allotype, Kojarena, W.A., 6.9.1926 (E. W. Ferguson).

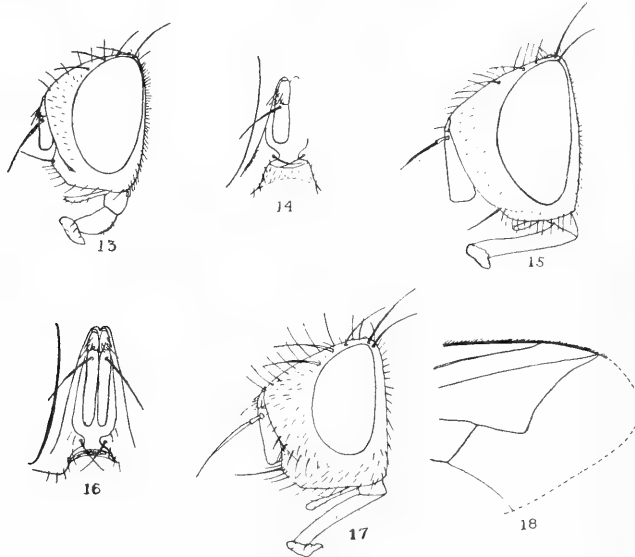


Fig. 13.—*Chaetometopia cinerea*. Head from the side.

Fig. 14.—*Chaetometopia cinerea*. Face, incomplete.

Fig. 15.—*Protomiltogramma laticeps*. Head from the side.

Fig. 16.—*Protomiltogramma laticeps*. Face.

Fig. 17.—*Aenigmatopia fergusonii*. Head from the side.

Fig. 18.—*Aenigmatopia fergusonii*. Apex of wing.

PROTOMILTOGRAMMA PLEBEIA, n. sp.

♂. Differs from the preceding species in having the frontal orbits and most of the parafacials yellow instead of white dusted, though in some lights the white colour may be distinguished, the scutellum is without dark marks except on sides, the dusting of thorax and abdomen is yellowish, and the abdomen is more extensively yellowish on sides; antennae with the third segment brown.

A stouter species than *laticeps*, with narrower frons and parafacials, shorter antennae, the vibrissae much higher above mouth-margin, arista tapered on apical half, the third visible abdominal tergite with stronger apical bristles, in addition to the characters mentioned in the key.

♀. Similar to the male, but the fourth visible tergite with some strong apical bristles.

Length, 7–8 mm.

Type, male, Sydney, N.S.W., 15.1.1923; allotype, same locality, 4.12.1921; paratype male, same locality, 30.3.1924 (Health Dept.); paratype female, Gundamaian, National Park, N.S.W., 14.2.1926 (Nicholson).

It appears to be worth noting that in both sexes in this genus there are four almost equally long vertical bristles, and in no case are the ocellars long or strong.

Genus AENIGMETOPIA, n. gen.

A peculiar genus, resembling in appearance some littoral Phaoniinae because of the grey colour and wide frons. Frons about one-half of the head-width, bristled as in the preceding genus, but the bristles much stronger, the parafacials exceptionally strongly setulose in front; profile as Figure 17. Dorsocentral bristles well developed both before and behind suture; sternopleurals one plus one. Abdomen flattened, ovate, with a pair of strong apical central bristles on second and third visible tergites and a complete series of strong apical bristles on fourth. First posterior cell of wing almost or quite closed in margin of wing (Fig. 18).

Genotype, the following species.

AENIGMETOPIA FERGUSONI, n. sp.

♂, ♀. Black, entirely grey-dusted, the parafacials and face more distinctly white-dusted; antennae and palpi black, mesonotum with faint traces of vittae in arrangement as in the preceding genus, abdomen slightly checkered on dorsum; legs black; wings greyish hyaline, veins fuscous, bright orange at bases; calyptreae white; halteres brown.

Ocellar bristles strong, divergent; outer orbitals generally four or five in number, the upper two recurved, the others proclinate, inner marginal bristles long; face not centrally carinate; profile as in Figure 17. Thorax with two plus three pairs of strong dorsocentrals and at least one pair of presutural acrostichals; prealar moderate in length; scutellum with six long marginal and two short discal bristles. Hypopygium of male small, semiconcealed. Legs much as in the preceding genus, but the ventral setulae on fore tibia inconspicuous; mid tibia with a long ventral bristle; hind femur as in *P. laticeps*; hind tibiae missing in male, that of female with one anteroventral and a number of rather irregular anterodorsal and posterodorsal bristles. Third wing-vein setulose above to beyond midway to inner cross-vein, and with one or two setulae at base below, apical venation as Figure 18.

Length, 7-8 mm.

Type, male, Geraldton, W.A., 5.9.1926; allotype, Wyalkatchem, W.A., 1.9.1926 (E. W. Ferguson).

Named in honour of the collector who was responsible for my undertaking work on Australian Diptera and who collected this and many other interesting species which have passed through my hands.

Family EMPIDIDAE.

This family has recently been reviewed for New Zealand by Mr. J. E. Collin* who records 102 species from that country, but there is no published work of any

* "New Zealand Empididae", British Museum (Natural History), London, 1928.



note on the Australian species. Tillyard, in his book on the Insects of Australia and New Zealand, published an estimate of the number of Australian species as 50, but there may be many more, as nothing has been done on the family here. I have no material of any consequence from Australia, but have quite a number of species from New Zealand, and have seen additional species from that country in the collection of the United States National Museum.

The economic status of the family is rather doubtful. Although the adults are mainly if not entirely predaceous, feeding largely upon other small insects, and especially Diptera, this does not necessarily imply that the insects are beneficial. This habit, and also that of parasitism, is too often accepted as indicative of benefit to mankind, but unfortunately neither can invariably be classed as such. There are, of course, a number of species of parasitic insects that confine themselves largely, or entirely, to one, or a few very closely related, injurious species and in such cases the parasites may be depended upon to justify their introduction into certain areas where they do not naturally occur, for the purpose of curtailing enemies of man; but, on the other hand, many such insects may eventually, on the elimination of their normal prey, or hosts, become injurious through attacking other than their normal hosts, the later choice being in no manner injurious, or even beneficial.

The larvae of many of the Empididae are found in rotten wood, in the earth in woods, and in mud of stream and lake beds. The transformation is complete. The adults of many species may be taken flying over streams, in glades in woods, or on flowers. Certain species have peculiar mating habits, the males capturing insects with which they fly past a group of females dancing in the air, whereupon one of the females darts out from the group and flies to the male, both of them settling upon the herbage or continuing flying, but almost immediately after they come together they may be found *in copula*. Several interesting notes on this habit have been published in Europe and North America.

I do not purpose presenting at this time a survey of the material in my hands, as it is quite insufficient to justify a revision of the Australian species, but I give below a key to the subfamilies, which may be found of interest to anyone having species available. The included subfamilies are those known to occur in New Zealand with the addition of Hybotinae from Australia. Possibly two or three of these do not occur in Australia.

Key to the Subfamilies.

1. None of the longitudinal veins of wing furcate, discal cell always lacking, first basal cell not longer than second *Tachydrominae*
One or more of the longitudinal veins of wing furcate, or if all are simple the first basal cell is distinctly longer than second; discal cell usually present . . . 2
2. Discal cell always present and with but two veins emanating from its apex, neither of them furcate 3
Discal cell present or absent, when present with three veins emanating from its apex, if with but two the upper one is furcate 4
3. Anal cell distinctly shorter than second basal *Ocydrominae*
Anal cell longer than second basal *Hybotinae*
4. Second antennal segment projecting forward into inner side of base of third in a finger-like process; anal cell of wing entirely lacking *Ceratomerinae*
Second antennal segment without a projection or process at apex on inner side . . . 5
5. Fore coxae elongate, at least twice as long as either of the other pairs; anal angle of wings never developed; fore legs usually fitted for holding prey
..... *Hemerodrominae*
Fore coxae not noticeably elongated, not twice as long as hind pair 6

6. Apex of anal cell of wing projecting beyond level of apex of second basal cell; mid femora distinctly thicker at bases than either fore or mid pairs, tapered to apices *Homalocneminae*
 Apex of anal cell not projecting beyond level of apex of second basal cell; mid femora not thicker than other pairs and not noticeably thickened at bases . . . 7
7. Empodium pulvilliform, the apical segment of tarsi pointed at apex above *Clinocerinae*
 Empodium normally slender and bristle-like; the apical segment of tarsi blunt or truncate at apex *Empidinae*

Subfamily EMPIDINAE.

Genus RHAMPHELLA, n. gen.

This genus has the anal vein incomplete, fading out before attaining margin of wing, and without a weak portion just after leaving the apex of the anal cell, and the subcostal vein (mediastinal of Collin) connects with the costa. It also is noteworthy that the fore metatarsus of the male is much thickened, the hypopygium of the same sex is somewhat keel-shaped; and I can detect no hairs on the posterior apical margin of the hind coxae.

Genotype, the following species.

RHAMPHELLA INCONSPICUA, n. sp.

♂. Brownish fuscous, with grey dusting. Antennae and palpi testaceous yellow. Thorax in type greasy so that it is impossible to decide if it is vittate. Abdomen largely testaceous, darkened on dorsum and hypopygium. Legs testaceous yellow, hind femora largely blackened, mid pair faintly so, apices of all tarsi fuscous. Wings hyaline, with a faint stigmal darkening below apex of first vein. Halteres brownish.

Frons at narrowest point at least as wide as base of third antennal segment, the posterior ocelli widely separated, lying close to margins of eyes; ocellar triangle not much elevated and with microscopic hairs only, no distinct bristles; vertical hairs pale and fine; antennae inserted about middle of eyes, damaged in type, but the third segment apparently short, conical, and with a terminal style; face as wide as frons; eye apparently notched at base of antenna; proboscis short and stout, not as long as height of head, projecting straight forward in type. Thorax with dorsal hairs weak and pale, mostly rubbed off in type; scutellum with four pale marginal bristles; propleura with some fine hairs below; metapleura bare. Abdomen slender, hypopygium of above average in size, rather sharply keeled below. Legs without bristles; fore metatarsus wider than apex of tibia. Upper vein emanating from apex of discal cell about one and a half times as long as that cell.

Length, 2 mm.

Type, Como, N.S.W., December, 1923, swept from flowers (H. Petersen). Submitted by the late C. F. Baker and in collection of author.

Genus RHAMPHIOMYIA Meigen.

This genus is a very large one and has recently been broken into a number of subgenera by Frey and Collin. It has been mentioned as occurring in Australia by Tillyard in his book on Australian and New Zealand insects, but no species has been described from this country up to the present. Collin does not record it for New Zealand, though I have before me one species from there.

RHAMPHOMYIA ALBIDIPENNIS, n. sp.

♂. Shining black, with milk-white wings, whitish calyptrae, and pale knobs to the halteres. Antennae and palpi black. Thorax slightly and evenly grey-dusted, with three indistinct blackish vittae on dorsum. Costal vein and apex of first vein blackish, the other veins pale. Fringes of calyptrae pale. Body and leg hairs and setulae black.

Eyes touching on about three-fourths of the extent of frons, ocellar triangle not noticeably elevated, the ocellar setulae very short and weak; third antennal segment broken off in type; proboscis not as long as height of head, eyes notched at base of antennae. Thorax rather elevated, with fine erect biseriate acrostichals and the dorsocentral series closely set and hardly stronger than the acrostichals, except posteriorly; collar with two or three hairs on each side above and one longer hair on each side below; propleural hairs not numerous; scutellum with two well developed apical marginal bristles; notopleural region with two posterior bristles and some weaker and shorter setulae in front of them and closer to margin; metapleural bristles in a single vertical series of about six. Abdomen normal, with short dark hairs, the hypopygium slightly keeled, higher than long. Legs normal, all tibiae with distinct setulose hairs amongst which there are two or three on the anterodorsal and posterodorsal surfaces of each distinctly longer than the others but not much longer than the diameter of the tibiae; fore tarsus normal; all tarsi with the claws long, equal, and curved. Wing much as in *aprilis* White, but without a dark stigmal spot, and with the discal cell comparatively longer than in that author's figure, the length of it being about three-fifths that of the upper vein emanating from its apex instead of less than one-half; sixth vein obsolete except at base.

Length, 3 mm.

Type, Seaford, Vict., no other data (W. F. Hill).

Subfamily HEMERODROMIINAE.

The genus *Ptilophyllostromia* Bezzi occurs in Australia. It is known from other genera by the plumose apical antennal arista. I have not seen the genus.

DESCRIPTIONS OF NEW SPECIES OF AUSTRALIAN COLEOPTERA. XXI.

By ARTHUR M. LEA, F.E.S.

[Read 24th September, 1930.]

In addition to truly Australian forms, five others from Fiji and Papua are herein described, but they are closely allied to Australian forms.

Family SCARABAEIDAE.

DIPHUCEPHALA GLABRA, n. sp.

♂. Green, coppery-green or coppery; elytra red with a green or coppery-green gloss, lower surface of clypeus blackish; antennae (club black), palpi, and legs (claws infuscated) reddish. Upper surface glabrous, under surface, pygidium and legs with rather dense white setae.

Head with crowded and rather shallow punctures. Clypeus almost parallel-sided, apex widely notched, front half with sparser and smaller punctures than elsewhere. Prothorax moderately transverse, with a wide median impression, evenly narrowed to apex, each side with a transverse fovea, outside of which is a strong but not very acute tooth; with large and comparatively sparse punctures, each with a central granule. Scutellum polished and impunctate. Elytra with slightly elevated lines, and coarse crowded punctures, larger across middle than elsewhere. Front tibiae bidentate at and near apex, front tarsi with four basal joints wider than those of other tarsi. Length, 8-9 mm.

New South Wales: Eccleston (J. Hopson).

The longitudinal sulcus of the pronotum is wide, fairly deep and continuous almost to apex, much as on *D. richmondia*, from which, as from most of the red-legged species, it is distinct by its glabrous upper surface. *D. pulcherrima* and *D. hirtipes* have parts of the prothorax densely squamose and are otherwise very different. The lateral foveae of the pronotum are usually isolated, but on several specimens there is a vague line connecting each of them with the median impression. I have not seen a female of this species, but there are nineteen males under examination.

DIPHUCEPHALA DICKSONIAE, n. sp.

♂. Metallic-green or coppery-green; elytra reddish with a green or coppery-green gloss, legs reddish, tarsi, antennae (except part of basal joint), palpi, and lower surface of clypeus black or blackish. Upper surface with rather sparse, uniform, white, depressed setae, becoming denser and longer on under surface and legs.

Head coarsely shagreened, punctures fairly distinct only on a semicircular space connecting the hind parts of the eyes. Clypeus with sides gently incurved to middle, apex deeply notched. Prothorax moderately transverse, median sulcus

in two parts: a wide, rather deep, and almost square basal portion, and a narrower part connected with the apex, each side with a deep transverse impression, shallowly connected with the median sulcus, the side beyond it with a distinct tooth; with irregularly distributed and fairly large punctures, each with a setiferous granule. Scutellum flat, shining, and with sparse, minute punctures. Elytra with feebly elevated lines and with coarse crowded punctures, becoming sparser at base and apex. Front tibiae bidentate at and near apex; three basal joints of front tarsi moderately wide, with dense white setae on under surface. Length, 9-11 mm.

♀. Differs in having the clypeus much shorter, traversed by an elevated line at the apical third, with the apical portion smaller, its sides not elevated and less deeply notched, abdomen more convex, middle of pygidium glabrous, and front tarsi thinner and only sparsely clothed on under surface.

New South Wales: Eccleston and Barrington Tops, in November (J. Hopson), Upper Williams River, in October (F. E. Wilson and A. M. Lea); common on tree-ferns (*Dicksonia antarctica*).

Some of the specimens, to a certain extent, resemble some of those of the preceding species, but may be at once distinguished by the clothing of the upper surface, and the median sulcus of the pronotum; on this species its basal half is wide, quadrangular, and connected with the lateral foveae. On the preceding species the sulcus decreases evenly in width from base to apex, and is isolated from the lateral foveae. In Blackburn's table it could be referred to A.B.B.C., and from the species there placed it differs from *D. nitidicollis* in its much sparser punctures of prothorax, with the lateral foveae slightly connected with the median sulcus, and in its entirely dark tarsi, which are sometimes purplish. From *D. richmondia* and *D. parviceps* it is distinct by the median sulcus of the pronotum. On some specimens the prothorax has been forced aside, exposing the basal portion of the scutellum; this is seen to be divided into two concave parts, each of which has crowded punctures.

VAR.—Three specimens (two males and one female) from the Upper Williams River have the elytra bright metallic-green (of the exact shade of the prothorax) without the least trace of red, and the antennae (except the club) reddish.

DIPHUCEPHALA CONCINNA, n. sp.

♂. Bright metallic-green, some parts coppery-green; antennae (club blackish), palpi, and legs (claws infuscated) pale-reddish. Moderately densely clothed with short, depressed, white setae, or thin scales, becoming denser on under surface; legs with thinner clothing.

Head with crowded punctures or coarsely shagreened. Clypeus convex in middle, sides gently incurved to middle, apex less deeply notched than usual. Prothorax rather feebly transverse, median line narrow but wider near apex than near base, transverse impressions narrow and isolated; punctures fairly dense and partly concealed. Elytra with several feeble elevations, and coarse, crowded punctures, becoming sparser about base and apex. Abdomen gently depressed in middle. Front tarsi with three basal joints wide, the first asymmetrical. Length, 6-7 mm.

♀. Differs in having the clypeus smaller, sides more narrowed to apex, which is less deeply notched, prothorax more transverse, apex and sides of elytra sub-opaque, abdomen more convex, club of antennae smaller, and front tarsi much thinner.

Queensland: Kuranda (F. P. Dodd).

In general appearance close to small specimens of *D. rufipes*, but hind tibiae of male not at all black, only the claws of the hind tarsi dark, and the pygidium evenly convex; on the males of *rufipes* there is a depression (sometimes almost foveate in appearance) on each side of the pygidium; its pronotum is also almost evenly clothed throughout, instead of being almost glabrous in the middle. *D. tarsalis* and *D. cribripennis* have more deeply notched clypeus, and clothing of upper surface considerably longer; the former also has much wider front tarsi in the male. *D. nitens* (which also occurs at Kuranda) is a much more brilliant species, with longer prothorax and sparser clothing on upper surface. In Blackburn's table of the genus it could be associated with that species. The head and prothorax are usually coppery-green, the head and scutellum on some specimens are almost coppery-red.

DIPHUCEPHALA MONTANA, n. sp.

♂. Metallic-green or coppery-green; antennae, palpi, and legs (tibial teeth reddish) black. Rather sparsely clothed with depressed white setae, becoming moderately dense on under surface.

Head with crowded and shallow punctures, or coarsely shagreened. Clypeus with sides feebly undulated, and apex widely notched. Prothorax moderately transverse, median sulcus very wide on basal half, and feebly connected with apex, transverse impressions deep and isolated, each side angulate in middle; with rather dense shallow, setiferous punctures. Scutellum with minute punctures and a large median impression. Elytra with several feeble elevations, and with coarse, crowded punctures, becoming smaller about base and apex. Front tibiae bidentate at and near apex; front tarsi with three basal joints dilated and densely clothed on under surface. Length, 6-7 mm.

♀. Differs in having the clypeus much smaller, less deeply notched, tips less upturned and front tarsi thinner and more sparsely clothed.

New South Wales: Barrington Tops (Australian Museum, in January, K.55866, and T. G. Sloane).

In general appearance like enlarged specimens of *D. carteri*, but prothorax with sparser punctures, median sulcus much wider, scutellum almost impunctate, and with a conspicuous impression. It is also close to *D. sordida*, but is slightly larger, and with more distinct punctures on pronotum. In his table Blackburn stated of that species, "Puncturation of pronotum (except fine close asperity) all but wanting". This is hardly correct; there are numerous shallow punctures, which are quite distinct on the front part of the prothorax, and close to the base, although on most of the surface they are partly obscured by dense and small punctures (hardly shagreened). On many specimens of *sordida* the colour is bronzy or coppery, occasionally green with a coppery gloss; of fourteen specimens of the present species, thirteen are green or coppery-green, and one is purplish, not one is bronzy. In Blackburn's table it might be associated with *D. quadratigera* and *D. angusticeps*, two considerably smaller species, with more sharply defined prothoracic punctures.

DIPHUCEPHALA PURPUREITARSIS MacL.

(*D. crebra* Blackb., var.)

The type of *D. crebra*, now in the British Museum, was described by Blackburn from a specimen I sent to him as *D. purpureitarsis*, and I believe correctly so.

He stated that from that species it "has widely different sculpture of the pronotum" and in the table they are separated by

"C. Longitudinal sulcus of pronotum not double in hind part" *crebra*
 "CC. Longitudinal sulcus of pronotum doubled in hind part" *purpureitarsis*

On most specimens of *purpureitarsis* the doubling is sufficiently distinct, but on several it is faint, and on an occasional specimen the sulcus is not at all doubled. Most of the specimens before me are from Galston, the National Park, and other localities near Sydney.

DIPHUCEPHALA CAERULEA Macl.

The type of this species has perished (Lea, *Trans. Roy. Soc. S. Aust.*, 1916, p. 294). It is probable that it was founded upon a female of a purplish variety of *D. pulchella*, which varies from 3 to 3½ lines, and in colour from coppery-green through various shades of green and blue, to deep-purple; and occurs in New South Wales, Victoria and Tasmania. Although no locality was given when the species was first described, it was afterwards recorded in the monograph as from Queensland.

CUNDERDINIA SETISTRIATA, n. sp.

♂. Bright metallic coppery-green; parts of legs blue, tarsi purplish, antennae and palpi black. Head, sides of prothorax, and lines on elytra with white setae, becoming hairs on under surface and legs.

Head with crowded, rough punctures between eyes, becoming smaller about base. Clypeus not quite twice as wide as long, sides moderately uplifted, apex more strongly so, and not at all notched. Antennae eight-jointed, club three-jointed. Prothorax slightly transverse, median line shallow, transverse impression on each side rather short and fairly deep, a marginal tooth near it; with crowded but sharply defined punctures. Scutellum convex and minutely punctate. Elytra almost parallel-sided to near apex; with crowded and rather coarse punctures, and transversely corrugated on most of surface. Front tibiae with a long and acute apical tooth, and a small subapical one, three basal joints of front tarsi densely setose on lower surface, all claws bifid. Length, 7-8 mm.

♀. Differs in having the clypeus shorter, its sides and apex less upturned, abdomen strongly convex, legs shorter and front tarsi thinner and less densely clothed.

Western Australia (H. M. Giles), Tammin (H. J. Carter).

Slightly larger than *C. variabilis*, and elytra with conspicuous lines of white setae on the alternate interstices.

HAPLONYCHA PILOSICOLLIS, n. sp.

Pale castaneous-brown; head reddish, parts of front tibiae blackish. Densely clothed with long stramineous hairs on base of head, prothorax, scutellum, under surface, and legs, but less dense on abdomen than on sterna, pygidium almost glabrous on disc.

Head with crowded punctures behind clypeal suture, less crowded but still dense in front, the punctures there of two distinct sizes. Antennae nine-jointed, club three-jointed. Penultimate joint of palpi slightly shorter than antepenultimate, and distinctly shorter than apical. Prothorax more than twice as wide as long, strongly convex, hind angles rounded off; with dense and rather small punctures. Elytra not quite parallel-sided, geminate striae well defined and with

fairly large punctures, the interstices with rather sparse and irregular ones, marginal fringe of setae long at base, becoming short posteriorly, without a dense downward fringe. Propygidium with punctures about as large as on pronotum, but not as dense, becoming sparser and smaller on pygidium, especially in middle. Second joint of hind tarsi slightly longer than first. Length, 13 mm.

South Australia: Minnie Downs (N.E. corner, L. Reese).

The pronotum, propygidium and sterna are more densely clothed than on any other species before me, but the lateral gutters of the pronotum are not more densely clothed than elsewhere. Still, if considered as belonging to Blackburn's Group 2, it is distinct from all the species of that group by its small size. The clothing is even denser than on *H. crinita* (of Group 1, with the antennae eight-jointed). Passing Group 2, it could only be referred to Group 6, from all the small species of which it is distinct by the clothing of the pronotum. The type is evidently a male, as the lamellae of the club are as long as the clypeal suture.

HAPLONYCHA BREVISETOSA, n. sp.

Purplish-brown, with a greenish iridescence; antennae and palpi castaneous, parts of front tibiae black. Head with a few long hairs near eyes, prothorax with a sparse marginal fringe, continued across part of the base, elytra with a marginal fringe of setae, rather long at the base, becoming smaller posteriorly, and absent from tips; with a very short and dense downward fringe, sterna and legs with long stramineous hairs, becoming sparser on abdomen, pygidium with minute pubescence.

Head with crowded punctures behind the bisinuate clypeal suture, clypeus more than twice as wide as the median length, with crowded punctures at base, becoming less crowded and individually distinct in front. Antennae nine-jointed, club three-jointed. Penultimate joint of palpi slightly longer than antepenultimate. Prothorax more than thrice as wide as long, hind angles rounded off; with a faint median line, and numerous but not crowded punctures. Elytra not quite parallel-sided, geminate striae rather feeble, especially posteriorly, the interstices with numerous but not crowded punctures of fairly large size, suture briefly mucronate. Pygidium with crowded and small, asperate punctures, becoming very small posteriorly. Second joint of hind tarsi distinctly longer than first. Length, 19-24 mm.

South Australia: Minnie Downs (L. Crabb, F. Parsons, and L. Reese), Birkett's Wool Shed (South Australian Museum Expedition, 1916); Western Australia: Coolgardie (Blackburn's collection).

In general appearance strikingly close to *H. deceptor* (the specimen from the Blackburn collection was placed with that species), but at once distinguished by the tip of the elytra, which has the apical downward fringe of setae very short; on a cotype of *deceptor*, and on many other specimens, the apical fringe is fully thrice as long. In Blackburn's table it could be associated with that species. The hairs near the eyes are readily abraded. Some of the specimens are more reddish than others.

HAPLONYCHA PRUINOSA, n. sp.

Head and prothorax dark-brown (the former almost black), elsewhere purplish-brown, the elytra with a pruinose bloom, antennae and palpi castaneous. Prothorax with a sparse lateral fringe of long hairs, elytra with a fairly long

fringe on each side almost to apex, downward fringe very short, dense and continuous, sterna densely pilose, abdomen sparsely pilose, pygidium glabrous.

Head with rather dense but not crowded punctures towards base, but crowded near clypeal suture; clypeus with slightly larger and more crowded punctures than behind its suture. Antennae nine-jointed, club four-jointed. Prothorax fully four times as wide as long, hind angles not rounded off, punctures of moderate size, and numerous but not crowded. Elytra somewhat dilated to near apex, geminate striae moderately distinct, interstices with slightly sparser and larger punctures than on pronotum, suture unarmed. Pygidium with small and fairly numerous punctures about base, sparser and smaller elsewhere. Second joint of hind tarsi slightly longer than first. Length, 17-18 mm.

Western Australia: Kellerberrin (J. Clark).

On the type, probably a male, the club has four long joints, and the preceding joint has an acute inner projection, which is rather too short to be considered as belonging to the club. On the second specimen the first joint of the club is about three-fourths of the length of the second joint, the preceding joint (fifth of antennae) is acute inwardly, but without a produced part. The penultimate joint of the palpi is just perceptibly longer than the antepenultimate, so by Blackburn's table it could be regarded as belonging to either Group 4 or 5. If referred to Group 4, it could be associated with *H. bella*, from which it differs in having the elytra more dilated posteriorly, the short downward fringe of elytra more conspicuous, and the prothorax with more conspicuous punctures; *bella* is a brilliantly iridescent species, without bloom on the many specimens before me; on each of the present species the elytra have a distinct bloom. If referred to Group 5, it could be associated with *H. electa* and *H. fraterna*, to neither of which is it at all close.

HAPLONYCHA IMMATŪRA, n. sp.

Flavous, part of head reddish-flavous. A few hairs on sides and base of prothorax, on base of elytra and of scutellum; elytra with a sparse marginal fringe of reddish bristles, but without a downward fringe; sterna moderately densely clothed, abdomen with hairs almost confined to a row across each segment, pygidium glabrous.

Head with numerous but scarcely crowded and rather small punctures. Clypeus wider than usual, the punctures smaller and sparser than on the surface behind its suture. Antennae nine-jointed, club four-jointed, the joints of the club as long as the clypeal suture. Penultimate joint of palpi slightly shorter than antepenultimate, the apical joint with a slight basal impression. Prothorax about thrice as wide as long, hind angles obtuse but not completely rounded off, punctures about as large as on head, but not quite as numerous, and interspersed with very minute ones. Elytra almost parallel-sided, geminate striae distinct, interstices with rather sparse punctures, and in places transversely rugose, suture slightly mucronate. Pygidium punctate and shagreened. Second joint of hind tarsi very little longer than first. Length, 11-12 mm.

South Australia: Minnie Downs (L. Reese).

In appearance like *H. pallida* (Group 5), on a reduced scale, but less shining, with more distinct punctures, impression of apical joint of palpi more distinct, although not strong enough for the species to be placed in Group 3; the lamellae of the club are also much longer. It is smaller than all the species known to Blackburn of Group 5.

HAPLONYCHA IRIDEA, n. sp.

Red; elytra blackish-purple, becoming reddish on sides, abdomen and pygidium usually, but not always, darker than sterna; elytra brilliantly iridescent, rest of upper surface moderately so.

Head with rather sparse and small punctures behind clypeal suture, denser but not very large in front of it. Antennae nine-jointed, club three-jointed. Prothorax about thrice as wide as long, front angles acute, hind ones somewhat obtuse but not rounded off; punctures much as on head. Elytra somewhat dilated to beyond the middle, with distinct geminate striae, the interstices with punctures about as numerous as on pronotum, but slightly larger. Abdomen shagreened. Pygidium with rather sparse and small punctures. Two basal joints of hind tarsi subequal. Length, 10-14 mm.

South Australia: Minnipa (H. A. Johnson), abundant at lights.

A beautiful species, with colours somewhat like those of *H. ruficollis*, but smaller and more brilliantly iridescent. With the mouth-parts detached it is evident that the penultimate joint of the maxillary palpi is slightly longer than the antepenultimate, and therefore that it should not be referred to Blackburn's Group 4, but without removing it from the head, on many of the specimens, the penultimate joint appears to be slightly the longer. Passing Group 4, it can only be referred to Group 7. The male has the lamellae of the club slightly longer than the six preceding joints combined, of these the fifth and sixth are pointed inwardly; on the female the lamellae are about one-third shorter, and the fifth and sixth joints are less pointed. The male also is narrower than the female, and has darker abdomen and pygidium.

HAPLONYCHA PYGIDIALIS, n. sp.

Black; elytra and parts of legs dark-brown, antennae somewhat paler. Prothorax with a sparse and dark fringe on each side, elytra with lateral fringe at base about as long as on prothorax, but becoming shorter posteriorly, downward fringe very short (almost absent), sterna with rather dense clothing, becoming sparse on abdomen, pygidium glabrous.

Head with crowded punctures, somewhat obscuring the clypeal suture. Antennae nine-jointed, club three-jointed, the lamellae not half the length of the clypeal suture. Palpi with penultimate joint shorter than the antepenultimate. Prothorax almost four times as wide as long, sides strongly rounded, front angles acute, hind ones almost rounded off; with sharply defined punctures, about as large as on head, but much less crowded. Elytra with sides dilated to beyond the middle, geminate striae well defined; punctures slightly larger than on prothorax and less crowded. Pygidium acutely carinated in middle, with dense and small punctures, becoming shagreened at base. Second joint of hind tarsi distinctly longer than first. Length, 17 mm.

Victoria: Murtoa.

In Blackburn's table belongs to Group 8, and in appearance is somewhat like *H. gagatina*, with the elytra darker than usual, but the punctures on the pronotum are sharply defined, and the pygidium is distinctly carinated. In appearance also it is fairly close to the specimen of *H. rustica* commented upon (*post.*), but that specimen belongs to Group 5. *H. nigra*, of Group 8, is larger, with the pygidium noncarinated.

HAPLONYCHA SETOSA Blackb., ♀ (*Colpochila*).
(*H. marginata* Blackb., ♂.)

The type of *Colpochila setosa* is now in the British Museum, and was unique when described; although noted as a male, its tarsi were not even mentioned.

There were, however, two specimens from Charters Towers labelled as *setosa* in the Blackburn collection, and apparently correctly so; they agree well with other specimens from Oodnadatta and Alice Springs (the type was from McDonnell Ranges), but these are all females (on dissection of one specimen eggs were found) and have the front claws not very different from the others. A male from Alice Springs (taken during the same trip as a female by Dr. C. J. Hackett) has the front claws asymmetrical, the outer one on each tarsus has a small basal appendix, and the upper portion evenly arched, but the inner one has a large basal appendix, and the upper portion, instead of being evenly arched, is somewhat sinuous. The male has the elytral margins thickened. The type of *H. marginata* (now also in the British Museum) was described as probably a female, but two cotypes in the South Australian Museum are certainly males, as they have the front claws asymmetrical (as on the Alice Springs male), and I believe them to be males of *H. setosa*. Fresh specimens have some straggling erect hairs or setae on the elytra, but they appear to be easily abraded.

H. gibbicollis (see the following note) and *H. tarsalis*, also have asymmetrical front claws in the male. On most species of the genus the claws are not sexually variable, and apparently Blackburn relied principally on the antennae for sexual distinctions, and did not examine the front tarsi.

HAPLONYCHA GIBBICOLLIS Blackb.

The sexes of this species may be at once distinguished by the front tarsi; on the female the claws are much as on the other tarsi, but on the male they are asymmetrical, the outer claw has a large basal appendix, and its upper portion is evenly arched, and regularly decreases in thickness, the inner claw has a much larger basal appendix, and its upper portion is somewhat sinuous, with the lower edge not evenly decreasing in thickness.

HAPLONYCHA RUSTICA Blackb., var.

A male from Pungonda (South Australia) appears to belong to this species, but has the prothorax subopaque, and with denser and larger punctures than usual; in general appearance it is like *H. gagatina*, but the club of antennae is four-jointed, instead of three-jointed, prothoracic punctures sharply defined, and elytral fringe fairly long at apex.

LIPARETRUS DISTINCTUS Blackb.

In the original description of this species (Blackb., *Trans. Roy. Soc. S. Aust.*, 1895, p. 34) the two basal joints of the hind tarsi were described as "*subaequalibus*". I cannot find that Blackburn commented upon it elsewhere, except that in the table (*Trans. Roy. Soc. S. Aust.*, 1905, p. 291) it is placed with those having (page 290) "Basal joints of hind tarsi equal (or scarcely differing) in length".

The types are in the South Australian Museum, and it is evident that Blackburn did not re-examine them (or that the apparent lengths of the two joints were partly obscured by a few bristles) when preparing the table, as the basal joint of the hind tarsi is distinctly longer than the second, and in that table it should have been placed with A, B, CCC, DDD, EE, and there associated with *L. melano-*

cephalus, to which it is certainly very close, and which, perhaps, should be considered as a variety of it. The types of both were from Lake Callabonna, both have the clypeus obtusely tridentate, and second segment of abdomen of male fasciculate at middle of apex.

Family CURCULIONIDAE.

EUTINOPHAEA FASCICULATA, n. sp.

Dark reddish-brown; legs and antennae paler. Densely clothed with light brown scales, obscurely variegated with paler and darker ones, becoming paler, but scarcely whitish, on under surface; in addition with short sloping setae, condensed to form a conspicuous black fascicle, on the suture half-way down the apical slope, two less distinct ones on the third interstice (near base and just beyond middle), and a still more feeble one on the fifth, about the middle.

Head as described in *E. bicristata*. Prothorax slightly longer than wide, sides rather strongly rounded, with large punctures indicated through clothing. Elytra much wider than prothorax, sides almost parallel on basal half, then rounded and near apex strongly narrowed; with regular rows of rather large, partly concealed punctures, odd interstices gently elevated above the even ones. Front and middle tibiae strongly curved, the hind ones almost straight. Length, 3.2 mm.

Queensland: Cairns district (A. M. Lea).

Distinct from all other species before me by the conspicuous black fascicle on the suture. Judging by the convexity of the abdomen the three specimens taken are all females. The clothing as described is that of two of them; on the third it is mostly sooty, obscurely variegated with small paler spots.

EUTINOPHAEA SETISTRIATA, n. sp.

♂. Reddish-brown; legs and antennae somewhat paler. Densely clothed with pale, almost stramineous, scales, variegated with pale-brown markings, the under surface with whitish scales. In addition with short sloping setae, on the elytra forming a distinct row on each odd interstice.

Head wide, with numerous concealed punctures. Rostrum with a feeble median line, near apex traversed by a line marking off the glabrous muzzle from the squamose portion; scrobes angular, upper portion of each distinct from above, oblique lower portion almost touching lower edge of eye. Scape short and stout; two basal joints of funicle moderately long, the first stouter than second. Prothorax slightly longer than wide, sides feebly bisinuate, with the middle portion slightly elevated across middle; with rather large punctures, faintly indicated through clothing or entirely hidden. Elytra oblong-cordate, much wider than prothorax, with regular rows of fairly large punctures, appearing much smaller through clothing, odd interstices slightly elevated above the others, the suture thickened, but not tuberculate, about summit of apical slope. Basal segment of abdomen flattened in middle. Front tibiae bisinuate on lower surface. Length, 3.0-3.5 mm.

♀. Differs in having wider elytra, abdomen more convex, and legs somewhat shorter.

Queensland: Mount Tambourine, in November (H. Hacker), in January (A. M. Lea); Bunya Mountain, in December (Hacker); National Park (H. J. Carter).

The setae on the alternate interstices of the elytra are very distinct. From the sides the upper surface appears to have several feeble fascicles, and the elytra to approach those of the female of *E. bicristata*, but the prothorax is decidedly narrower than on that species, and the elytra of the male are very different. The hind margin of each eye is slightly encroached upon by the derm, so that it is not quite circular in outline; it is slightly suggestive of the encroachment on the eyes of the species of *Ophryota*. The darker markings of the upper surface are not very dark, and consist of two small spots on the head, a fairly wide median vitta on the pronotum (sometimes longitudinally divided in the middle) and a patch occupying most of the basal half of elytra (excluding the shoulders), but they vary considerably in size and intensity; there are sometimes faint markings on the sides of the prothorax, and the prothoracic setae usually cause the surface to appear speckled. On several specimens the scales on the under surface have a faint bluish tinge, but are not metallic.

EUTINOPHAEA SUTURALIS, n. sp.

Dark reddish-brown; legs and antennae paler. Densely clothed with greyish-white scales mottled with darker ones, becoming whitish, or with a faint bluish tinge, on under parts; in addition with sparse, sloping setae.

Head wide, with large, concealed punctures. Rostrum short, muzzle glabrous, separated from the clothed portion by a narrow transverse line; scrobes with upper portion short, the lower narrow and oblique. Prothorax slightly longer than its greatest width, sides rather strongly rounded in middle, feebly transversely impressed near base and apex, with punctures as on head. Elytra oblong-cordate, much wider than prothorax, parallel-sided to about middle; with regular rows of large punctures, appearing small through clothing, odd interstices slightly elevated above the even ones, the third more noticeably (but not suddenly) elevated just beyond the middle; suture subbituberculate at summit of apical slope. Front tibiae gently curved. Length, 3.2-3.7 mm.

Queensland: Mount Tambourine, in November (H. Hacker), in January (A. M. Lea), National Park, in November (Hacker), in January (H. J. Carter); New South Wales: Dorrigo (W. Heron).

Allied to the preceding species, but average size larger, alternate interstices with series of setae scarcely defined even from the sides, but nevertheless giving the surface a flea-bitten appearance, and suture conspicuously subbituberculate at summit of apical slope. The elevation of the third interstice on each elytron, although distinct, is not so sudden as on *E. bicristata*. On some specimens there is a fairly large dark patch at the base of the prothorax, and the patch is continued on to the elytra, then suddenly dilated so as almost to touch the sides, excluding the shoulders, and terminated about the middle; but on some specimens the mottling is more vague, and is extended over most of the surface; in fact the scales on the prothorax and elytra (except on the sides) could sometimes be regarded as of a vaguely mottled muddy-brown colour. The abdomen of the female is more convex than that of the male, but the external sexual distinctions are otherwise very slight.

EUTINOPHAEA SUBVIRIDIS, n. sp.

Dark reddish-brown; legs and antennae paler. Densely clothed with scales varying from whitish to dark-brown, and becoming green on sides (invisible from

directly above), under surface and bases of femora, in addition, with sloping setae, also varying in colour; on the elytra setae are confined to the alternate interstices.

Head and prothorax sculptured as in preceding species. Elytra oblong-cordate, parallel-sided to beyond the middle; with regular rows of large, partly concealed punctures, odd interstices very feebly elevated above the even ones. Front and middle tibiae curved only at apex. Length, 3 mm.

Queensland: Cairns district (A. M. Lea).

Allied to *E. setistriata*, but with green (usually glittering) scales on under surface, prothoracic and elytral markings different, and setae less numerous. The two specimens obtained are probably males, as the abdomen is but slightly convex, and are similarly marked; on the head and prothorax the scales are mostly of a pale slaty-grey, vaguely mottled with brown, and the prothorax with two feeble fascicles in front; on the elytra there is a fairly wide, irregular sutural space, from near the base to beyond the middle, where the scales are whitish, with a slight golden gloss, elsewhere the scales (except on the sides) are mostly mouse-coloured, with some dark-brown spots. The elevation of the third interstice, on each elytron, is no greater beyond the middle than elsewhere, but is marked there by a short strip of blackish scales; the suture is not subtuberculate.

EUTINOPHAEA MURINA, n. sp.

Black; parts of antennae and of legs obscurely reddish. Densely clothed with mouse-coloured scales, changing to whitish on under surface; in addition with setae scarcely rising above the general level.

Head with punctures traceable through clothing. Rostrum with a distinct median line, near apex traversed by a narrow groove, dividing off the glabrous muzzle from the densely clothed portion. Prothorax with sides strongly rounded and widest near apex, where the width is slightly more than the length; with large punctures indicated through clothing, and each containing a seta. Elytra oblong-cordate, much wider than prothorax, parallel-sided to beyond the middle; with regular rows of large punctures, appearing smaller through clothing; interstices even. Front tibiae curved only at apex. Length, 5-7 mm.

North Australia: Groote Eylandt (N. B. Tindale).

Considerably larger than any species previously referred to *Eutinophaea*, but several species of *Ottistira* (which should probably be regarded as a generic synonym) are quite as large. On this, as on other species of the genus, each scrobe is in two parts, a short, deep, and comparatively wide part, running parallel with (or but slightly divergent from) the upper edge of the rostrum, and a narrower and longer part, joining the upper portion at right angles, so as to resemble an elongated T. As on other species also, the claws are separated only at their tips. The rostrum is traversed by a narrow deep line near the apex, but, viewed from behind, the edge of the line appears as a shining carina bounding the glabrous muzzle. The clothing of the upper surface is almost uniform, but on close examination some feeble pale spots may be noticed. It is probable, however, that the clothing is variable. As the two basal segments of abdomen are flattened in the middle the type is probably a male.

EUTINOPHAEA VITIENSIS, n. sp.

Dark reddish-brown; antennae and legs paler. Densely clothed with pale, fawn-coloured scales, variegated with chocolate-brown, becoming paler on under

surface, but most of under surface highly polished, setae inconspicuous, even on legs.

Head with rather large punctures indicated through clothing. Rostrum with a feeble median line, near apex traversed by a narrow deep line, separating the glabrous muzzle from the squamose portion. Prothorax feebly transverse, sides rather strongly rounded and widest slightly nearer apex than base; punctures well indicated through clothing. Elytra oblong-cordate, much wider than prothorax, parallel-sided to beyond the middle; with regular rows of large, partly concealed punctures, interstices evenly elevated. Front tibiae moderately strongly curved, the middle ones less strongly. Length, 2.6-2.8 mm.

Fiji: Viti Levu and Taveuni (A. M. Lea).

Quite an ordinary species of the genus, with markings nearer those of *E. variegata* than any other Australian species. The claws from most directions appear to be single, but, as on *variegata*, they are slightly separated at the tips; the scrobes are also as on that species. On the pronotum there are two chocolate-brown vittae, narrowly separated by a pale median line, and usually one or two spots on each side; on the elytra there are numerous small dark spots, often joined together and covering almost as much space as the paler scales, on two specimens covering more; the abdomen and median parts of the metasternum are almost entirely glabrous, allowing the punctures to be plainly seen. One specimen has the paler scales of the upper surface of a slaty-grey colour. On another the scales at the sides of the sterna are greenish.

Three specimens, from Viti Levu and Ovalau, probably belong to this species, but are considerably smaller (2 mm.); one specimen has the aedeagus protruding, so is certainly a male. The difference in size is probably sexual, and is no more pronounced than on the Australian *E. dispar*.

EUTINOPHAEA PAPUENSIS, n. sp.

Blackish-brown; antennae and parts of legs obscurely reddish. Densely clothed with green and chocolate-brown scales.

Head with fairly large, concealed punctures. Rostrum with squamose portion sharply limited by the scrobes and a transversely impressed line behind the muzzle. Prothorax slightly transverse, sides strongly rounded, punctures concealed but indicated through clothing. Elytra oblong-cordate, much wider than prothorax, sides parallel to beyond the middle; with regular rows of large punctures, appearing much smaller through clothing, interstices even. Front tibiae strongly curved, middle ones moderately so, hind ones almost straight. Length, 2.8-3.0 mm.

Papua: Mount Lamington, 1,300-1,500 feet (C. T. McNamara); New Guinea: Komba, 5,000 feet (Rev. L. Wagner).

A beautiful species, and structurally quite an ordinary member of the genus, although the clothed portion of the upper surface of the rostrum is rather smaller than usual. It appears to be allied to *Ottistira pulchella*, from Morty and Macassar. On the type the brown scales form a basal triangle on the head, two interrupted vittae on the pronotum, and three irregular fasciae on the elytra. On the specimen from Komba the scales are more golden than green, the basal spot is absent from the head, and the elytral fasciae are more irregular. On a second specimen from Mount Lamington the scales are entirely green, except that some of those on the elytra are golden. There are some pale setae on the upper surface, but as they do not rise above the general level they are inconspicuous even from the sides.

EUTINOPHÆA, 1870.

(Ottistira, 1872.)

It appears to be probable that these names should be regarded as synonymous. The type of the former is *E. nana*, from South Australia, and the genus to Pascoe was monotypic, the type (or at least the first described species) of *Ottistira* is *O. bispinosa* from Dorey, etc. *Eutinophæa*, however, is now known to contain many species from Australia, Fiji, and New Guinea. *Ottistira* was recorded from New Guinea to the Malay Archipelago. The two species before me (*O. ocularis* Pasc. and *O. sulcicollis* Faust.) agree in having the scrobes (which are very distinctive) and claws (soldered together except at the tips) uniform with those of the species of *Eutinophæa*, and in all other generic details.

VITICIS, n. gen.

Head moderately large. Eyes round and lateral. Rostrum short, dilated to near apex, each scrobe in two parts: a short upper portion, and a longer one cutting obliquely downwards slightly nearer eye than apex. Antennae with scape moderately long, funicle six-jointed, club elliptic-ovate. Prothorax subcylindrical, without ocular lobes. Scutellum absent. Elytra wider than prothorax. Front and middle coxæ slightly separated, the hind ones more distant; femora bidentate; tibiae arched, hooked at apex; tarsi three-jointed.

A remarkable genus, certainly close to *Eutinophæa*, but with the funicle six-jointed, and without a claw-joint, as in *Misophrice* of the Erihrinides. The third tarsal joint is wide, with a faint median notch, as on many species of *Misophrice*. The femoral dentition is also remarkable, each femur has an acute and fairly large tooth near the base, and a smaller one about the middle (very feeble on the hind pair).

Genotype, the following species.

VITICIS BIDENTATUS, n. sp.

Black; scape and funicle reddish. Moderately densely but irregularly clothed with ochreous scales.

Head with dense, partly concealed punctures. Rostrum as wide near apex as the median length, upper surface flat and with a feeble median line. Scape curved and clavate, first joint of funicle stout, about the length of second, but much stouter, second thinner and slightly longer than third, third slightly shorter and thicker than fourth, fifth and sixth slightly increasing in length and thickness. Prothorax slightly longer than wide, sides gently dilated near base, with dense punctures, partly concealed by scales. Elytra about one-third wider than prothorax, sides feebly dilated to beyond the middle; with regular rows of large, partly concealed punctures, the interstices even. Front and middle tibiae strongly arched, the hind ones less strongly. Length, 2.5 mm.

Fiji (Blackburn's collection), Viti Levu (A. M. Lea).

The scales on the type, from some directions, have a golden gloss, but they usually appear opaque; on the elytra they are dense across the apical third so as to appear almost fasciate. The second specimen is badly abraded, and the scales are usually whitish, but some of them have a greenish gloss.

NESOGENOCIS, n. gen.

Head directed downwards. Eyes lateral, briefly elliptic. Rostrum short, near apex traversed by an impressed line, cutting off the glabrous muzzle from the

squamose portion; scrobes each in two parts, a short upper one, and a longer one joining its middle at right angles. Prothorax with the front and sides rounded, the front turned down so as to present a vertical face, on the same plane as the interocular space, and the upper surface of rostrum. Scutellum absent. Elytra oblong-cordate. Front and middle coxae slightly separated; front tibiae long and strongly arched, middle shorter and less strongly arched, hind ones almost straight; claws soldered together almost to tips.

Close to *Eutinophaea*, and with very similar head, rostrum, antennae, and claws, but at once distinguished by the prothorax; this is abruptly turned down in front, the turned-down portion being almost as long as the head itself, instead of the front edge of the prothorax appearing as a narrow section of a ring, as on most weevils. I know of no other genus having the prothorax like it, except the Australian genus *Cucullothorax*, of the Phalidurides. There is a slightly thickened transverse ridge on each side of the scutellar position, but the scutellum itself is absent.

Genotype, the following species.

NESOGENOCIS CUCULLUS, n. sp.

♂. Dark-brown; legs and antennae paler. Densely clothed with chocolate-brown and somewhat stramineous scales; sparsely setose.

Head with punctures normally concealed. Scape about as long as funicle, first joint of the latter rather large, club briefly ovate. Prothorax with apex and sides strongly rounded, base truncate; punctures large and well indicated through clothing. Elytra at base wider than base of prothorax, but no wider than its widest part, parallel-sided to beyond the middle; with regular rows of punctures, appearing much smaller through clothing, interstices even. Basal segment of abdomen depressed in middle. Length, 2.1-2.3 mm.

Fiji: Viti Levu (A. M. Lea).

The scales on the rostrum are mostly pale, on the head the pale ones encircle the eyes like a pair of spectacles, on the pronotum the dark scales are in the majority, leaving a median line and small spots and lines on the sides; on the elytra small pale spots are numerous, and there are two of larger size at the base and some forming an irregular fascia at summit of the apical slope; much of the under surface is glabrous. The abdomen of the two specimens certainly appears to be masculine, as is also the great width of the prothorax; the front tibiae have some rather long hairs on the under surface, that are probably absent from females.

EUPHOLOCIS, n. gen.

Eyes lateral, almost circular in outline. Rostrum short, each scrobe in two parts: an upper one almost parallel with the upper edge of the rostrum, and a longer one joining it at right angles, directed to the lower surface, and passing close to the eye. Prothorax subcylindrical, without ocular lobes. Scutellum minute. Elytra rather long. Front and middle coxae slightly separated; femora dentate; front and middle tibiae falcate, the others almost straight; third tarsal joint widely bilobed, claws widely separated.

Allied to *Eutinophaea*, but with claws diverging from their bases, and widely separated at their tips; the muzzle also is not separated from the rest of the rostrum by a deeply impressed line. In some respects it is close to *Viticis*, but that genus has clawless tarsi.

The two species before me are structurally much alike, but differ considerably in their clothing. The tooth on each front and middle femur is submedian and distinct, but on the hind ones is very feeble.

Genotype, the following species.

EUPHOLOCIS DENTIPES, n. sp.

Black; legs and parts of antennae reddish. Rather densely clothed with green and golden-green scales, becoming sparse on under surface.

Head with dense, partly concealed punctures. Rostrum very short, its greatest width (close to apex) more than the median length. Scape rather short and clavate, basal joint of funicle stout, club ovate. Prothorax about as long as wide, sides gently rounded in middle; with rather coarse, partly concealed punctures, and with a feeble median elevation. Elytra about twice as long as wide, decidedly wider than prothorax, parallel-sided to about apical third; with regular rows of large punctures, partly concealed by scales, interstices even. Front femora arched, with an acute tooth at basal third, middle femora less arched and with a smaller tooth nearer the middle, hind femora still less arched, and very feebly dentate. Length, 2.2-2.5 mm.

Queensland: Cairns district (A. M. Lea).

There is a fairly distinct spot, or two conjoined spots, of paler scales, on the middle of each elytron, and two near the apex, but, except for these, the scales on the upper surface are almost evenly distributed; when wet they are nearly all brilliantly golden.

EUPHOLOCIS MACULATUS, n. sp.

Black; part of scape reddish. Rather sparsely clothed, except for spots of blue scales.

Head and rostrum with rather coarse punctures, becoming small and inconspicuous on apical half of rostrum. Prothorax very slightly wider than long, sides gently rounded, punctures rather coarse, but leaving a short, shining, median ridge. Elytra rather long, considerably wider than prothorax, sides feebly dilated to beyond the middle; with regular rows of large punctures. Legs slightly longer, but otherwise much as on preceding species. Length, 2.2 mm.

New Britain: Beining district (G. F. Hill).

Structurally near the preceding species, but with blue scales covering much less of the surface, and mostly condensed to form spots or vittae; on each side of the prothorax there is a vitta extending from the base, where it is widest, almost to the apex; on each elytron there is a small spot on the third interstice at the basal fourth, a transverse series a short distance behind it, commencing on the fifth interstice, two spots at the apical fourth, and a right-angled strip at the tip; there are also some blue scales on the sides of the under surface; and on the upper parts of the legs. In some lights the scales glitter.

PLATYNOTOCIS, n. gen.

Head rather wide. Eyes round and lateral. Rostrum very short, muzzle glabrous; scrobes curved, one portion of each directed downwards in front of the eye. Scape stout, scarcely the length of club, first joint of funicle as stout as scape, and half as long, second longer and thinner, club elliptic-ovate. Prothorax subcylindrical. Scutellum small but distinct. Elytra somewhat flattened, much wider than prothorax. Front coxae touching, middle ones moderately, the hind

ones widely separated. Femora stout, the hind ones very stout and strongly dentate, the others edentate, tibiae gently bisinuate on lower surface, third tarsal joint widely bilobed, claws widely separated at their tips.

The type is a somewhat pear-shaped but flattened insect with head and rostrum approaching those of *Eutinophaea*, to which it is certainly allied, but from which it differs in its powerful hind legs, with widely separated claws; the hind legs also distinguish it from *Eupholocis*.

Genotype, the following species.

PLATYNOTOCIS PYRIFORMIS, n. sp.

Dark brown; legs and antennae (except club) paler. Densely clothed with scales varying from almost white, through fawn, to chocolate-brown, and becoming sparser, thinner and uniform on under surface.

Head with punctures faintly traceable through clothing. Rostrum with a feeble median line. Prothorax slightly longer than basal width, sides feebly dilated to base, and slightly rounded near it, with dense, concealed punctures. Elytra much wider than prothorax at base, sides dilated to beyond the middle, where the width is more than twice that of the base of prothorax; with regular rows of large punctures, only partly concealed by clothing; interstices even, except that the odd ones are slightly elevated above the even ones, more noticeably at apical third than elsewhere. Length, 3.4 mm.

North Queensland (Blackburn's collection).

Most of the scales on the head and prothorax are fawn-coloured, but there is a narrow stramineous vitta on each side of the latter; on the elytra they are also mostly fawn-coloured, but there are several pale vittae at the base (one on each side continuing the one on each side of the prothorax), and an oblique fascia commencing near the suture before the middle and touching the sides near the shoulders, between the fascia and the base the clothing is mostly darker than elsewhere, beyond the clothing is faintly variegated, with indications of a pale fascia crowning the apical slope.

PELIOCIS, n. gen.

Head wide. Eyes small, lateral, and obtusely pointed in front. Rostrum short, scrobes reversed-L-shaped, the upper part of each rather short and wide, the lower part narrow and cutting into the side to its lower edge, slightly nearer the eye than the muzzle. Scape much shorter than funicle, first joint of the latter large; club elliptic-ovate. Prothorax subcylindrical. Scutellum distinct. Elytra subcylindrical, not much wider than prothorax, base trisinate. Front coxae touching, middle slightly, the hind ones moderately separated; femora unarmed; tibiae very short; third tarsal joint widely bilobed, claws widely separated at tips.

Allied to *Eutinophaea*, *Eupholocis* and *Platynotocis*, but with very different legs, and eyes less rounded. In some respects it approaches *Homoeotrachelus*, but the species of that genus have the scrobes terminated before the lower edge of the rostrum. The claw-joint of the front tarsi projects but little beyond the lobes of the third, but on the middle and hind ones it passes them for some distance. The type is a subcylindrical insect, in appearance slightly suggestive of some species of *Platypus*, of the Scolytidae.

Genotype, the following species.

PELIOCIS SUBCYLINDRICUS, n. sp.

Pale reddish-flavous, club darker. Densely clothed with stramineous scales, having a slight golden gloss, and somewhat variegated on upper surface.

Head with punctures concealed but evidently rather dense. Rostrum more than twice as wide as long. Prothorax no wider than head across eyes, middle of sides very little wider than base or apex. Elytra very little wider than prothorax, parallel-sided to near apex; with rows of punctures appearing small through clothing, the interstices not separately convex. Metasternum elongate. Two basal segments of abdomen each as long as the three apical combined. Length, 4 mm.

New South Wales: Gosford (H. J. Carter). Unique.

On the pronotum there are four slightly infuscated vittae, continuous from base to apex; on the elytra there are numerous inconspicuous pale spots or vittae, and still fewer blackish ones, the latter mostly confined to the median parts of each elytron; there are also three brownish vittae on the three apical segments of abdomen. The type being in perfect condition, no scales were abraded to see the punctures more clearly, but on the elytra they appear to be in feeble rows without striae.

. PHELYCTINUS CALLOSUS Boh. (Schh., *Gen. Curc.*, ii, p. 523.)

A small (6 mm., including the rostrum) grey weevil, with very prominent eyes, has been identified by Dr. Guy Marshall as this South African species. In Australia specimens have been taken at Blackheath (New South Wales) and Gawler (South Australia).

Family CERAMBYCIDAE.

RHYTIPHORA FRENCHI Blackb.

Numerous specimens of this grand beetle were taken in the Cue district of Western Australia by Mr. H. W. Brown. The type was a female; the male differs in being somewhat narrower, with slightly longer antennae, but in particular by the abdomen; this has six large pads of dense pale clothing, instead of two, as is common in the genus; the two pads nearest the base are so large (they are sometimes so close together that they appear as but one) that they entirely conceal the suture between the two first segments and, as a result, the abdomen appears to be composed of but four segments.

NOTES ON GALL-MAKING COCCIDS WITH DESCRIPTIONS OF
NEW SPECIES. II.

By WALTER W. FROGGATT, F.L.S.

(Plates xvi-xvii.)

[Read 24th September, 1930.]

In this paper I add five new species to the genus *Apiomorpha*. Three of them in the coccid collection of the Queensland Museum I have been able to study by the courtesy of the Director (Mr. Heber A. Longman).

The female coccids are examined (when possible) and measured before they are boiled in potash. The descriptions are made upon the examination of the cleared mounted specimens. The specific characters are based upon the form and arrangement of the chitinous bands, spines and hairs, upon the dorsal surface of the derm, and the structure of the anal appendages which are very constant and distinct.

I have added notes on the exact locality and range of several species, and record the specific names of the Eucalypts upon which they develop, previously undetermined.

APIOMORPHA DUMOSA, n. sp.

I am indebted to Mr. W. S. Campbell (late of the Department of Agriculture) for the specimens of this coccid which he collected from a Mallee Gum (*Eucalyptus* sp.) near Mildura, Victoria.

The ♂ galls are typical circular tubes dilated at the apex, about 4 mm. in height, produced upon the small branchlets.

The ♀ galls develop upon the branchlets, clustered together or scattered over the twigs, attached to them with a slightly thickened base, green in colour, oval in form, with a small circular opening at the apex. The outer surface is sometimes roughened; walls thin, hard; gall chamber large, oval. Height 12 mm., diameter 8 mm.

Female coccid yellowish-brown, broadly rounded at the apex, turbinate, the abdominal segments contracted to the terminal ones which are narrow; anal appendages black, very small, separated from the base and pointed at the tips. Ventral surface of the usual wrinkled form, the cephalic portion folding over the thoracic segments, which are well defined, the first and second depressed in the centre, with the third rounded across the body. Abdominal segments well defined, the last two very small. Length 9 mm., width 6 mm.

Antennae reddish-brown, small, terminal one with tip curving inward. Legs normal, first and second pairs small. Hind ones longest, basal joint broad, rounded, second short, third short, blunt and curved inwards. Derm thick, with the abdominal segments chitinous. Dorsal surface lightly clothed with small spiny hairs. The abdominal segments also clothed with bands of large spines, crossing

the centre of each segment. On the first these spines are smallest and irregular, on the second to sixth the transverse chitinous bands show groups of pores and bands of fine pointed spines, and spiny hairs increasing in number and density to the base of the anal appendages.

APIOMORPHA LONGMANI, n. sp. Plate xvi, fig. 2.

This is one of the species received from the Queensland Museum. Exact locality and specific name of Eucalypt unrecorded. Locality, Queensland.

The ♂ galls reddish-brown, produced upon the leaves, typical tubular form with the apex dilated. Height, 4 mm.

The ♀ galls formed upon the branchlets, the action of the coccid causing a circular raised platform about 13 mm. in diameter and 6 mm. above the surface of the surrounding stem; from the centre of this, the circular gall stands up 10 mm., with basal diameter 8 mm., and apical diameter 3 to 4 mm.; truncate at the apex with a small circular anal aperture.

Female coccid yellow, legs and antennae reddish-brown, anal appendages black, tipped with reddish-brown. General form turbinate, abdominal segments elongated. Cephalic and thoracic portion rounded to the second pair of legs. Anal appendages rounded at the base, stout, long, separated from each other two-thirds from the base, rugose on the sides as if annulated, fringed with stout reddish hairs, and several stout spines towards the tips. Legs large, stout, first joint broad, second swollen, oval, truncate at the base and rugose on the inner margins, tarsal claws small, pointed. Antennae small, with short irregular joints. Dorsal surface clothed with rather long, scattered, spiny hairs on the cephalic portion and thoracic segments, thickly fringing the abdominal segments in regular bands and finest at the base of the anal appendages. Abdominal segments, with the first and second segments with transverse bands of irregular spiny hairs, third with similar bands interspersed with stout spines, fourth with similar band as third but further thickened with stout lobed spines, last two segments banded in a similar manner with longer, slender spines on the sides of the apex of the last two segments.

APIOMORPHA ANNULATA, n. sp. Plate xvi, fig. 6.

This coccid is also described from specimens in the Queensland Museum, with no record of exact locality or specific name of Eucalypt. Habitat, Queensland.

The ♂ galls scattered over the surface of the leaves, generally in line with, if not upon, the midrib of the leaf, typical cylindrical form dilated at the apex. Height 5 mm., diameter 1.5 mm.

The ♀ galls growing on the branchlets singly or in groups of three or four, contracted and rounded at the base, cylindrical to the truncate apex, which is smooth, depressed in the centre, where it is slightly funnel-shaped, with a rather large circular orifice at the bottom. The basal portion of the gall is green, the apical portion ringed with light-brown scars. Sometimes the whole of the gall is ringed with these roughened scars, only the base being smooth. Height 12 mm., diameter 6 mm.

Female coccid dull-yellow with darker transverse bands along the upper half of the thoracic and abdominal segments. Antennae and legs yellowish-brown, anal appendages reddish-brown. General form turbinate, abdominal segments of uniform width. Length 8 mm., diameter 5 mm.

Antennae small, second and third joints rounded to the tip. Legs: first pair small, second and hind pairs large, basal joint squat, irregularly oval, second joint swollen in the centre, third joint or tarsal claw short, arcuate on the side, tip blunt. Dorsal surface of cephalic and thoracic segments covered with very small scattered tubercles each bearing a short, pointed bristle, the abdominal segments more thickly clothed with similar, tiny tubercles and a short band, increasing in length and density to the sixth segment, of large irregularly-rounded brown tubercles each bearing a short conical spine. Anal appendages reddish-brown, well developed, long, rounded on base and sides, which are serrate and fringed with fine hairs, finely pointed at the tips, which are almost in contact, with only a slight opening between them towards the tips.

APIOMORPHA FUSIFORMIS, n. sp. Plate xvi, fig. 3.

The galls of this curious species also came from the Queensland Museum collection. Exact locality and specific name of Eucalypt unrecorded. Habitat, Queensland.

The ♂ galls unknown.

The ♀ galls produced on the surface of the leaves, singly or in groups of three or four, spindle-shaped, slender, cylindrical, narrowest at the base, broadest at the apex which forms a convex button of light-yellow, in the centre of which is the rounded anal aperture. Length 13 mm., diameter at base 1.5 mm., in the centre 2 mm. Probably coloured green when fresh.

Female coccid dull-yellow, legs and antennae brownish, anal appendages light reddish-brown. General form round, tapering to tip of abdomen, elongate. Length 7 mm. Antennae very small, legs small, hind pair hardly larger than the fore and middle pairs, basal joint short and broad, second joint short, broad, tarsal joint small, narrow, coming to a point. Dorsal surface lightly clothed with rather long fine hairs. The fourth, fifth and sixth abdominal segments with a transverse row of widely separated, small, short, conical spines. Anal appendages with a cone-shaped base, slightly rounded at junction with the last abdominal segment, truncate at base with the anal appendages only occupying half the apex which is fringed with fine hairs. Anal appendages narrow, straight, of uniform width to the tips, which are deeply arcuate, with a sharp point on either side, slightly serrate on the outer margins.

APIOMORPHA SPINIFER, n. sp.

The specimens were sent to me by Mr. Herbert Jarvis from Stanthorpe, Queensland. He collected them upon the foliage of an undetermined species of Eucalypt growing in that district.

The ♂ galls unknown.

The ♀ galls are scattered over the surface of the foliage in a similar manner to those of *Apiomorpha fusiformis*, which they resemble in general form. They differ in being slightly shorter, cylindrical in form, not contracted at the base, but of a uniform thickness to the apex which is similar in form and coloration, but more depressed round the anal aperture.

The female coccid is very similar in form, but the cephalic fold bears a short transverse chitinous plate near the summit, apparently above the base of the antennae, on which are three or four stout, short spines. The derm is more chitinous, particularly upon the abdominal segments. The thoracic segments and abdominal segments have a row of stout spines along the lower margin

varying in number on each. The first abdominal segment has a row of three, the second five, the third seven, fourth none to thirteen, the fifth five to seven, and the sixth six to eleven. The anal appendages reddish-brown and somewhat similar in structure to those of *Apiomorpha fusiformis*, except that the inner spine is much smaller than the outer point. The curious stout spines on the cephalic portion are quite unique and unknown upon any other species of the genus.

APIOMORPHA DIPSACIFORMIS Froggatt. Plate xvi, fig. 5.

This year I have received a fine series of the male and female galls of this fine species from Mr. J. Macqueen, who collected them upon the branchlets of the narrow-leaved ironbark, *Eucalyptus pilligaensis* at Millmerran, Southern Queensland.

This is an interesting record because the exact locality or host-plant of the type was unknown when I received a bunch of female galls from South Australia with the information that they had been collected in Queensland. It is evident, as can be seen in the figures given, that as the female galls mature the spiny filaments covering the surface become dry and brittle and break off. In the type the spiny filaments were much more developed and perfect than those figured in the present plate.

The male galls (previously unknown) are somewhat like those of the allied species, *Apiomorpha excupula*, being attached to the twigs in the same manner in irregular little masses of tangled tubes, but are shorter, more irregular in form, and the filaments covering them are so fine that they almost look woolly. The closed apex is more rounded and ribbed, but opens out later in the same manner. In fresh specimens they vary in colour from light-red to reddish-brown and if anything are more massed together at the base.

APIOMORPHA DUPLEX Sch. Plate xvii, fig. 4.

The female gall of this remarkable species is probably the largest insect gall in the world. I have had specimens more than a foot in length from the base of the gall to the tips of the stout flattened horns. As they spring directly from the side of a branch and are of the same green tint as the surrounding leaves, with their curling leaf-like tails, in spite of their size, they easily escape detection. This species seems to have a restricted range and, as far as we know, its commonest locality is the Hawkesbury River district, ranging north as far as Glen Innes, but C. French, Jr., has found it at Dandenong Ranges, Victoria. The following is its range, with the host-plants: *Eucalyptus piperita*, Katoomba; *E. haemastoma*, *E. Camfieldi* and *E. eugenioides*, Hornsby (W. F. Blakely); *E. occidentalis*, Glen Innes (I. Dorrington); *E. saligna*, Thornleigh (W. W. Froggatt); *Eucalyptus* sp., Paterson River (Rev. H. M. R. Rupp); *Eucalyptus* sp., Cheltenham (H. E. Ellen).

Though the female galls have been known since Schrader described the species in 1862, we had no knowledge of the male galls until I found the specimens now figured, in the Herbarium of the Botanic Gardens, together with a female gall sent to the Curator by Mr. H. E. Ellen.

Male galls massed together covering both sides of leaves and branchlets between them; there are more than a thousand galls on the leaves figured. They are dark-red, faintly striated on the outer surface, cylindrical, of uniform thick-

ness from attachment to the surface of leaf to the apex, the latter rounded and closed (until the gall is full grown) with a raised cork-like plug. When it falls out the rounded apex is slightly expanded. They average 7 mm. in height. Diameter 1.5 mm.

APIOMORPHA EXCUPULA Fuller. Plate xvi, fig. 1.

This species was originally described from the Port Stephens district. I have since had specimens from the Tweed River. I now record them from the following localities in New South Wales: Narrabri, on *Eucalyptus Woollsiana* (J. H. Maiden); Ourimbah, on *E. paniculata* (F. McPhearson); Wollomba State Forest, Nabrac, on *E. paniculata* (L. C. McIvor).

The male galls are either situated upon the twig at the base of the female gall, or more frequently form an irregular mass of twisted tubes turning at all angles, upon the branchlets. Each gall is about 6 mm. in height, of a greenish tint when fresh. It is an irregularly rounded tube, rough and clothed with fine filaments. In the immature specimen the apex is closed and covered with a tuft of filaments like a plug. When adult the plug drops off, leaving a roughened, rounded summit with a rounded opening into the male gall chamber.

APIOMORPHA FLETCHERI Fuller. Plate xvii, fig. 7.

In my previous paper last year, when noting the enormous number of female galls infesting the branches of the Red Box (*Eucalyptus bicolor*) on the Murray River, I stated that the male galls of this species were unknown. Since then I have received a fine series of the male galls with some female galls infesting the leaves of the Long-leaved Box (*Eucalyptus elaeophora*) collected by Mr. C. French, Jr., at Dandenong, Victoria. I have also a record of specimens of the female galls being collected at Gulgong, New South Wales (J. H. Maiden and J. L. Boorman) on *Eucalyptus tereticornis*. The ♂ galls are rich deep pink with a whitish bloom covering the upper surface. They are very slender, cylindrical tubes, broadest at the base, tapering slightly to the open apex, which is not dilated like the typical tubular galls of other species. They measure from 3 to 4 mm. in height and hardly 1 mm. in diameter. They are massed together on the upper surface of the leaves, so as to be almost in contact at the base. There are more than 1,100 tubular galls on the largest leaf figured.

APIOMORPHA PHARATRATA Sch. Plate xvii, figs. 5, 6.

Two figures are given to show the normal form and the abnormal form when the male gall-mass is many times larger than the overshadowed female gall.

There are three species described of these curious combined male and female galls, formed by these coccids. The elongate-oval female gall is produced upon the midrib or base of a leaf stalk, and in some remarkable way the male larvae gather together on the side of the well-grown female gall, and by their united action cause a rounded excrescence to grow out from the surface of the female gall. This finally forms a fleshy sheath, rounded above, with the under surface flattened into a mass of coalesced, rounded tubes open at the apex, each containing a winged male. It would be very interesting to watch the early development of these galls for, while both the male and female larvae desert the matured gall at the same time, the female gall has to grow to a certain size before the male larvae can find lodgment upon it.

This species has a wide range: South Australia: Encounter Bay, on *Eucalyptus Baxteri* (Prof. J. B. Cleland); Border Town, on *Eucalyptus* sp. (L. G. Manning); New South Wales: Guyra, on *E. coriacea* (Rev. E. N. McKie); Braidwood, on *E. rubida* (H. A. Vining); Kendall, on *E. pilularis* (Prof. J. B. Cleland).

APIOMORPHA ROSAEFORMIS Froggatt. Plate xvii, fig. 1.

The type specimen, which came from the Manning River, New South Wales, was much larger than the specimen figured here. It has, however, the same bright coloration and slightly convex under surface of the mass of male galls.

The specimen figured is of a brilliant red tint, but the under surface (the sheath of male galls) is clothed with a white bloom from the floury secretion from the enclosed larval male coccids, so that the outer margin is much brighter than the rest of the gall mass.

Habitat.—Middle Harbour, Sydney, N.S.W., on *Eucalyptus* sp. (Prof. J. B. Cleland).

APIOMORPHA THORNTONI Froggatt. Plate xvii, figs. 2, 3.

This is a very variable form of the "cocks-comb" group; the female galls formed on the leaves upon the main rib or stalk, oval and ribbed; the mass of male galls often very wrinkled and irregular in form.

Lately I have received a very fine series of immature female galls from Archdeacon Haviland, who collected them at Portland on an undetermined species of *Eucalypt*. The first form of the female gall is an irregular, rounded rosette of soft reddish tissue with a roughly granulated surface, which, when opened, shows a tiny, white, oval cell, based on the surface of the leaf. The coccid enclosed is pale-yellow, rounded and thickly covered with floury matter and bearing two white tails. At this stage the galls are about 3 mm. in diameter. When more developed, though still rosette-like, they stand up from the leaf and the apex is open and surrounded with floury matter. These contain perfectly-formed pupal coccids (if we can use the term), somewhat more elongate in form than the adult female. They have the same development of legs and anal appendages, and the rows of spines across the dorsal surface of the abdominal segments are very well defined. The female galls are usually almost full-sized before the mass of male galls accumulates and develops.

APIOMORPHA URNALIS Tepper. Plate xvi, fig. 4.

This species has a wide range over Australia from the west, across South Australia and Victoria, through New South Wales to Southern Queensland. It is an inland form and very partial to the small Mallee Scrub gums. It is very variable in form, but the thick-set vase shape is the most typical form, as figured (Plate xvi, fig. 4).

I have included it in my plate to show the variation in the form of the female gall. The following localities and host-trees are recorded: Millmerran, South Queensland, on *Eucalyptus pilligaensis* (J. Macqueen). New South Wales: Condobolin, on *E. sideroxylon* (J. H. Maiden); East Merool, on *E. macrocarpa* (W. Campbell); Kenmore, on *E. melliodora* (J. H. Maiden). South Australia: Paretta Forest, on Mallee (*E. calycogona*) (Botanic Gardens Herbarium); Border Town, on *E. gracilis* (L. E. Manning). Western Australia: Conderdes, on *E. spathulata* (W. V. Fitzgerald); Swan River, on *Eucalyptus* sp. (L. J. Newman).

EXPLANATION OF PLATES XVI-XVII.

Plate xvi.

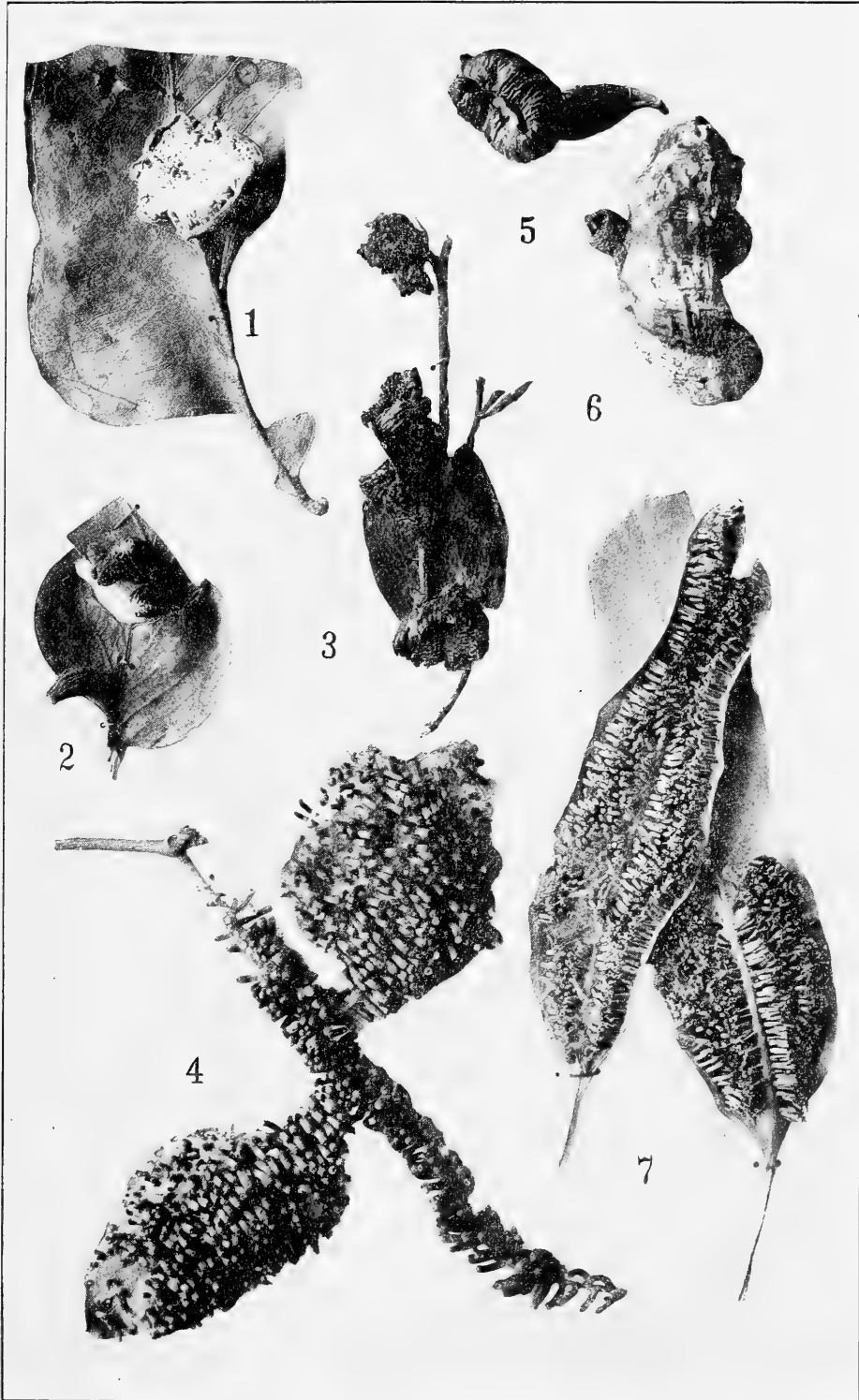
1. *Apiomorpha excupula*, showing the peculiar form of the ♂ galls and the various forms of the ♀ galls in all stages of development.
2. *Apiomorpha longmani*, n. sp. ♀ galls on branchlet.
3. *Apiomorpha fusiformis*, n. sp. ♀ galls on leaves.
4. *Apiomorpha urnalis*, showing the variations in form of the ♀ galls.
5. *Apiomorpha dipsaciformis*, showing ♂ galls in groups like those of *A. excupula* and variations in form of ♀ galls.
6. *Apiomorpha annulata*, n. sp., showing ♂ galls on leaves and ♀ galls on branchlet.

Plate xvii.

1. *Apiomorpha rosaeformis*, showing the rounded mass of ♂ galls above the slender ♀ gall attached to the leaf.
 2. *Apiomorpha thorntoni*, showing immature ribbed ♀ galls on leaf before the ♂ gall develops.
 3. *Apiomorpha thorntoni*, with the ♂ galls above the single ♀ galls, when adult.
 4. *Apiomorpha duplex*, showing twig and leaves encrusted on both sides with ♂ galls.
 5. *Apiomorpha pharatrata*. Typical ♀ gall with mass of ♂ galls.
 6. *Apiomorpha pharatrata*, with an abnormal mass of ♂ galls on ♀ gall.
 7. *Apiomorpha fletcheri*, showing massed ♂ galls on upper surface of leaves.
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Species of *Apimorpha*.



Species of *Apiomorpha*.

AN ABNORMAL XANTHIUM BURR.

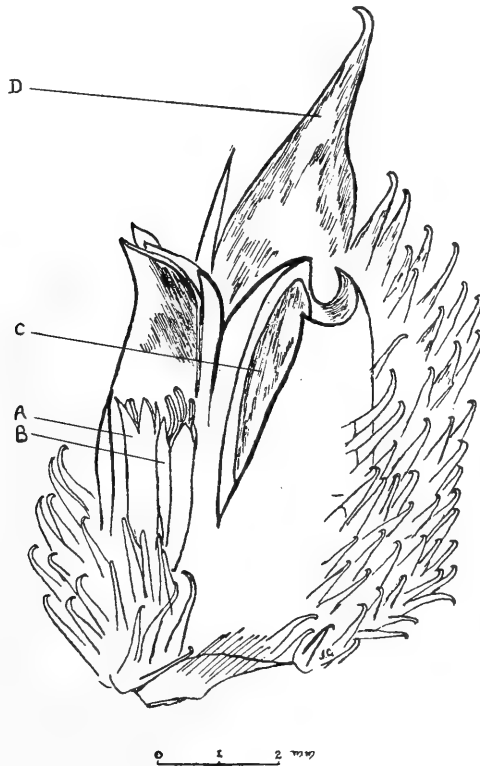
By J. CALVERT, M.Sc., F.L.S., Division of Plant Industry, Canberra.

(Communicated by Dr. B. T. Dickson.)

(One Text-figure.)

[Read 24th September, 1930.]

During the course of investigations on Noogoora Burr (*Xanthium pungens* Wallr.) a collection of burrs made at Goondiwindi was received through Mr. A. P. Dodd of the Commonwealth Prickly Pear Board. While looking through these specimens, the abnormal burr, which is the subject of this note, was discovered.



Text-fig. 1.—Burr of *Xanthium pungens* Wallr., Noogoora Burr, showing A, B, two male florets; C, an unopened floret; D, beak on the normal half of the burr.

It is well known that the genus *Xanthium* is monoecious, that is, the flowers are unisexual, both sexes occurring on the same plant, the globular male inflorescence being surrounded by the female inflorescence which, after fertilization, develops into the common burrs. The burrs generally are bilocular, each loculus containing one seed, but sometimes multiple-seeded burrs are recorded, i.e., burrs with several loculi, each loculus containing one seed. Naturally-occurring multiple-seeded burrs have been recorded five times, as far as the writer can ascertain, four times in America by C. A. Shull (*Bot. Gaz.*, 83, 1927, 385; 84, 1928, 240) and once in Queensland, Australia, by J. White-Haney (unpublished report, Division of Plant Industry, 1929).

In the present instance, two male florets, A and B in Text-fig. 1, were discovered occupying a portion of the burr, whilst just alongside, a loculus contained what looked like an unopened floret (C). This made up one-half of the burr and the other half consisted of the normal one-seeded loculus with the beak (D) projecting at the summit of the burr, as is usual. From the arrangement of the loculi it appears that one-half of the burr is normal while the other half is tending to become a multilocular burr.

Concerning the two male florets, the abnormality may be either that (1) the involucre has enclosed part of the male inflorescence; or (2) some male primordia have taken the position usually occupied by female primordia.

Summing up, the question appears to be whether the male primordia in question have wandered or the involucre taken upon itself to enclose these male primordia, both processes bringing about a similar result.

P.S.—Since the above was written the May issue of the *Botanical Gazette* (Vol. 89, No. 3, 1930) has been received, containing an article by Dr. C. A. Shull on the occurrence of multiple-seeded *Xanthium* in Australia. In this he makes a significant statement, viz.: "It seems probable, therefore, that the sporadic occurrence of these unique plants may be expected in any part of the world where cockleburs are found, or at least in localities where two or more species occupy the same region".

Acceptance of his statement indicates the necessity of a widespread collection of Noogoora Burr material for the purpose of naming. In the most recent issue of the *Journal of the Council for Scientific and Industrial Research*, a note on the botanical name of material received, is published.

TRICHOPTERYGIDAE OF AUSTRALIA AND TASMANIA.

DESCRIPTIONS OF SIX NEW GENERA AND ELEVEN NEW SPECIES.

By CEDRIC DEANE, A.M.I.E.Aust.

(Twenty-two Text-figures.)

[Read 24th September, 1930.]

The only species belonging to this family of minute Coleopterous insects previously described from Australia are six species by A. M. Lea in the genus *Rodwayia* Lea, 1907, and one each in the genera *Actinopteryx*, 1872, and *Ptilium*, 1878, by Matthews. With the material sent to me by the authorities of the South Australian Museum for naming, and other which has been collected, it is probable that the numbers will be greatly swelled. The author hopes to deal with these and some island forms in subsequent papers.

One of the chief points of interest centring around this group is the fringed formation of the wings, the hairs composing the fringe often extending completely and uniformly around both anterior and posterior margins as well as apex. The length of these hairs is sometimes ten times as great as the width of the membrane. The hair fringing of the wings, although greatly developed in the Trichopterygidae, is by no means confined to this family, or even to the order Coleoptera, being present in most orders of insects. It appears to be a characteristic of size rather than kind, being usually most pronounced in the most minute forms. As we pass from the larger forms of insect life, such as the Cicadas and large wasps, to the smaller and finally to the extremely minute, a remarkable change commonly occurs when the overall length is in the neighbourhood of one millimetre; hair fringe appears on the posterior or trailing edge of the membrane and, extending towards the apex, passes round to the forward side, until in the smallest species it adorns the complete margin uniformly. Accompanying this transition the supporting rib—radius, costa, subcosta, etc., in the Cicadas—moves from the anterior edge to the centre. Under these conditions propulsion would be by a flapping movement of the wing, like that of a feather fan or a shark's tail. These modifications, I should say, are provided by Nature to enable the creature to cope with meteorological and other physical forces, which in bodies of those dimensions would differ from those with which we are ordinarily acquainted.

PHILAGARICA, n. gen.

Oval, convex, margin entire. Head of medium size, scarcely visible from above, widest at base, deeply inserted in prothorax, not salient, widely produced anteriorly downwards to a chisel-edge medially excavated widely and faintly. Eyes medium, not visible from above, widely separated, the head conforming to the anterior marginal curvature of pronotum. Antennae eleven-segmented, 1 and 2 large sub-

cylindric, 2 longer than 1 but of equal diameter, 3 to 8 subequal, less than half as thick as 1 and 2, 9 to 11 large, of nearly equal thickness, thicker than 1 and 2, furnished with bristles, segments 9 and 10 spheroidal, 11 longer, pointed at apex. Length of antennae 0.45 of the length of insect without antennae. Palpi exerted. Pronotum widest at base, not exerted, posterior angles very acute, produced backward, lying close to body, conforming to integral margin. Prothorax transverse. Elytra sub-elongate, extending well beyond apex of abdomen, diaphanous, somewhat tapering, rounded at apex. Lateral margins somewhat incurved at middle. Wings long, narrow, lanceolate membrane, fringed with fine long hairs, these hairs ten times as long as width of membrane at middle of latter. Legs: anterior strong, large; intermediate medium; posterior small; tarsi not slender, claws moderate to small. Anterior femora robust, wide, and somewhat flat, margins convex throughout, tibiae more slender, thickening towards apex, margin concave along interior basal half. Coxae: anterior medium, round, almost contiguous; intermediate not nearly contiguous, rather widely separated by "sternal process"; posterior large, almost contiguous, occupying the full width of the body. Metasternum extending nearly to sides of body. Scutellum medium, visible portion rather small, triangular, one-seventh of width of base of pronotum. Sternal process conspicuous, lightly convex.

Genotype, *P. agilis*.

Philagarica is perhaps in general facies nearest to *Nossidium* Matthews, figured and described by him in his monograph of the family published in 1872. Some of the most conspicuous differences are: elytra extending far beyond apex of abdomen, metasternum attaining the sides of the body, head more deeply inserted in prothorax and almost concealed from above, pygidium rounded at apex, not tridentate.

PHILAGARICA AGILIS, n. sp. Text-figures 1-3.

Oval, convex, brown, translucent, scarcely pubescent, the several parts forming an integral margin. Without sculpture. Head normal size, very little visible from above, produced downwards, anterior medial excavation conspicuous, conforming to anterior marginal curvature of pronotum. Antennae 0.45 length of body. Eyes not visible from above. Palpi prominent, large. Antennal segments 9, 10 and 11 of equal thickness, furnished with bristles up to one and a half times the length of the segment they are set on. Body widest before middle. Pronotum nitid, widest at base, lateral margins entirely convex, posterior angles very acute, produced backwards and conforming to the integral margin. Elytra slightly pubescent, elongate, extending well beyond apex of abdomen, diaphanous, somewhat tapering, rounded at apex, lateral margins incurved at middle. Wings long narrow, the hairs of fringe equal and about ten times as long as width of membrane at middle. Hairs very pale, almost white. Membrane colourless with blackish patches. Legs: anterior strong, large, intermediate medium, posterior small; tarsi not slender, claws moderate to small. Sternal process conspicuous, lightly convex.

Length, 0.57 mm.; width, 0.28 mm.

Habitat.—Eungai, Macleay River District, N.S.W. (Lea and Deane).

Type in Coll. Deane; co-types in South Australian Museum, National Museum, etc.

PHILAGARICA PILOSA, n. sp.

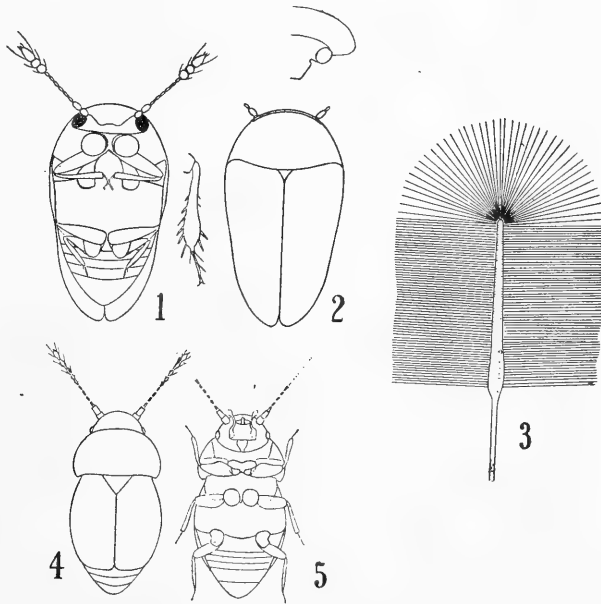
Elliptical, convex, light-brown, pilose, translucent, widest at middle. Head less deeply inserted, less concealed from above than *P. agilis*, more produced at mouth. Palpi rather small, concealed. Eyes just or almost visible from above, medium, moderately separated. Antennal segment 10 thicker than 9, 11 thicker than 10. Legs: posterior large. Antennae length 0.44 of the length of the body, segment 9 not as thick as 10 and 11 and considerably shorter than 8, segments 3-8 slender, gradually thickening, subcylindric, 1 and 2 large, 2 larger than 1. Pronotum paler than elytra, basal margin convex posteriorly at centre but reverses near angles, which are acute but small. Elytra entire, convex, darker than pronotum, strongly pilose, slightly translucent on apical two-thirds, scarcely dehiscent at apex, but often not quite closed in repose, extending well beyond tip of pygidium, without depression along suture, lateral margins not incurved at middle. Wings 1.92 times length of body, narrow, hairs of fringe dark-brown. Tarsi slender, claws large. Coxae: anterior globular, contiguous; intermediate rather widely separated by the mesosternal process; posterior contiguous, occupying the full width of body. Sternal process convex, prominent, hastate.

Length, 0.74 mm.; width, 0.35 mm.

Habitat.—Waratah, Tasmania (Lea).

Type in Coll. Lea; co-types in Coll. Lea and Coll. Deane.

This species may be compared with the previous one as follows: Body larger, about 30 per cent. on the length, paler, more strongly pilose. Head less clearly cut, front and clypeus less sharply defined; palpi less prominent and smaller, not



Text-figs. 1, 2.—*Philagarica agilis* Deane.

Text-fig. 3.—Wing of *Philagarica agilis* Deane.

Text-figs. 4, 5.—*Leaduadicus tolerabilis* Deane.

so vitreous. Antennae with segments 9, 10 and 11 increasing instead of equal. Sternal process much narrower. Posterior coxae having anterior plate narrower. Posterior legs longer.

LEADUADICUS, n. gen.

Oval, convex, widest across elytra, margin not entire. Head medium to small, not concealed from above, widest across eyes, slightly exerted, margin concave before eyes, rounded in front. Eyes medium to small, easily visible from above. Antennae 11-segmented, 1 and 2 large, 1 thickest, cylindrical, 2 slightly tapering towards apex, 3 to 8 slender, 3 slightly tapering towards apex, 4, 5 and 6 cylindrical, 7 thickening towards apex, 8 and 9 elongate-elliptic, 8 to 11 increasing in size; length of antennae 0.48 of length of body. Palpi prominent, terminal joint large, oval or globular. Pronotum widest before base, nearly as wide as elytra; posterior angles not acute, lateral margins strongly convex, anterior margin convex, posterior concave on lateral thirds; base wider than base of elytra. Elytra oval, convex, widest at middle, subtruncate, exposing 2 or 3 dorsal segments of abdomen, not or only lightly rounded at basal angles. Legs moderate, subequal. Coxae: anterior strongly contiguous, subquadrilateral; intermediate almost contiguous, junction masked by narrow sternal process; posterior remote, medium to small. Femora: anterior robust, swollen at middle on anterior margin; intermediate robust, margins convex throughout; posterior medium. Tibiae subequal, medium; apices of anterior rounded, of intermediate truncate, of posterior pointed. Tarsi medium. Prosternum: divisional plates distinct. Mesosternum rounded at sides. Metasternum attaining sides of body; posterior margin of intercoxal piece lightly rounded. Abdomen with six visible ventral segments; basal, 2nd, 3rd and 4th not attaining side margins of elytra. Scutellum large, triangular, more than one-third the width of base of elytra.

Genotype, *D. tolerabilis*.

Leaduadicus is not closely allied to any existing genus. It differs from *Ptenidium* notably in having elytra truncate instead of elongate and rather pointed. It has the apical dorsal segments of abdomen exposed. The whole form is wider and more robust. The posterior coxae are more widely separated.

LEADUADICUS TOLERABILIS, n. sp. Text-figures 4, 5.

Widely obovate, light-brown, moderately convex, sparsely pubescent. Head widely rounded in front, irregularly clothed with fine pale pubescence; deep-brown. Pronotum convex, light-brown, uniformly pubescent, anterior margin rounded with sides, not forming humeral angles, lateral margins very convex, pale; posterior margin dark-brown. Elytra oval-quadrangle, truncate, light-brown, uniformly pubescent; basal angles not rounded. Abdomen pale-brown, each ventral segment with a row of longish hairs. Pro-, meso- and metasternum flavous. Tarsi, palpi and segments 3 to 9 of antennae pale-yellow.

Length, 1.125 to 1.25 mm.; width, 0.55 to 0.58 mm.

Habitat.—Ourimbah, N.S.W., in rotting leaves (A. M. Lea).

Type in Coll. Lea.

LEADUADICUS IMPERIALIS, n. sp. Text-figures 6, 7.

Widely obovate, brown to dark-brown, convex, strongly pubescent. Head widely rounded in front, deep-brown, pubescence white. Pronotum dark-brown,

pubescent, convex; anterior margin not merging into sides, forming obtuse humeral angles, these rounded; lateral margins convex. Elytra subquadrate, truncate, dark-brown, strongly pubescent, pubescence white to pale-yellow; basal angles rounded. Abdomen brown, each ventral segment with a row of longish hairs. Pro-, meso- and metasternum light-brown. Tarsi, palpi and antennae flavous.

Length, 1.02 mm.; width, 0.55 mm.

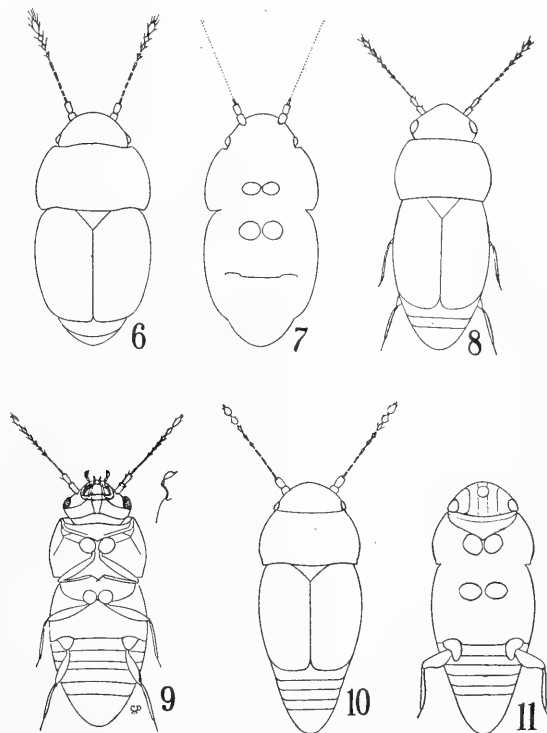
Habitat.—Tambourine, Queensland (A. M. Lea).

Type in South Australian Museum.

L. imperialis differs from *L. tolerabilis* in having length smaller and less variable, width also less variable; form wider in proportion. The colour is much darker and the pubescence thicker and whiter. The humeral angles of pronotum are formed, the basal angles of elytra are rounded, and the apex of abdomen is less exposed. The posterior margin of metasternum is less curved.

ACHOSIA, n. gen.

Elongate-oval, subdepressed, widest across elytra. Head largely visible from above, prominent, widest across eyes; front medium, margins straight near insertion of antennae, capable of being exerted, narrowing a little towards base. Eyes easily visible from above. Mouth not produced. Antennae 11-segmented, basal segment and 2 large cylindrical, 3, 4 and 5 slender, 6 to 11 gradually



Text-figs. 6, 7.—*Leaduadicus imperialis* Deane.

Text-figs. 8, 9.—*Achosia lanigera* Deane.

Text-figs. 10, 11.—*Achosia femoralis* Deane.

becoming larger. Palpi elongate, 4-segmented; basal segment cylindrical, 2 elongate, 3 very large, 4 minute, basal and stem of 2 forming a swan-neck. Prothorax: posterior angles obtuse, distinct; component ventral plates well marked; widest before base, almost as wide as body across elytra. Elytra widest at middle, subtruncate, exposing 3, 4 or 5 dorsal segments of abdomen; slightly dehiscent at apex. Legs uniform; coxae: anterior and intermediate globular, contiguous or almost so; posterior lamellate, very remote, rather small. Mesosternum without medial carina, but having a small shallow granule on the intercoxal process. Metasternum extending to sides of body, hind margin scarcely excavated for insertion of coxae; anterior outer angles acute. Scutellum triangular, large, more than one-third the width of pronotum at base. Abdomen with six visible ventral segments.

Genotype, *A. lanigera*.

Achosia has for its nearest ally in the existing genera, *Ptinella*, from which it differs conspicuously in having posterior angles of pronotum not acute, elytra not so truncate; antennal segments 6 to 11 gradually becoming thicker towards the apex, segments 3, 4 and 5 more slender, almost cylindrical. It is also allied to *Cnemadoxia* described herein, the chief differences being antennal segments 8 to 11 elongate-subovate, tapering towards apex, less plumage; mouth parts more centrally situate; frons less narrowed; humeral angles of pronotum more distinct; prothoracic sternites distinct; form narrower.

ACHOSIA LANIGERA, n. sp. Text-figures 8, 9.

Pubescent, brown. Head sub-trapeziform; front narrow, rounded; rather exserted. Antennal segments 3, 4 and 5 cylindrical, 6 to 11 pointed both ends. Pronotum wider at base than apex. Elytra with apices greatly rounded at interior corners, sloping away at sides. Femora slender. Tarsi slender.

Length, 1.25 mm.; width, 0.49 mm.

Habitat.—Glen Innes, N.S.W. (A. M. Lea).

Type in South Australian Museum.

ACHOSIA FEMORALIS, n. sp. Text-figures 10, 11.

Elongate-oval, somewhat depressed, light-brown, pilose, slightly wider across elytra than prothorax, widest at one quarter from base. Head largely visible from above, rather deeply inserted, widest across eyes. Eyes rather large, visible from above. Mouth somewhat produced. Antennal segments 10 and 11 large. Scutellum rather broad. Elytra normal. Abdomen elongate. Posterior coxae somewhat produced longitudinally backwards; posterior femora dilated on hind margin.

Length, 1.26 mm.; width, 0.51 mm.

Habitat.—Tamworth, N.S.W. (A. M. Lea).

Type in Coll. Lea.

EPOPTIA, n. gen.

Oval, very convex, especially below, widest across elytra. Head rather large, easily visible from above, widest across eyes, widely rounded in front. Eyes medium, little visible from above. Antennae 11-segmented, 1 and 2 large, 1 cylindrical, 2 barrel-shaped, apical margin projecting slightly at outer edges, 3 to 9 slender, 3 thickening towards apex, 4 elongate-conic, 5 and 6 elongate-elliptic, 7 and 8 oval, 9 similar to 8 but larger, 10 and 11 very large, flask-shaped, 7, 9, 10

and 11 but not 8 furnished with setae. Length of antennae 0.47 of length of body. Pronotum mobile, very convex, widest at middle, nearly as wide as body, anterior and side margins very convex throughout, basal margin with a wide space stretching from side to side to permit of movement relatively with the mesothorax. Elytra oval, convex, entire, extending beyond apex of abdomen, not dehiscent at apex, fitting unusually closely along entire suture, widest at one-third from base, margins inflexed on basal three-quarters to cover edges of meta-thorax, forming epipleurae. Wings long, stalked; membrane narrow, bent; hairs of fringe six times as long as width of membrane at middle. Legs slender, subequal. Coxae: anterior contiguous, junction hidden by prosternal process, somewhat transverse; intermediate globular, contiguous, junction hidden by metasternal process; posterior distant. Femora moderate. Tibiae: anterior truncate, thickening towards apex; intermediate normal, thickening towards apex, finely serrate on apical one-third or more of inner margin; posterior thickening at first, then tapering to apex, finely serrate on apical half of inner and one-third of outer margin. Tarsi rather short, claws rather large. Prosternal process rather long, prominent, slender, pointed. Metasternal process rather long, slender, blunt. Scutellum very large, triangular, more than half the width of base of pronotum, indistinct. Abdomen seven-segmented, basal segment fixed, or semifixed, all others mobile, retractile.

Genotype, *E. rotunda*.

Epoptia has its closest ally in the previously described genus *Ptenidium*, by comparison with which the following points of distinction are easily noticeable: Form more robust, wider, more highly convex; head set downwards, front decumbent; antennae differently clothed, pedicel without setae, this and basal thicker, segment 10 larger than 11, 10 and 11 only forming the club; eyes not so prominent; pronotum much more convex, almost or quite as wide as elytra; these with apical margin entire; pronotum with a wide tergite running from side to side at base; scutellum much larger; posterior coxae more distant; abdomen contracted, not nearly extending to apices of elytra.

Note.—The scutellum is indistinct and tangential illumination is required to distinguish it.

EPOPTIA ROTUNDA, n. sp. Text-figures 12-14.

Oval, very convex, black, nitid, with sparsely scattered short hairs or setae. Head widely rounded anteriorly, front somewhat produced downwards. Antennae pale-yellow, rather small, slender, 0.48 of length of body. Pronotum very sparsely setose, very convex. Elytra oval, convex, entire, nitid, dark-brown to black, apices semi-transparent, flavous, the colour extending around side margins, tapering and disappearing at widest part of body. Wings: membrane long, narrow, colourless; hairs of fringe dark, visible through apical parts of elytra. Legs flavous.

Length, 1.06 mm.; width, 0.57 mm.

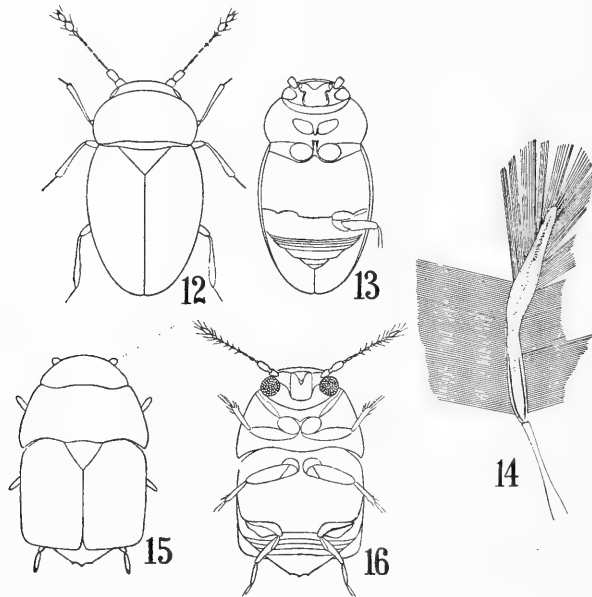
Habitat.—Launceston, Tas. (A. M. Lea).

Type in South Australian Museum.

TRICHOPTERYX AUSTRALICA, n. sp. Text-figures 15, 16.

Quadrata, lightly convex, dark-brown to nearly black, opaque, pilose, dorsal surface strongly granulate, sides parallel. Head largely visible from above; eyes hardly visible from above, large. Antennae rather short, slender, segments 1 and 2 large, subcylindric, 2 largest, 3 to 8 slender, elongate-oval, each being thicker

at apical half than basal, 9 to 11 larger, increasing in size and diameter, 11 largest of the three but not so large or so thick as 2, 7 and 8 not thicker than 5 and 6. Pronotum scarcely wider than elytra, widest at or near base; posterior angles not very acute. Elytra quadrate, parallel, truncate, exposing pygidium, opaque.



Text-figs. 12, 13.—*Epopitia rotunda* Deane.

Text-fig. 14.—Wing of *Epopitia rotunda* Deane.

Text-figs. 15, 16.—*Trichopteryx australica* Deane.

Legs: anterior and intermediate nearly equal; posterior smaller and more slender; tarsi very slender, rather long; coxae: anterior round, medium, contiguous; intermediate small, nearly contiguous; posterior very remote. Metasternum: posterior intercoxal production moderate or weak. Scutellum: visible portion large, nearly one-third the width of pronotum at base.

Length, 0.78 mm.; width, 0.47 mm.

Habitat.—Melbourne (C. Deane), Ferntree Gully, etc. (C. Oke).

Type in Coll. Deane.

The dorsal facies of this species somewhat resembles that given by Matthews for *T. volans*, but posterior outer angles of elytra are curved downwards, and head larger. Antennae are 0.44 of length of insect as against 0.55 for Matthews' outline figure for the genus.

COCHLIARION, n. gen.

Oval, highly convex above, rather flat below, margin entire. Head medium to small, visible from above, deeply inserted in prothorax, lightly salient, front not produced, mouth produced. Eyes wanting. Scarcely conforming to anterior margin of pronotum. Antennae rather short, 0.31 of the length of body, 11-segmented but appearing only 10-segmented, segment 3 contained within 2; 1 and 2

large, 3 to 9 slender, 10 and 11 large forming the club, bristles twice as long as segment on which they are set. Setae on club long. Body receding into shell cavity formed by pronotum and elytra as in *Coccinellidae* and *Paropsis*. Widest at base of pronotum. Pronotum widest at base, posterior angles sharp, but not acute. Elytra entire, extending beyond abdomen, narrowing towards apex, not dehiscent at apex. Wings absent. Legs: femora robust, having deep grooves for the reception of the tibiae. Tibial interior outline convex, exterior nearly straight. Intermediate tarsi with a hook process attached to base of basal segment. Coxae: anterior elongate, transverse, separated by small prosternal positive process; intermediate subtriangular, separated by small mesosternal receptive process; posterior large, not nearly contiguous, extending to sides of body. Abdomen with six visible ventral segments, taper conforming to elytra. Metasternum attaining the sides of the body, scarcely produced anteriorly between the coxae. Mesosternal carina with a groove for the reception of the prosternal process.

Genotype, *C. victoriense*.

Cochliarion differs widely from all previously described genera, especially in having form more compact, even more so than in *Rodwayia*; margin more oval, more entire; appendages secluded in repose; more convex above; head decumbent; anterior coxae narrower and more oblique. This genus is blind, a feature which it possesses in common with *Rodwayia* of Australia and *Limnodes* of America. Also the antennae have a passing resemblance to those of *Rodwayia*, one of the chief differences being the greater size of the basal segment in the new genus. In other features and in general form *Cochliarion* in no way suggests *Rodwayia*, the former being almost subnavicular, while the latter is subquadrate. The striking and conspicuous form of sternal process, so characteristic of *Rodwayia*, does not appear in *Cochliarion*.

COCHLIARION VICTORIENSE, n. sp. Text-figure 17.

Oval, brown. Antennae yellow, segments 1 and 2 barrel-shaped, 3 of peculiar form, enclosed within 2, 4 cylindric, 5 and 6 ovoid, 7, 8 and 9 nearly globular and equal or very slightly increasing in width, 10 and 11 large forming the club, 10 nearly globular, 11 pointed. The bristles more than twice as long as the segment on which they are set. Legs rather short, femoral grooves deep. Coxae: anterior narrow, diagonal; intermediate triangular, their anterior and approaching angles rounded. Intermediate tarsal appendages long, claws almost obsolete. Mesosternal median groove small, deep, proceeding to a blunt carina.

Length, 0.87 mm.; width, 0.5 mm.

Habitat.—Ferntree Gully, Vic. (C. Oke).

Type in Coll. Deane.

RODWAYIA GRANDIS, n. sp. Text-figures 18, 19.

Large, ovate-quadrate, widest across pronotum at one-third from base, convex, reddish, marginal outline interrupted at hind angles of prothorax and at apex of elytra. Head visible from above, conforming in front to the anterior curvature of pronotum, paler than pronotum. Palpi small. Antennae 10-segmented, robust, short, 0.22 of length of insect without antennae, basal segment small, deeply inserted, 2 large, ellipsoidal, 3 to 7 normal, cylindric, of equal thickness, 8 sub-conic, much smaller than 9, 9 globular, 10 largest, pointed, 8, 9 and 10 forming the club, bristles not longer than the segments on which they are set. Pronotum:

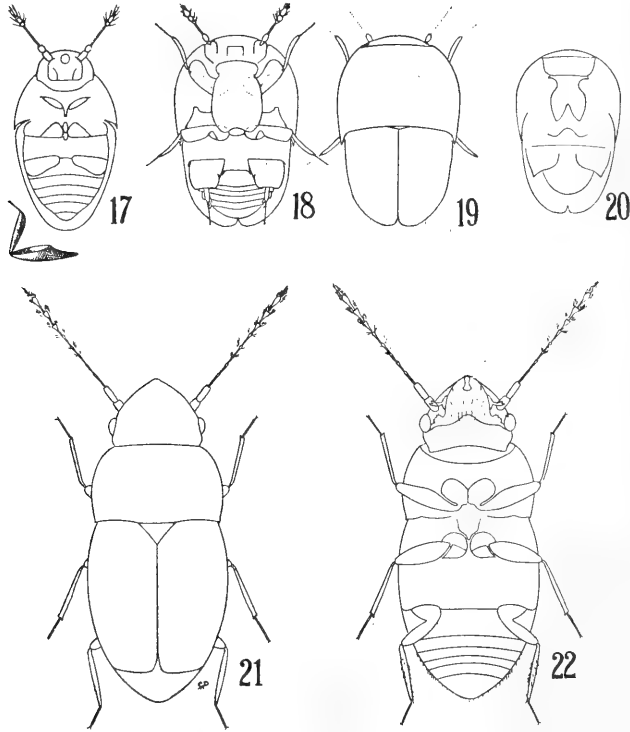
posterior angles very acute, projecting backwards. Legs: anterior and intermediate rather long; tibiae curved, convex sides exterior, long, slender, not thickening towards apex; anterior and intermediate femora very broad and flat; posterior femora concealed by coxae. Sternal process large, posterior medial and anterior side marginal incurvatures very shallow. Posterior coxae large, quadrate, widely distant. Abdomen with six visible ventral segments. Elytra extending beyond pygidium, slightly tapering, rounded at apex.

Length, 0.96 mm.; width, 0.61 mm.

Habitat.—Belgrave, Vic. (C. Oke).

Type in Coll. Deane.

R. grandis differs from *R. orientalis* (Text-fig. 20) notably in having posterior angles of pronotum less acute, posterior coxae almost square, and the prosternal process larger and much less excavated all round; the insect as a whole is considerably larger; colour darker and redder; pubescence coarser.



Text-fig. 17.—*Cochliarion victoriense* Deane.

Text-figs. 18, 19.—*Rodwayia grandis* Deane.

Text-fig. 20.—*Rodwayia orientalis* Lea.

Text-figs. 21, 22.—*Cnemadoxia okei* Deane.

CNEMADOXIA, n. gen.

Elongate-elliptic, very large, widest across elytra at one-third from base. Head, pronotum and elytra clothed with short hairs. Head largely visible from above, large, subtriangular, pointed anteriorly. Eyes easily visible from above.

Antennae long, slender, 11-segmented, 1 and 2 very large, cylindric, 3 to 11 slender, clavate, 7, 8, 9 and 10 gradually increasing in size, 10 and 11 subequal; setae fine, long, numerous. Pronotum widest before base, posterior angles not acute; side margins uniformly rounded. Elytra widest behind base, truncate, a little dehiscent at apex. Legs long; femora slender, straight, nearly equal. Coxae: anterior contiguous; intermediate nearly contiguous; posterior very remote. Metasternum attaining the sides of the body. Scutellum: visible portion large, more than one-quarter the width of base of pronotum. Metasternal process prominent but not carinate, of peculiar form. Abdomen with six visible ventral segments, projecting beyond apices of elytra.

Genotype, *C. okei*.

Cnemadoxia, when compared with previously described genera from other parts of the world, is possibly nearest to *Ptiliodes* figured in Matthews' monograph of the family (Supplement). The chief differences are: form more oval, much larger; antennae slender, segments 6 to 10 elongate-conic, each thickening towards the apex, 5 to 11 furnished with long hairs, head narrowly produced in front; prothorax widest behind middle. Compared with *Ptinella* it has antennal differences as above, also front and hind angles of pronotum not acute, posterior margin of metasternum not deeply excavated at coxal insertions; elytra less truncate; dorsal apical abdominal segments less exposed. From *Ptilium* it differs in antennal segments 6 to 10 subclavate; hind angles of pronotum more distinct; elytra less elongate; coxae narrower laterally, and widely separated. It also bears certain resemblances to the genus *Achosia* described above (see note, p. 482).

CNEMADOXIA OKEI, n. sp. Text-figures 21, 22.

Elongate-elliptic, large, pale-yellow, pubescent. Head narrowly pointed in front. Mouth finely produced. Palpi prominent, bifid. Antennae very slender, long, segments 6 to 11 clothed with numerous long fine hairs, 6 to 10 increasing in size, 10 and 11 almost equal; basal and second segment cylindric, 1 slightly thicker than 2. Pronotum with side margins entire, more strongly curved anteriorly. Elytra: side marginal curvature elliptical, conforming to sides of abdomen. Legs long; femora robust; tibiae slender, straight; anterior and intermediate scarcely thickening towards apex, posterior thickest at middle, tarsi well formed. Abdomen exposed beyond apex of elytra.

Length, 1.37 mm.; width, 0.54 mm.

Habitat.—Victoria (C. Oke, in nests of the ant, *Amblyopone obscura*).

Type in Coll. Deane.

In submitting the foregoing descriptions of new genera and species, and also a number of other new genera and species of this family which, it is hoped, will follow in subsequent papers, I have to thank Mr. A. M. Lea and the authorities of the South Australian Museum, Miss Winifred Kent-Hughes and the authorities of the Canberra Museum, and Mr. C. Oke for the gift of specimens and loan of others, Mr. F. Erasmus Wilson, Mr. W. B. Gurney and Mr. C. Oke for the loan of literature, Mr. R. Blackwood for the gift of specimens, and Mr. A. M. Lea for checking the descriptions contained in the foregoing paper.

NOTES ON AUSTRALIAN DIPTERA. XXVI.

By J. R. MALLOCH.

(Communicated by Dr. G. A. Waterhouse.)

(Three Text-figures.)

[Read 24th September, 1930.]

Family OCHTHIPHILIDAE.

This group has been variously treated by systematists, in some cases as a subfamily, and in others either as a tribe, or as a family. In his most recent paper on the families of European Diptera, Hendel has used the latter category and called it Chamaemyiidae. In two previous papers in the present series I have had occasion to deal with the genus revised below, and in both cases I referred it to the subfamily Ochthiphilinae, placing the latter in the family Agromyzidae according to the more general practice in North America and Europe. It is my opinion that the placing of the group in Agromyzidae cannot be maintained, and I consequently tentatively accept it as a distinct family, distinguished from others in its neighbourhood by the lack of breaks in the costa, the complete auxiliary vein, presence of a cross-vein at base of discal cell and a complete anal cell, lack of vibrissae and of distinct hairs on the arista. This characterization places it close to the family Sapromyzidae, but the preapical tibial bristle is undeveloped, and the propleural is lacking.

For the information of Australian students of the acalyptrate Diptera, I present below a key to all the genera of this family known to me, many of them not as yet in the material from Australia which has reached me.

Key to the Genera.

1. Frontal orbits each with one or more well developed bristles 2
 Frontal orbits without bristles in front of the verticals 6
2. Head pointed at base of antennae, the face almost horizontal; wings distinctly spotted with fuscous *Acrometopia* Schiner
 Head not pointed at base of antennae, the face shorter and nearly, or quite, vertical; wings unspotted 3
3. Thoracic dorsum with four pairs of dorsocentral bristles; ocellar bristles absent; mesopleura bare *Chamaemyia* Panzer
 Thoracic dorsum with two or three pairs of dorsocentral bristles; ocellar bristles present, sometimes short and weak 4
4. Thoracic dorsum with three pairs of well developed dorsocentral bristles
 *Ochthiphila* Fallen
 Thoracic dorsum with but two pairs of well developed dorsocentral bristles 5
5. Mesopleura with one strong hind marginal bristle *Pseudodinia* Coquillett
 Mesopleura without a hind marginal bristle *Pseudoleucopis* Malloch
6. Arista lacking *Cryptochaetum* Rondani
 Arista present 7
7. Costa with small setulae on under surface; species glossy blue-black
 *Paraleucopis* Malloch
 Costa not setulose; species densely grey dusted *Leucopis* Meigen

Genus PSEUDOLEUCOPIS Malloch.

My reason for dealing with this genus at the present time is that I have received from Mr. A. Tonnoir examples of a species which he informs me may be of considerable economic value and, as he desires a specific name for it, I am compelled to make a revision of the described species and augment the published data thereon.

The species described as new in this paper bears a label stating that it was "bred" from *Eriococcus* sp. and, in his letter, the sender states that it is a parasite. I have another species labelled "parasite", referred to below, but I am inclined to suggest that the species are rather predaceous than parasitic, though the distinction is sometimes a rather fine one. The genus *Cryptochaetum* is undoubtedly parasitic in the larval stages, living inside its host, but *Leucopis*, on the other hand, is predaceous, feeding in the larval stages on various plant lice, and travelling about amongst its prey like a small syrphid larva which it rather closely resembles. Of course, in the case of the present genus, the larva may attach itself either outwardly or internally to a single host-specimen and thus be rankable as a true parasite. In this latter case its efficacy would be much less than if it were predaceous and destroyed a number instead of but one specimen of the species upon which it preys. However, these matters are of economic and not systematic importance and, aside from merely referring to them, I give them no weight herein.

I have not previously presented a key to the species of this genus and to make it possible for students to recognize them without referring back to the original descriptions, I do so now.

Key to the Species.

1. Abdomen with the tergites conspicuously bicoloured, deep velvety-black at bases and densely whitish-grey-dusted at apices; third antennal segment sharply angulate at upper, broadly rounded off at lower apical extremity *fasciventris* Malloch
- Abdomen not conspicuously bicoloured on dorsum, either entirely shining black or with slight grey-dusting which is not confined to apices of the tergites; third antennal segment equally broadly rounded at upper and lower apical extremities 2
2. Frontal orbits when seen from behind narrow, grey-dusted to base of upper orbital from upper extremity, from there to lower orbital very narrowly or not at all grey-dusted, slightly so at base of the bristle, and practically without dusting from there to anterior margin; face with a linear carina above, which becomes greatly elevated to epistome, and glossy-black on each side below; tibiae largely, tarsi entirely, testaceous yellow *magnicornis* Malloch
- Frontal orbits when seen from behind grey-dusted on their entire extent, sometimes narrowed above or below, but never without a broad grey portion between the orbital bristles; face with a linear carina on upper half, but slightly, or not at all, elevated in centre below, and entirely dull-grey-dusted 3
3. Frons distinctly longer than its width at vertex, the latter distinctly less than one-third of the head-width, interfrontalia when seen from behind dull black, much darker than the grey-dusted orbits, the latter reduced to a mere line opposite posterior ocelli; ocellar bristles much weaker and shorter than upper pair of fronto-orbitals *flavitaris* Malloch
- Frons as wide as long, at vertex much more than one-third of the head-width, interfrontalia when seen from behind almost as densely grey-dusted as the orbits, the latter not attenuated behind; ocellar bristles at least as long and strong as the upper pair of fronto-orbitals *benefica*, n. sp.

PSEUDOLEUCOPIS FASCIVENTRIS Malloch.

Besides the type material from Waterfall, N.S.W., I have a male from Cronulla, N.S.W., which differs from the former in having the basal black fascia on visible tergites 2 to 4 carried over the lateral curves instead of tapering off posteriorly and ceasing at the lateral curve on anterior margin. This may represent a distinct species, but the third antennal segment is similar to that of the type, and the face has the same raised vertical line on the upper half. The inner cross-vein of the wing is nearer to the middle of the discal cell than in the other group, sometimes even a little basad of the middle, and the penultimate section of fourth vein is thus almost half as long as the ultimate section, while in the other species of the genus listed below the inner cross-vein is distinctly beyond middle of the discal cell and the penultimate section of fourth vein is always much less than half as long as the ultimate one.

PSEUDOLEUCOPIS MAGNICORNIS Malloch.

This species is readily distinguished from the preceding one by the rounded apex of the third antennal segment, the elevated lower portion of the face with its glossy-black colour, and the paler legs.

Described from Sydney, N.S.W.

PSEUDOLEUCOPIS FLAVITARSIS Malloch.

I have seen only the type and one other specimen of this species. There is no record of the larval habits of the type, but the additional specimen has a label on it with the following notation: "Parasite on Mealy-bug on *Ac. linearis*".

PSEUDOLEUCOPIS BENEFICA, n. sp.

♂, ♀. Similar in general coloration to *flavitarsis*, but the frons is more evenly pale-grey-dusted when seen from behind, the mesonotum has traces of two submedian brownish vittae on anterior half and two fainter outer vittae, and the apical segment of each tarsus is slightly infuscated.

Structurally the two species are very similar, but the head seen from above is differently proportioned, as indicated in the foregoing key to the species, the inner vertical pair of bristles is proportionately longer and erect and incurved, not proclinate and incurved as in *flavitarsis*, the portion of the frontal orbits anterior to the lower bristle is less copiously haired, and the frons is not appreciably widened anteriorly as in that species. The thoracic dorsum is not so closely haired as in *flavitarsis*, but otherwise they agree very closely.

Length, 2.5 mm.

Type, male, allotype, and two paratypes, Black Mt., F.C.T., December, 1929, "Bred from *Eriococcus* sp." (A. L. Tonnoir).

Genus CRYPTOCHAETUM Rondani.

I have already dealt with the species of this genus known to me from Australia in a paper in this series.

Genus LEUCOPIS Meigen.

I have not seen any species of this genus from Australia, but it very probably occurs here as it is almost cosmopolitan in distribution. I have divided the genus into three subgenera and should it occur in Australia it will be of interest to find out which subgenus, or subgenera, may appear.



Genus OCHTHIPHILA Fallen.

This genus is almost as widely distributed as *Leucopis*, but it is unknown to me from Australia and its life-history details have not been clearly established.

Genus CHAMAEMYIA Panzer.

This genus occurs in the old world and I have taken it in the United States. It was for many years considered as a synonym of *Ochthiphila*, but it is quite distinct.

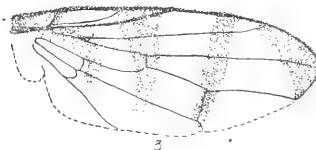
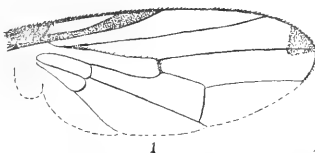
Family ORTALIDAE.

Genus RIVELLIA Robineau-Desvoidy.

Up to the present time I have seen three species of this genus from Australia. They may be distinguished from each other as in the key presented below.

Key to the Species.

1. Wing without black fasciae, with only the following black marks: Along costa to slightly beyond humeral cross-vein, in the entire subcostal cell, and a spot on tip of third vein touching costa which extends from about midway between apices of second and third veins to a little below apex of latter, but never to fourth vein (Text-fig. 1) *connata* Thomson.
 Wing with more extensive black markings, the basal and apical marks much larger, and two complete, or almost complete, fasciae centrally, one over inner cross-vein, the other over outer cross-vein 2
2. Apical dark mark on wing never encroaching on tip of marginal cell, though there may be an isolated dark spot there, and not extending more than midway across first posterior cell near its apex, costal cell almost uniformly dark; femora and tibiae black, knees yellow (Text-fig. 2) *isolata*, n. sp.
 Apical dark mark on wing more elongate, always encroaching upon apex of marginal cell and extending over entire apex of first posterior cell to apex of fourth vein, apical half or more of costal cell hyaline (Text-fig. 3); legs generally yellow *virgo* Hendel



Text-fig. 1.—Wing of *Rivellia connata*.
 Text-fig. 2.—Wing of *Rivellia isolata*.
 Text-fig. 3.—Wing of *Rivellia virgo*.

RIVELLIA CONNATA Thomson.

I have already recorded this species from Australia. It occurs in the Samoan and Fiji Islands.

RIVELLIA VIRGO Hendel.

This species is very similar to the next one, comparative characters being given under the description of the latter and in the foregoing key. Wing as Text-figure 3.

Locality: Herberton, N. Qld., January, 1911, 3,700 feet (Dodd). In Lichtwardt collection, Deutsches Entomologisches Museum, Berlin-Dahlem, Germany.

RIVELLIA ISOLATA, n. sp.

♂, ♀. Frons brown, becoming orange in front, orbits white-dusted except on the upper fourth which, like the ocellar triangle, is shining black; face orange, infuscated above, and slightly grey-dusted; antennae dull-orange, third segment darkened apically; arista black; palpi fuscous, paler at apices. Thorax dark metallic-blue, slightly obscured by grey-dusting. Abdomen concolorous with thorax, without dusting, the surface roughened or granulose, and rather densely covered with decumbent black hairs. Legs black, apices of coxae and femora, and all tarsi except their apices, fulvous yellow. Wings hyaline, with black markings as in Text-figure 2. Calyptrae pale. Halteres missing in type material.

Vertex with four strong bristles, the outer pair divergent, inner pair cruciate; two orbitals present on each side, which are much shorter than the verticals; ocellars very short and fine; arista bare; third antennal segment extending to the mouth-margin. Thorax with well developed humeral bristle, one pair of prescutellar acrostichal and dorsocentral bristles, and four strong marginal scutellars. Legs normal, mid femur of male with a series of pale bristly hairs on the posteroventral surface.

Length, 4-4.5 mm.

Type, female, Illawarra, N.S.W.; allotype, Botany Bay, N.S.W. (H. Peterson). Material submitted to me by C. F. Baker some years ago and in my collection.

Most nearly related to *virgo*, but readily distinguished from it by means of the wing markings. The wing figured is that of the female type, the male lacks a well defined black dot at apex of the marginal cell, but possibly this character is variable and not a sexual one.



NOTES ON THE AUSTRALIAN SPECIES OF THE GENUS ATRIPLEX.

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(Plate xviii.)

[Read 29th October, 1930.]

The following notes on established species and the descriptions of proposed new ones are offered as a contribution to the knowledge of the Australian species of the genus *Atriplex*. It was hoped to make the revision complete and to offer a key to all species, but material of several species was not available for examination.

The genus offers a number of difficulties to the systematist, as the species are remarkably variable within themselves, and it is often difficult to define their limitations satisfactorily. Apart from habit of growth, most of the specific differences must be founded upon the character of the fruiting bracteoles and leaves, as the male flowers and seeds afford few points of difference.

The fruiting bracteoles of any one species are usually most variable in character, not only on different plants of the same species, but on the individual plant itself. *Atriplex vesicarium* Hew., for example, is usually characterized by the presence of spongy appendages on the fruiting bracteoles. These appendages are usually present on both bracteoles, but vary considerably in size, being sometimes very small, but in other cases they completely cover or exceed the bracteoles. Frequently, however, the appendages are missing from one bracteole and occasionally are absent from both. All stages can be found on the one plant, so that the presence or absence of appendages on the fruiting bracteole of this species is altogether variable. The same inconstancy is noticed in many other species of the genus.

Leaf characters are also variable within a species, as indicated in the notes given on some of the species in this paper. A study of the gradations and intermediate forms between species leads one very easily to the opinion that possibly, if not probably, there is a good deal of natural hybridization taking place within the genus. Many of the species grow in close proximity to each other and there appears to be little obstacle to some degree of cross-fertilization.

The idea that many intermediate forms between species may be largely due to the result of natural hybridization is strengthened by a comparison of specific definiteness in this genus with that found in the genus *Bassia*. When revising the latter genus it was found that specific differences were mainly constant and there were very few intermediate forms. The flowers in the various species of *Bassia* are bisexual, whereas those of *Atriplex* are unisexual and very frequently dioecious, so that one would expect a much higher rate of possible hybridization in the latter genus.

In the case of these genera, then, we have a possible connection between floral characters which favour natural hybridization and the presence of intermediate forms between species.

To the systematist this genus is difficult, and, in many ways, unsatisfactory. It is essentially a plant group in which the taxonomic worker appears to require the cooperation of the geneticist and cytologist in order to define adequately the individual species.

ATRIPLEX ELACOPHYLLUM F.V.M.

Fragm., vii, 1870, 8.

This species is rather imperfectly described both by Mueller in the original description and by Bentham in the *Flora Australiensis*. Neither mentions the three small protuberances or tooth-like appendages which are present on the face of both or one of the fruiting bracteoles. These are present on the type specimen, collected at Sturt's Creek in 1856 by Mueller, and are characteristic of all specimens of this species seen by me.

Bentham also describes the leaves as rarely exceeding 2 lines (2.2 mm.) long, whereas the leaves of the species usually vary from 8 to 18 mm. in length, and average between 10 and 12 mm. Mueller, in the original description, gives the leaves as $1\frac{1}{2}$ -3 lines long, more rarely 9 lines long. The leaves of the type specimen examined varied up to 12 mm. long. These apparent imperfections in the descriptions of this species are important in view of the opinions expressed below on *Atriplex varia* Ewart and Davies.

The fruiting bracteoles of *Atriplex elacophyllum* approach in some respects to those of *Atriplex Muelleri*, especially those forms of the latter species in which the free portion of the bracteoles is reduced to a narrow rim. The bracteoles of *Atriplex Muelleri*, however, differ in having no appendages and in their upper part being much more acutely triangular and sharply toothed. The leaf characters of the two species are also usually quite distinct. There does, however, appear to be distinct affinities between the two species and intermediate forms are not wanting. The typical forms of each species are, however, quite sharply different.

Atriplex crassipes J. M. Black (*Trans. Roy. Soc. S. Aust.*, xlii, 1918, 171) was reduced to a synonym of *Atriplex elacophyllum* F.v.M. by the author of the former species (*Trans. Roy. Soc. S. Aust.*, xlv, 1921, 8). The fruiting bracteole of *Atriplex crassipes*, however, appears to be very distinct from that of *Atriplex elacophyllum*, differing in shape, in the possession of a short, thick pedicel, and in the absence of the three characteristic appendages. *Atriplex crassipes* appears to be a valid species.

ATRIPLEX VARIA Ewart and Davies.

Fl. N. Terr., 1917, 94.

There appears to be no essential difference between this species and *Atriplex elacophyllum* F.v.M. As indicated above, the description of *Atriplex elacophyllum* was imperfect, both in regard to the fruiting bracteoles and the leaves, and perhaps this was partly responsible for the erection of *Atriplex varia* by the authors.

The fruiting bracteoles of one of the type specimens of *Atriplex varia* (G. F. Hill, No. 284a, 7.6.1911) bear on their faces the three protuberances or appendages so typical of *Atriplex elacophyllum*, and the general characters of the fruiting bracteoles agree fairly closely with those of that species, the only point

of difference being in the slightly stronger tothing of the free upper portion of the bracteoles.

There is also some confusion in the description of the size of the leaves of *Atriplex varia*. The authors describe them (*Fl. N. Terr.*, 1917, 94) as 15-20 cm. long. This is probably a misprint for 15-20 mm. But in the key to the species on page 93 the leaves of *Atriplex varia* are given as 2 inches long or more, which means approximately 5 cm. This is at variance with the description of the species on page 94, whether it be read as 15-20 cm. or 15-20 mm. I have examined portion of the type specimen and found the leaves measuring from 8-25 mm. in length. There is, therefore, no essential difference between the leaf measurements of the type specimens of both *Atriplex varia* and *Atriplex elacophyllum*.

In our specimens of *Atriplex elacophyllum* we have one from the Hungerford-Brindingabba district (J. L. Boorman, 10/1912) which is a very robust form of that species, the leaves measuring up to 4 cm. long. *Atriplex varia* may be regarded as the strong growing form of *Atriplex elacophyllum*, and on the present evidence must be regarded as a synonym of that species.

J. M. Black (*Flora S. Aust.*, p. 683) is of opinion that it is doubtful whether *Atriplex varia* is more than a variety or form of *Atriplex Muelleri*. *Atriplex varia* certainly approaches *Atriplex Muelleri* in some respects, but differs from that species in the same respects as does *Atriplex elacophyllum*, mentioned in the notes on the latter species given above.

ATRIPLEX SEMIBACCATUM R. Br. forma TENUIS Bail.

Qld. Agric. Journ., xxv, 1910, 164.

I have examined the type specimen of this form and found that the fruiting bracteoles closely resemble those of *Atriplex elacophyllum*, except for the apparent absence of the three appendages on the face. The tendency for ribbing is also rather more marked than in some specimens of *Atriplex elacophyllum*. All the leaves appear to be entire, whereas those of *Atriplex elacophyllum* are generally sinuately or more sharply toothed.

The affinities of this form, however, are undoubtedly with *Atriplex elacophyllum* rather than with *Atriplex semibaccatum*, and, on the evidence offering, it can hardly be separated from that species, even as a variety.

ATRIPLEX FISSIVALVE F.V.M.

Fragm., ix, 1875, 123.

This species is a rather small growing annual with greyish-coloured, scaly tomentose leaves and usually densely massed greenish fruiting bracteoles, giving the plant a rather distinctive appearance.

The fruiting bracteole of this species is a well defined one, being deeply toothed with the central, very acute, lobe usually the largest and the remaining margin of the bracteoles spiny-lobed or lacinate. Each bracteole is strongly veined and bears a spiny-edged flat appendage somewhat resembling the bracteole itself. In some specimens the appendage itself bears a number of small spines at the base.

Occasionally the appendages are reduced to a deeply-cut and narrow fringe, superficially resembling a row of spines, situated near the base of the fruiting bracteoles, and it is interesting to note that all specimens seen by me which exhibited this feature were from Western Australian localities. The difference, however, does not appear to be worthy of varietal rank.

ATRIPLEX SPINIBRACTUM, n. sp. Plate xviii, fig. 4.

Fruticulus saepe decumbens, caulibus gracilibus, foliis lanceolatis vel anguste obovatis, ad basin attenuatis, 8-25 mm. longis, marginibus breviter denticulatis vel sinuato-dentatis; bracteolis fructiferis late-triangularibus 3-6 mm. latis, reticulatis, fere ad basin liberis, marginibus valde denticulatis vel spinosis, 3-6 spinis dorsalibus instructis, semine orbiculari fusco, radícula supera. Minore, J. L. Boorman, February, 1899.

A small plant, usually creeping, with slender stems. Leaves 8-25 mm. long, lanceolate or narrowly obovate, more or less scaly tomentose, tapering at base into a short pedicel, the margins shortly denticulate or sinuately toothed. The fruiting bracteoles are broadly triangular, 3-6 mm. broad, and about the same in length, but often longer, free almost to the base, strongly veined, the edges strongly toothed or spiny, the central lobe broader but acute. Each fruiting bracteole bears 3-6 spine-like appendages on its face and is shortly stalked, the pedicel being up to 1.5 mm. in length.

In addition to the locality quoted above, the following localities are represented by specimens in the National Herbarium: Bathurst (W. Webb, 6/1910); Coonamble (Archdeacon Haviland, 2/1923); Gilgandra (J. D. Simon, 4/1916); Nyngan (E. Breakwell, 8/1915); Narromine (E. Breakwell, 4/1913); Barraba (Rev. H. M. R. Rupp, 4/1913); Dubbo (J. L. Boorman, 12/1897); Coolabah (J. H. Maiden and J. L. Boorman, 12/1908).

This species has strong affinities with *Atriplex semibaccatum* on the one hand, and *Atriplex fissivalve* on the other. In general habit of growth and leaf character it is very suggestive of the former species, but the fruiting bracteoles are quite different. The fruiting bracteole of *Atriplex semibaccatum* is, however, most variable in character. It varies from almost rhomboidal in shape with entire edges and no pedicel to a broadly triangular, almost cordate, shape, distinctly pedicellate and with denticulate margins. This latter form merges to some extent into the type of bracteole commonly found in *Atriplex spinibractum*, and the two species are further linked by some specimens of *Atriplex semibaccatum* showing rudimentary appendages on the face of the bracteoles, somewhat similar to those of typical *Atriplex spinibractum*. In spite of the intermediate forms, however, the typical fruiting bracteoles of the two species are very different.

The fruiting bracteole of *Atriplex spinibractum* is also strongly suggestive of that of *Atriplex fissivalve*, and individual ones may be selected from both species which are almost identical. The characteristic spiny-edged flat appendage of the fruiting bracteole of *Atriplex fissivalve* is, however, not found in *Atriplex spinibractum*, but is replaced by several separate spines or bristles. In this respect *Atriplex spinibractum* approaches the Western Australian form of *Atriplex fissivalve* mentioned previously in the notes on the latter species. The fruiting bracteoles of *Atriplex fissivalve* are, moreover, always arranged in fairly dense clusters, which are abundantly produced, whereas those of *Atriplex spinibractum* are much more sparingly produced, and are shortly stalked and rather more tomentose than those of *Atriplex fissivalve*.

The leaves of the two species also differ, those of *Atriplex spinibractum* being much smaller and narrower, and the whole plant more slender and less crystalline hoary than *Atriplex fissivalve*.

The general appearance of the two species appears to be quite different, and the specimens are readily separated in the herbarium, but the close resemblance of some of the fruiting bracteoles of the two species suggests that *Atriplex spinibractum* combines the fruiting bracteoles of *Atriplex fissivalve* with the general habit and leaf characters of *Atriplex semibaccatum*.

A close study of all the specimens cannot but result in the opinion that the three species, *Atriplex semibaccatum*, *Atriplex spinibractum* and *Atriplex fissivalve* are closely related, and a genetical or cytological study of these may be of interest.

ATRIPLEX LOBATIVALVE F.V.M.

Iconog. Austr. Salsol. Plants, vi, 1889; *Vict. Nat.*, ix, 1893, 187.

This species was figured in the *Iconography of Australian Salsolaceous Plants*, but the first written description appeared in the *Victorian Naturalist*.

It is a small prostrate plant, distinguished by the deeply-lobed, usually five-lobed, valves of the fruiting bracteoles, which bear no appendages but are characterized by a ridge-like thickening at the base continued vertically from the short stalk.

It appears to be most closely allied to *Atriplex fissivalve*, but is readily distinguished from that species by the absence of any appendages to the bracteoles, which are also less spiny-edged and more regularly lobed.

ATRIPLEX ANGULATUM Benth.

Fl. Aust., v, 1870, 174.

The exact limitations of this species are not altogether definite. Bentham described the species from three small specimens of which the "fruiting perianth was not yet quite ripe". Mueller subsequently considered it as merely a form of *Atriplex campanulatum* Benth., and figured both species (*Icon. Salsol. Plants*, Plate xi) under the name of *Atriplex angulatum* Benth. Later botanists, however, have accepted the two species as being quite distinct.

An examination of the material in the New South Wales National Herbarium indicated that several varieties or species could be separated from the *Atriplex angulatum*-*Atriplex campanulatum* group. These may be designated as follows:

1. *ATRIPLEX CAMPANULATUM* Benth.—The fruiting bracteoles in this species are usually unequal in length, the anterior one being the shorter and bearing at the base two herbaceous or somewhat inflated appendages. Occasionally the two bracteoles are equal, but the appendages are always present.

2. *ATRIPLEX CAMPANULATUM* var. *INAPPENDICULATUM*, n. var.—Variet bracteolis fructiferis inappendiculatis aequalis, pediculis aliquantum crassis. Murrumburrah Town Clerk, 5/1911; Zara Station, Miss E. Officer, 5/1905.

This variety is distinguished by the complete absence of appendages on the fruiting bracteoles, or their reduction to rudimentary structures, by the two bracteoles being equal in length and usually of thicker texture, and by the more solid pedicel. The variety shows affinities with *Atriplex intermedium*, n. sp., and also approximates closely to *Atriplex crassipes* J. M. Black, particularly in the general shape of the bracteoles which, however, are more tomentose, and have a longer pedicel than in that species.

In addition to the specimens mentioned above, the following in the National Herbarium are included in the variety: Brewarrina (J. L. Boorman, 11/1903); Coolabah (Peacock, 3/1900); Nulty-Toorale (J. L. Boorman, 9/1912).

The Brewarrina specimen shows small appendages on the fruiting bracteoles, and is intermediate in general characters between the species and its variety.

For systematic purposes this variety is an aggregate one, embracing a number of individuals which, while obviously differing from each other in some respects, exhibit a somewhat uniform divergence from the typical species.

3. *ATRIPLEX ANGULATUM* Benth.—As mentioned above, the exact limitations of this species have been somewhat indefinite, especially as Bentham described it from imperfect material. Two specimens are quoted by Bentham in the *Flora Australiensis*, viz., Cudnaka (Mueller) and Murray River (W. Ross). An effort was made to get these specimens from the Melbourne Herbarium, but it was found that only the Murray River specimen was represented in that collection. The Victorian Government Botanist reported that this specimen very closely resembled portion of the drawing of *Atriplex angulatum* (*Icon. Salsol. Plants*, Plate xi), which was evidently taken from the type. This portion is represented by the large central branch in the Plate, and by figures numbered 6, 7, 8 and 9.

Our material of specimens assumed to be *Atriplex angulatum* shows two distinct forms. The first is characterized by the valves of the fruiting bracteoles being rather short but broad (7–11 mm.), often cordate or somewhat so at the base, and with the tube continued into a moderately stout to rather slender pedicel. The leaves are broad, obtuse, sinuate-lobed and rather large.

The second form is characterized by the valves of the fruiting bracteoles being subrhomboidal or somewhat triangular in shape, and tapering gradually into the pedicel, showing no evidence of the cordate base characteristic of the form mentioned above. The pedicel is much thickened or swollen, especially just below the valves, and tapers towards the base. The bracteoles are usually marked by three longitudinal lines.

These two forms appear to be specifically quite distinct, and as the first form mentioned appears to resemble most closely the type specimen of Bentham from the Murray River, I propose accepting it as *Atriplex angulatum* Benth.

The second form described above appears to be undescribed, and it is hereunder offered as *Atriplex intermedium*, n. sp.

J. M. Black (*Trans. Roy. Soc. S. Aust.*, 42, 1918, 171) has drawn attention to two forms of *Atriplex angulatum* which he is of the opinion may prove to be distinct. I am not, however, sure that the forms so described are referable to those mentioned above.

ATRIPLEX INTERMEDIUM, n. sp. Plate xviii, fig. 3.

Herba annua, foliis ovato-lanceolatis vel lato-obovatis, sinuato-dentatis vel nonnunquam integris, 2–4 cm. longis; bracteolis fructiferis sub-rhomboidis marginibus plus minusve denticulatis, circiter 3–4 mm. longis et 2–4 mm. latis, saepe 3 nervis conspicuis longitudinalibus, pediculis sub bracteolis dilatatis, ad basin attenuatus, 4–6 mm. longis; semine orbiculari, radícula supera. Paroo River (E. Betche, 9/1900); Stephen's Creeks, Broken Hill (A. Morris, No. 170, 4/1920; No. 710, 10/1921); Corona (Miss M. Collins, No. 33, 9/1921).

Apart from its affinities with *Atriplex angulatum* mentioned previously, this species somewhat approaches some of the forms of *Atriplex leptocarpum* F.v.M., particularly the forma *turbinatum*, which, however, differs in the long tube formed by the bracteoles and in other respects. In a number of ways, however, the species appears to be a connecting link between *Atriplex angulatum* and *Atriplex leptocarpum*.

ATRIPLEX LEPTOCARPUM F.V.M.

Trans. Phil. Inst. Vict., ii, 1857, 74.

This species is readily distinguished by the union of the fruiting bracteoles to form a distinct tube, the lower portion being somewhat hardened and swollen, the upper part more herbaceous, and terminated by the two free, very short, triangular lobes of the bracteoles. The fruiting bracteoles vary from 4 to 8 mm. in length, and are sessile or tapered at the base to form a short pedicel up to 2 mm. in length.

Two rather distinctive forms of this species in regard to leaf character are found. In one form the leaves are narrow-oblong or almost lanceolate, and entire. In the other they are obovate and sinuately toothed. This difference in leaf character, however, is not accompanied by any difference in the nature of the fruiting bracteoles. The species is generally a variable one, with several well marked forms and varieties, some of which indicate affinities with *Atriplex intermedium*. The chief of these forms of varieties are indicated below.

ATRIPLEX LEPTOCARPUM F.V.M. var. ACUMINATUM J. M. Black.

Trans. Roy. Soc. S. Aust., xlvi, 1922, 568.

This is a well marked variety, and perhaps sufficiently distinct to warrant specific rank. The fruiting bracteoles are free for almost half their length, being produced into acuminate lobes which usually bear one or two fine marginal teeth towards the base. The basal portion of the tube is somewhat hardened and swollen. The leaves of this variety are similar to the obovate sinuately-lobed-leaved form of the species.

The close affinities of this variety with *Atriplex acutivalvum*, n. sp., are dealt with under the description of that species.

ATRIPLEX LEPTOCARPUM forma MINOR, n. form.

Herba parva, bracteolis fructiferis 2-4 mm. longis tubo dilatato subgloboso. Tibooburra (O. E. Couch, 1913, and A. Morris, No. 709, 1921).

This is a small growing form of *Atriplex leptocarpum* F.v.M. which also possesses fairly distinctive fruits. The lower half of the tube formed by the fruiting bracteoles forms a smooth, swollen, semi-spongy or solid, rounded mass, the somewhat herbaceous and fairly strongly veined upper portion of the bracteoles being comparatively flattened. The bracteoles and tube vary from 2 to 4 mm. in length. The two specimens collected from the same locality are almost identical, and the fact that two different collectors obtained similar material after an interval of eight years may indicate that this form is worthy of varietal rank.

ATRIPLEX LEPTOCARPUM F.V.M. forma TURBINATUM, n. form.

Bracteolis fructiferis sub-turbinatis ad basin attenuatis vix induratis nec dilatatis. Mt. Lyndhurst, South Australia (Max Koch, 1897); Hergott (J. M. Black, 10/1917).

In this form the tube formed by the united fruiting bracteoles tapers fairly regularly towards the base, forming a narrow inverted cone with a very short thick pedicel, and does not become swollen and hardened as in the typical form of the species. The bracteoles at their upper end are also broader. The leaves are rather small, broadly lanceolate, entire or somewhat toothed.

Mr. J. M. Black, in a note on the specimen from Hergott which he kindly forwarded to me, writes: "I take this to be *Atriplex leptocarpum* tending towards



Atriplex angulatum". The form certainly tends towards *Atriplex intermedium*, which in turn shows affinities with *Atriplex angulatum*.

At present I do not feel inclined to give this form varietal rank, but the discovery of additional plants with a wider range might justify such a course. It is, however, a well defined form.

ATRIPLEX ACUTIBRACTUM, n. sp. Plate xviii, fig. 5.

Fruticulus parvus ramosus, foliis late-obovatis sinuato-dentatis ad basin attenuatis 15-20 mm. longis; bracteolis fructiferis 3-5 mm. longis, subrhomboidalibus, ad medium liberis, breviter pedicellatis, 2 appendicibus dorsalibus instructis; semini orbiculari, radícula supera. Murray Flats, west of Blanchetown, South Australia, J. B. Cleland, 5/1911.

This species is a small branching undershrub, with broadly obovate, sinuately toothed leaves which taper into a short pedicel. It is characterized by the subrhomboidal fruiting bracteoles, the free upper portion of which is acutely triangular, and by the presence of two prominent appendages on each bracteole about half-way down the tube. In some cases these appendages are reduced to one or two small tubercles, or, in the case of immature bracteoles, may be entirely wanting. The tube formed by the fruiting bracteoles is produced at the base into a short thick pedicel.

This species approaches *Atriplex leptocarpum* F.v.M. var. *acuminatum* J. M. Black fairly closely, differing mainly in the presence of the two appendages on both bracteoles. J. M. Black (*Trans. Roy. Soc. S. Aust.*, 46, 1922, 569) describes the fruiting bracteoles of *Atriplex leptocarpum* var. *acuminatum* as often having two small tubercles at the base. These are not evident in the Tarcoola specimen examined by me, but a specimen from Ooldea is also quoted which I have not seen.

A method of dealing with the proposed new species which suggested itself to me was to include the specimens assigned to it under *Atriplex leptocarpum* var. *acuminatum* and raise the variety to specific rank. This, however, I did not feel justified in doing, firstly because I was not altogether satisfied that the Murray Flats specimen was not specifically distinct from the variety *acuminatum*, and secondly because the name *acuminatum* has already been given to a species of *Atriplex* by Waldstein and Kitaibel. The Index Kewensis quotes this species as a synonym of *Atriplex nitens* Schk., but the International Rules of Botanical Nomenclature definitely recommend the avoidance of using names which are homonyms.

The affinities of *Atriplex leptocarpum* var. *acuminatum* certainly lie with *Atriplex acutibractum* rather than with *Atriplex leptocarpum*, but, pending further investigation, it seems advisable to allow that variety to remain as it is.

A specimen from Hughes, South Australia (E. H. Ising, No. 1508, 9/1920) can also be included under *Atriplex acutibractum*. The fruiting bracteoles in this specimen differ from the type specimen in being borne on a slender pedicel 2-3.5 mm. long, and the appendages, although present, are not so strongly developed.

ATRIPLEX MUELLERI Benth.

Fl. Aust., v, 1870, 175.

This species is distinguished by the obovate or broadly oblong, coarsely toothed or sinuately lobed leaves, which are generally greenish above and more or less

mealy-white beneath. The fruiting bracteoles are small and usually fairly densely clustered, but vary rather considerably in shape. In some forms the bracteoles are swollen in the lower part to form a globular or somewhat compressed tube, the free upper portion of the bracteoles forming a narrow, shortly denticulate rim. Most typically the bracteoles are more or less rhomboidal in shape, free for half their length and 3-7 toothed along their margin. They are described by Bentham as sessile, but quite commonly they are quite distinctly pedicellate, the pedicels being up to 1-1½ mm. long. Both sessile and pedicellate forms are found on the one plant.

Atriplex Muelleri, especially those forms with shortly pedicellate, denticulate bracteoles, approaches fairly closely to certain forms of *Atriplex semibaccatum*. The bracteoles also occasionally exhibit to a less degree the rather conspicuous nervation associated with the bracteoles of the latter species, although typically they are much more mealy. The much broader obovate leaves, however, provide the most readily observed point of difference between the two species.

The affinity existing between *Atriplex Muelleri* and *Atriplex elacophyllum* has already been dealt with in the notes given on the latter species.

Mueller (*Fragm.*, vii, p. 9) refers certain specimens of *Atriplex Muelleri* to *Atriplex rosea* L., but, as Bentham points out, they are quite distinct from that species.

In the "Report of the Babbage's Expedition into the North-west Interior of South Australia", published in 1858, Mueller refers a specimen collected at Emu Springs to *Atriplex roseum* var. *stipitatum*. The fruiting perianth is described as "small and tapering into a thick pedicel which is ½-1 lines long". This specimen has not been seen by me, but it might be referable to the form of *Atriplex Muelleri* which has shortly pedicellate fruiting bracteoles, or possibly to *Atriplex semibaccatum*.

ATRIPLEX HYMENOTHECUM Moq.

DC. Prodr., xiii, ii, 1849, p. 101.

This species approaches very closely to *Atriplex vesicarium* Hew., the character of the fruiting bracteoles and appendages of the two species being almost identical. It differs, however, in the leaves, which are smaller, narrower, and less white scaly tomentose than those of *Atriplex vesicarium*. Herbarium material of the two species is fairly readily separable, and possibly they look very different under field conditions.

Moquin, in the original description of the species, definitely describes the fruiting perianth as without appendages, and it is difficult to understand the very conspicuous bladder-like appendages being overlooked.

Bentham (*Fl. Aust.*, v, 1870, 173), however, described the same material as Moquin (Drummond's Nos. 128 and 129) and observed the appendages, at the same time commenting on Moquin's omission. It is apparently quite safe, in spite of the original description, to ascribe the conspicuously appendaged fruiting bracteoles to this species.

The leaves of *Atriplex hymenothecum* are nearly always quite entire, but one specimen (Cunderdin, J. B. Cleland, 1908) has the margins shallowly sinuately toothed.

The species is apparently confined to Western Australia.

ATRIPLEX PALUDOSUM R. Br.

Prod., p. 406.

Perhaps the main characteristic of this species is the comparative glabrousness of the upper surface of the leaves, which, contrasted with the pale-coloured scaly tomentum on the under surface gives the leaves a more or less green and white appearance. This feature was partly referred to in the original description by Robert Brown, but Bentham in the "Flora Australiensis" omits any reference to it. In some specimens, however, the leaves are more or less equally tomentose scaly on both sides.

The fruiting bracteoles on most of the specimens examined are ovate-triangular and generally cordate at the base. Only occasionally do the margins appear to be toothed, although all the figures except one in the "Iconography of Salsolaceous Plants", Plate xiv, depict the margins as markedly so.

ATRIPLEX PALUDOSUM VAR. APPENDICULATUM Benth.

Fl. Aust., v, 1870, 170.

I have seen no specimens of this variety, but it would appear to be more closely allied to *Atriplex vesicarium*, and might be better placed under one of the many forms of that variable species.

ATRIPLEX CINEREUM Poir.

Dict., Suppl. i, 471.

This species appears to be confined to coastal areas, and is distinguished by the oblong or lanceolate ashy-grey leaves which are usually 2-7 cm. long. The fruiting bracteoles are variable in shape from broadly triangular and somewhat cordate to almost rhomboidal.

Specimens from Rottnest Island, Western Australia (W. V. Fitzgerald) are rhomboidal in shape, the bracteoles united to half-way and the upper free halves triangular and rather acutely pointed. At the base the bracteoles form a short, more or less turbinate, solid base. These specimens show affinities with *Atriplex rhagodioides* F.v.M.

The species also approaches *Atriplex isatidea* to some extent, especially in the general character of the leaves, but differs in the fruiting bracteoles.

Plate xv in the "Iconography of Salsolaceous Plants" includes a number of fruiting bracteoles, showing the variability of this species, but the more common form with the broadly triangular bracteoles and somewhat cordate base is not figured.

J. M. Black in the "Flora of South Australia" describes the species as "with a spongy rugose appendage or tubercle on the lower part of each bracteole, and sometimes covering the pedicel also". I have not seen this form, and it was not figured by Mueller in the "Iconography", but Bentham in the "Flora Australiensis" describes the fruiting perianth as with rarely one or two tubercles.

ATRIPLEX RHAGODIOIDES F.V.M.

This species in many respects resembles *Atriplex cinereum* Poir., and it is difficult to separate them clearly.

Bentham (*Fl. Aust.*, v, 1870, 172) remarks that the specimens are insufficient to determine whether the species is more than a variety or state of *Atriplex cinereum*. Mueller perhaps was a little uncertain of its specific rank, as it is not figured in the "Iconography".

I have seen the Murchison River specimen collected by Oldfield and mentioned by Bentham, and also another specimen determined by Bentham as *Atriplex rhagodioides*, but with no locality given. The latter is possibly the Murray Scrub type specimen collected by Mueller.

These specimens differ from typical *Atriplex cinereum* Poir. both in the character of the fruiting bracteoles and the leaves. The bracteoles are much thickened and rhomboidal, with the upper portion usually much shorter than the lower portion, and are united for more than half their length. There is no suggestion of cordateness about the base. The leaves are smaller and more angular or hastate at the base than those of typical *Atriplex cinereum*.

A specimen collected by Mueller (no locality given) is intermediate between *Atriplex rhagodioides* and *Atriplex cinereum*, being distinguished by the rather sharply acute fruiting bracteoles.

Atriplex rhagodioides has undoubtedly close affinities with *Atriplex cinereum*, and some of the specimens attributed by botanists to the former species might more correctly be placed under the latter.

Atriplex rhagodioides, however, as represented by the Murchison River specimen mentioned above, appears to be specifically distinct.

ATRIPLEX QUINII F.V.M.

Vict. Nat., v, 1888, 96.

This species has affinities with *Atriplex vesicarium*, from which it is distinguished by the much thickened and conspicuous pedicel (2-4 mm. long) of the fruiting bracteoles, by the reniform shape of the appendages on the bracteoles, and by the narrower, more linear leaves.

Specimens from Booroorban (F. A. G. Fisher) in the National Herbarium show the close affinity between the two species. The leaf character of these specimens is similar to that of *Atriplex Quinii*, but the conspicuous pedicel of the fruiting bracteoles is almost entirely absent, and the specimens are probably best included under *Atriplex vesicarium*.

ATRIPLEX CONDUPLICATUM F.V.M.

Journ. Pharm., i, 1886, 429.

The typical form of this species is very different from *Atriplex halimoides* Lindley, and the degree of transition between the two species is no more marked than in many other species of the genus.

Mueller regarded *Atriplex conduplicatum* as only a variety of *Atriplex halimoides*. He omits it from the "Census of Australian Plants" and in the "Iconography of Salsolaceous Plants", Plate xix, figures both species under the name of *Atriplex halimoides*.

Mueller and Tate (*Trans. Roy. Soc. S. Aust.*, 16, 1892, 345) list this species as *Atriplex halimoides* var. *conduplicatum*, and other botanists have subsequently accepted this reduction to varietal rank.

The fruiting bracteoles of *Atriplex conduplicatum* are united for the greater part of their length, but instead of forming the circular and horizontally flattened structure as in *Atriplex halimoides*, produce well developed opposite-winged structures which are free for about two-thirds the length of the bracteoles. These wings almost or quite exceed the ununited tips of the bracteoles, the free portion of the bracteoles being also much longer and more strongly developed than in

Atriplex halimoides. The fruiting bracteoles are also usually much less spongy in texture than those of *Atriplex halimoides*, and at times are hardly more spongy than the majority of *Atriplex* species.

A number of transition forms between *Atriplex conduplicatum* and *Atriplex halimoides* are to be found, but the typical forms of both species are so well marked that it is desirable to keep them specifically distinct. The fruiting bracteoles of *Atriplex halimoides* occasionally exhibit a tendency to form the two opposite lobes characteristic of *Atriplex conduplicatum*, but the lobing is not so marked, the free tips are much smaller, and the bracteoles retain their spongy character.

The difference between the two species is well illustrated in the figure of *Atriplex halimoides* in the "Iconography of Australian Salsolaceous Plants", Plate xix. Figure 6, the upper right hand fruit of Figure 4, and the twig on the right hand side represent *Atriplex conduplicatum*, the remainder being *Atriplex halimoides*.

ATRIPLEX SPONGIOSUM F.v.M.

Trans. Phil. Instit. Vict., ii, 1857, 74.

This species is a small-growing plant rarely exceeding 30 cm. in height and characterized by the spongy inflated fruiting bracteoles which are entirely coalesced except for the two minute tips. In some specimens the whole of the fruiting bracteoles remain spongy or fibrous in texture, but most commonly the inner portion surrounding the seed becomes more or less hardened.

Atriplex holocarpum F.v.M. must apparently be regarded as a synonym of this species. Mueller (*Rep. Babb. Exped.*, 1858, p. 19) describes it as closely allied to *Atriplex inflatum* (*Atriplex halimoides*), but does not mention its affinity to *Atriplex spongiosum*, although recording a specimen of the latter species from Lake Gregory in the same report.

Bentham retains specific rank for both *Atriplex holocarpum* and *Atriplex spongiosum*, but the only points of difference noted by him between the two species are in the size of the fruiting bracteoles, and to a lesser extent in their shape. That of *Atriplex holocarpum* is given as "turbinate-globular 4-6 lines diameter", that of *Atriplex spongiosum* as "depressed globular not 2 lines diameter".

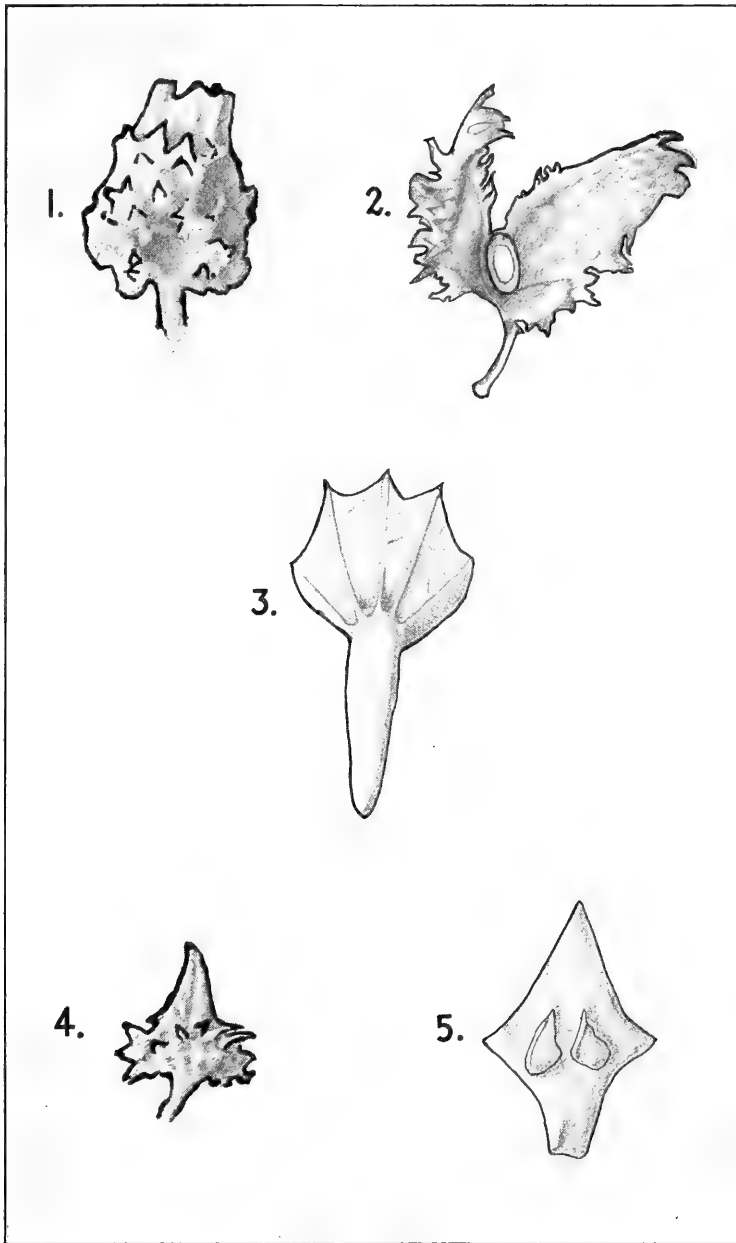
Mueller himself omits *Atriplex holocarpum* from his "Census of Australian Plants", and in the "Iconography of Australian Salsolaceous Plants" only figures *Atriplex spongiosum*, the figure, however, including both the large- and small-fruited forms.

There appears to be no justification for maintaining specific rank for both *Atriplex spongiosum* and *Atriplex holocarpum*. J. M. Black in the "Flora of South Australia", p. 188, places *Atriplex holocarpum* as a synonym of *Atriplex spongiosum*.

In the "Census of New South Wales Plants" Maiden and Betche make *Atriplex spongiosum* a variety of *Atriplex holocarpum*, quoting Mueller as the authority for the variety. *Atriplex spongiosum*, however, has priority and must stand, and there appears to be little to justify even a varietal difference between the two species.

ATRIPLEX MORRISII, n. sp. Plate xviii, figs. 1, 2.

Herba annua plus minusve cano-farinosa, foliis obovatis sinuato-dentatis 10-20 mm. longis, ad basin attenuatis; floribus monoicis glomerulis confertis axillaribus,



Fruiting bracteoles of 1, 2. *Atriplex Morrisii*; 3. *A. intermedium*; 4. *A. spuiibractum*; 5. *acutibractum*.

masculis in apice ramulorum sitis et aliquat floribus femineis circumdatis, glomerulis inferioribus omnino femineis; bracteolis fructiferis oblongis vel truncato-obovatis fere ad apicem connatis, appendicibus rugosis plus minusve spongiosis instructis, apicibus bracteolorum dentatis 2 mm. latis; semine orbiculari fusco, radícula supera.

Broken Hill District, A. Morris, No. 123, 1/1920, No. 711, 11/1921, and No. 1075, 1/1924.

This species is a small branching annual plant more or less completely scaly tomentose. The fruiting bracteoles are very distinct and separate it sharply from any of the allied species. They are somewhat oblong or truncate obovate and united practically for the whole of their length, the apex being about 2 mm. wide and 2-4 toothed. The lower three-quarters of the bracteoles are spongy and covered with soft pointed projections which give it a rough or rugose appearance.

The upper quarter of the bracteoles is comparatively smooth and fairly strongly veined. At the base the bracteoles are produced into a short, fairly stout pedicel 1-2 mm. long.

So far the species has been recorded only from the Broken Hill district, where it occurs fairly plentifully in some seasons.

The species is named in honour of Mr. A. Morris of Broken Hill, who for many years has studied the flora of the Broken Hill district and who first collected this species and drew the attention of the Herbarium staff to its distinctiveness.

Acknowledgments.

I wish to acknowledge the valuable assistance, by means of specimens and notes, received from Mr. J. M. Black of Adelaide, the staff of the Victorian National Herbarium, and Mr. C. T. White, Government Botanist of Queensland.

EXPLANATION OF PLATE XVIII.

1, 2.—Fruiting bracteoles of *Atriplex Morrisii* (Broken Hill, A. Morris, No. 123, 1/1920).

3.—Fruiting bracteole of *Atriplex intermedium* (Corona, Miss M. Collins, 9/1921).

4.—Fruiting bracteole of *Atriplex spinibractum* (Coonamble, Archdeacon Haviland, 2/1923).

5.—Fruiting bracteole of *Atriplex acutibractum* (Murray Flats, Dr. J. B. Cleland, 5/1911).

THE UTERINE CYCLE OF PREGNANCY AND PSEUDO-PREGNANCY AS IT
IS IN THE DIPROTODONT MARSUPIAL *BETTONGIA CUNICULUS*.

WITH NOTES ON OTHER REPRODUCTIVE PHENOMENA IN THIS MARSUPIAL.

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(Plates xix-xxi; three Text-figures.)

[Read 29th October, 1930.]

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Introduction.

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INTRODUCTION.

Little attention has been paid to the investigation of reproductive phenomena in the diprotodont marsupials, and the present communication is an endeavour to lessen the gap in our knowledge by describing the uterine cycle in one of them, *Bettongia cuniculus*. Opportunity is also being taken to offer some remarks on the breeding season, pouch-phenomena, foetal nutrition, the gestation period and other matters having to do with reproduction in this marsupial.

The observations herein set down can be regarded as being preliminary only, it being intended that the reproductive cycle in its various phases will be more intensely investigated later.

Bettongia cuniculus is one of the so-called "rat kangaroos" and is a diprotodont marsupial of small size found in Tasmania. There is some difficulty in securing specimens at present and it is inevitable that, with the spread of settlement, its numbers will be even more seriously depleted in the near future.

Collection of material of *Bettongia* has proceeded since 1924 and has been supported by funds supplied by the Trustees of the Ralston Bequest and more recently by a grant from the Grants Committee of the Royal Society. To both these bodies I take the opportunity to express my heartfelt thanks for their generous assistance.

Much of this work was carried out in vacation time in the Zoology Department of the University of Sydney and I have to express my sincere thanks to Professor W. J. Dakin for placing the resources of his department at my disposal.

The fixatives employed in the preserving of uteri, ovaries and associated organs have been of several kinds, mainly, however, corrosive sublimate with acetic acid and Bouin's picro-formol-acetic solution. Carnoy's mixture of acetic alcohol with chloroform and Sansom's modification of the same have been employed where a quickly penetrating fluid has been required as, for example, in the fixation of

whole uteri with contained embryos. In this latter case, in order to preserve as far as possible the relationships of the foetal membranes to the uterine wall, the process of double embedding with paraffin and celloidin has been resorted to.

REPRODUCTIVE PHENOMENA IN BETTONGIA.

(a.) *Number of Pouch Young.*

Bettongia cuniculus agrees with *Potorous tridactylus*, *Phascolomys*, *Trichosurus* and various species of Macropodinae in that it produces but one young at a birth. There being four teats in the pouch, three of them are unoccupied at a time. In the respect that there are insufficient young born at one time to occupy all the teats of the pouch, *Bettongia*, with those marsupials above mentioned and some others, differs very considerably from another group in which the number of newly-born is normally greater than the pouch can accommodate. This phenomenon was first noted by J. P. Hill (1910) in *Dasyurus*, and was shown afterwards to occur in *Didelphys* (Hartman, 1920; Hill, 1918) and probably happens also in *Sarcophilus* (Flynn, 1921).

Pseudochirus cooki, with respect to the number of young born, occupies a position intermediate between these two groups (Flynn, 1921). Possessing four teats, two are functionless. These never become enlarged and are never used by the pouch young. There may be as many as six young produced at a birth in this animal; usually there are three; rarely there is but one. In this way *Pseudochirus cooki* may be recognized as an example now living of a marsupial showing progressive reduction of the number of teats and of young. Where, as in *Trichosurus*, *Phascolarctos*, *Phascolomys*, various species of Macropodinae and others, the number of young ones born is normally less than the number of teats available, the phenomenon might be termed Hypogony.

Bearing in mind the suggestion of Hill and O'Donoghue (1913) that marsupials show a progressive reduction in the number of teats present in the pouch—a statement with which one must agree—it is also obvious that, in the Class, there is also to be found a progressive reduction in the number of young born, and that this reduction has reached its limit in the hypogonous marsupials in which it has proceeded in advance of teat reduction.

(b.) *Breeding Habits, etc.*

I have been able to collect females of *Bettongia* over the greater part of the year, and find that its breeding season lasts at least from March to December, that is, over the autumn, winter, spring and early summer months. I have not yet had the opportunity of collecting animals during January and February, but there is every possibility that during these months the animal rests from its breeding activities.

Bettongia is polyoestrous. This is shown by the fact that most of the females obtained over the above-mentioned breeding season are found to be pregnant, by the condition of the ovaries, and by the fact that quite a large number of the pregnant females possess at the same time a pouch young. Thus, of eighty-one females taken in the breeding season of 1924, no less than seventy were pregnant, and of these twenty-six had in addition a young one in the pouch. Of the other pregnant animals, some eight were in a condition that showed that the young animal still occasionally visited the pouch to be suckled.

This shows that, of the seventy pregnant females gathered in the breeding season of 1924, at least thirty-four had given birth to an embryo some short time previously.

Evidence of the condition of polyoestrus is given by the following notes taken from my laboratory note-book. These examples are only two of many.

Example 1. *Bett.* A., 1/10/27.

"Pouch, fairly well haired pouch young present, left anterior gland and teat well developed, other three resting and small.

"Uteri, both about equal in size and of similar appearance.

"Ovaries, left ovary with fairly recent corpus luteum, whitish in colour, right ovary with one very old corpus luteum."

On opening the left uterus a small blastocyst was found.

Example 2. *Bett.*, 15/10/27.

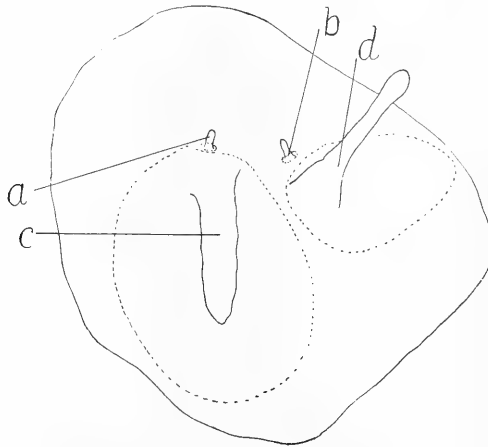
"Pouch, pouch young present, very small.

"Teats, the young one attached to the anterior right teat, anterior left and posterior right teats very small and undeveloped, posterior left teat and gland very large giving indication of the fact that this teat and gland had up till recently been used by a young one that had been visiting the pouch for the purpose of being suckled.

"Uteri, small, slightly congested, both about the same size.

"Ovaries, left ovary with a recent corpus luteum, the right ovary with an old corpus."

A small blastocyst was found in the left uterus. These organs showed that there had been three successive pregnancies.



Text-fig. 1.—Direct evidence of the condition of polyoestrus as shown by the arrangement of the nipples in the pouch of specimen *Bett.*, 10/8/28. The mammary glands are indicated in their extent by broken lines. The right posterior gland is strongly secreting and its condition and the size and form of its nipple (*c*) show that a young one still visits the mother to use it. To the left posterior nipple (*d*) was attached a pouch foetus measuring 25 mm. in direct length. The anterior nipples (*a* and *b*) and glands are small and non-functioning. An early blastocyst was found in the right uterus. There is, therefore, definite evidence of three successive pregnancies.

Not only are these examples definite evidence of the condition of polyoestrus, but they also bring to mind a suggestion made some time ago by O'Donoghue (1916, pp. 442 and 457), that in *Phascolarctos* and *Trichosurus vulpecula*, in which animals only one young one is produced at a birth, ovulation is alternate from each ovary.

As will be seen from the body of this paper, pregnancy in *Bettongia* is normally alternate and it is very likely that in *Phascolarctos* and *Trichosurus* this condition also holds. While one of the uteri is pregnant, the other is "pseudo-pregnant" and, for this reason, it is impossible to know by external examination of the uteri alone, until mid-pregnancy, which of the uteri is the gravid one.

The condition of "pseudo-pregnancy" in *Bettongia* is of a somewhat different type and has a correspondingly different history from that which supervenes in all marsupials when the spontaneously discharged ovum is not fertilized.

This subject will be discussed later in this paper. A full and complete understanding of it will finally depend, however, on the results obtained by a thorough examination of the ovaries at various stages. This work is being carried on by Miss M. Garde, B.Sc., of the School of Anatomy, University of Sydney.

(c.) *Periods of Gestation and of Lactation.*

On the length of these periods I have at present very little information based on direct evidence. So far, I have been unable to get *Bettongia* to breed in captivity, so that coitus has never been observed. The same difficulty arises with *Potorous tridactylus*, as has already been pointed out by Misses Altmann and Ellery (1925, p. 466). It does not seem possible that the period of gestation in such a marsupial as *Bettongia*, in which pregnancy is unilateral and ovulation spontaneous, could ever be correctly determined. An approximate calculation might be made by opening animals under anaesthesia and determining the age of the corpus luteum. This I have not yet attempted. The few cases which I have had under observation point to about six weeks as being the approximate length of gestation in both *Bettongia cuniculus* and *Potorous tridactylus*.

Records relating to the length of time which elapses between coitus and parturition in the Macropods exist in widely scattered publications and are so conflicting as to suggest that considerable research and observation are necessary before the matter can be cleared up. Wood Jones (1923, p. 74) quotes a case in which a male and female *Macropus rufus* were kept for some time in the Zoological Gardens in Philadelphia, the male dying on October 28, 1908. Seven weeks after the male died an embryo was observed in the pouch of the female. This young suckled till November 7, 1909, but on September 25, 1909, another, apparently new-born, embryo was noticed in the pouch.

The interval between coitus and parturition in this case could not have been less than eleven months. It is hardly likely that the gestation period in the Macropods would extend over more than six weeks or so, and it is evident that more information is needed as to the length of time the spermatozoa may remain alive and retain their fertilizing power in the body of the female in these animals.

With regard to the period of lactation, the recording of observations is difficult in the case of *Bettongia*, since in most cases the pouch young disappear a few days after the animals are put in the yard. However, since there is never more than one foetus found in the pouch at one time and since in pregnant animals

there is present in many instances a pouch foetus, it is obvious that in normal cases the duration of the lactation period is about equal to the length of the gestation period, i.e., about six weeks. It is also worthy of note that the lactation period of one pregnancy is overlapped by the gestation period of the next succeeding one.

(d.) *Pregnancy and Pseudo-pregnancy.*

In all viviparous mammals, it is agreed, the growth and shedding of the ovum have a profoundly stimulating effect on the uterus and upon the remainder of the female reproductive organs. It is now universally admitted that this effect is due to hormones secreted by the growing follicle and the corpus luteum, but the whole series of occurrences is not yet sufficiently investigated, and it is obvious that other glandular structures may also be effective in this stimulation.

In those mammals in which ovulation is spontaneous, normal pregnancy may be expected to supervene if fertilization follows ovulation; on the other hand, should fertilization fail, the uteri and other female organs enter into a condition which simulates pregnancy. This condition, noticed first by Hill and O'Donoghue (1913) in *Dasyurus*, was called by these investigators "pseudo-pregnancy". It is a most significant phenomenon, since it shows definitely the influence of ovarian structures, before and after ovulation, in activating the uterus. Pseudo-pregnancy is, naturally, a temporary condition and the transition to normal anoestrus or dioestrus consists in the reconstitution of the uterine and gland epithelia and in the resorption of the distending lymph material found in the connective tissue of the mucosa (Hill and O'Donoghue, pp. 159-160).

In *Bettongia*, ovulation is spontaneous, as might be expected, but is unilateral, and only one ovum is shed at a time. Either pregnancy or pseudo-pregnancy may follow, according as this ovum is fertilized or not. Unfertilized ova are quite rare. Ordinary pseudo-pregnancy in this animal is of the same character as in the case of *Dasyurus* (Hill and O'Donoghue) and has not been examined in any detail for the purposes of this paper.

Pregnancy is obviously unilateral and the pregnant uterus proceeds to undergo the usual changes associated with this condition and which have their climax in the act of parturition. More interesting, however, is the fact that the contralateral (non-pregnant) uterus also undergoes changes by which it is not to be distinguished either by external observation or by microscopical examination from the pregnant uterus until the time of mid-pregnancy. The non-pregnant uterus is therefore in a condition of pseudo-pregnancy. But this pseudo-pregnancy is of a somewhat different type from that occurring in the case of ovulation not followed by fertilization. In the latter type, the pseudo-pregnant uterus returns more or less gradually to the condition of anoestrus or dioestrus, this return being caused apparently by the waning hormonal influence of the ovary. In *Bettongia*, however, the history of the unilaterally pseudo-pregnant uterus is peculiar and significant. It does not attempt to return immediately to the condition of dioestrus, but remains through the latter half of pregnancy in a well stimulated condition, exhibiting a turgid mucosa, with a well-developed lymph and blood supply. Just before parturition occurs in the contralateral uterus, there is a convulsive expulsion of the contained lymph from the connective tissue of the mucosa of the pseudo-pregnant uterus.

The significance of this behaviour is to be found apparently in two causes: (a) the presence of an embryo in the pregnant uterus, (b) the stimulation of the

uterine muscles which results in parturition. These will be discussed later in this paper.

THE UTERINE CYCLE OF PREGNANCY AND PSEUDO-PREGNANCY IN BETTONGIA.

Stage 1. *Bett.* E., 15/9/26 (stage of anoestrus). (Plate xix, figs. 1, 2.)

It is remarkable at what an early stage the young *Bettongia* is able to receive the male. Coitus seems to occur soon after the young animal is reasonably free of the pouch. For this reason it is difficult to obtain resting uteri from free animals during the breeding season. Consequently I have taken as an example of the anoestrous condition the uterus of a young *Bettongia* which had not yet entirely severed its connection with the pouch.

Each of the two uteri measured 7×3.5 mm. Sections show that the wall has the usual layers found in the uterine wall of other marsupials. The uterine epithelium consists of a single layer of columnar cells of moderate height with somewhat large nuclei. The latter are found near the centre of the cell, not basally, situated as is the case with the nuclei of the gland epithelium. The nuclei are oval in shape and to a great extent fill the centre of the cell. The shape and position of the nucleus vary according to the direction in which the cell is cut. Narrow cells with thin nuclei mostly prove to be cells cut along one edge. The cytoplasm of the cell is finely granular. The nucleus has a well defined membrane and is coarsely granular, often with one large chromatic particle standing out from the rest. The thickness of the epithelium varies between 0.019 and 0.025 mm.

The uterine epithelium in the anoestrous stage is strongly and almost uniformly ciliated. I have not been able to find in literature any reference to the fact that the surface epithelium of the uterus of any marsupial is ciliated at any stage. Hartman states (1923, p. 372) that his preparations of the anoestrous uteri in the opossum do not allow him to say whether any of the cells of the epithelium or of the glands possess cilia. Hill and O'Donoghue (1913) refer to gland ciliation only, so we may infer that no surface ciliation is present in the uterus of *Dasyurus*.

The uterine glands are also strongly ciliated, even to their bases. The glands are of comparatively large diameter, having a diameter of from 0.046 to 0.058 mm. The glands are straight and are lined by fairly high columnar cells in which, however, the nuclei are basally situated. They have small but distinct lumina, these, particularly in their basal portions, being occluded by a mass of material which, when examined, proves to be closely aggregated cilia, these being just as strongly developed in the lower portions of the glands as in the upper.

Of the remainder of the mucosa there is nothing to be said other than that it is in the resting condition. It is not markedly supplied with blood vessels or with lymphatic material. There is a slight condensation of the connective tissue below the uterine epithelium to form a sub-epithelial layer.

Stage 2. Oestrous Stage. (Plate xix, figs. 3, 4.)

As an example of this stage will be taken the sterile uterus of specimen *Bett.* F., 29/8/24. In this specimen the two uteri were empty, but there was a very small young one in the pouch, newly born. This foetus measured 14.8 mm. direct length. There was in the pouch also a larger pouch-foetus which had been dead

for some time and which had become quite putrescent. No doubt if this latter one had lived it would have been by this time free of the pouch.

Examination of the uteri showed that the smaller foetus had come from the left uterus which showed remains of the foetal membranes, not yet completely absorbed. The right uterus, from which the larger foetus had been born, has now recovered and has progressed to a stage closely corresponding to oestrus.

The epithelium of the right uterus is very high and the nuclei are plentiful and are arranged at several heights so as to resemble the similar stage in the pig (see Corner, 1921, Plate 4, figs. 25, 26). Mitotic figures are very common in the epithelium and there are instances of the vacuolar degeneration to which Corner refers. The epithelium measures from 0.021 to 0.028 mm. in thickness, so that it is appreciably thicker than in the anoestrous stage, but cilia are not nearly so plentiful on the surface epithelium.

The cells of the gland epithelium are extremely active in division, mitotic figures being very common. In a single cross-section of a gland as many as three cells may be seen in division. A gland section containing two divisions is shown on Plate xix, fig. 4. Cilia are abundantly present in the glands, and they often project profusely from the gland mouth into the uterine lumen. The gland lumina are larger than in the previous stage and there is sometimes present a little secretion. The diameter of an average gland is 0.46 mm. Before dividing, the gland cell falls out of line, approaching nearer to the gland lumen. After division the two cells apparently work back again to their place in the gland epithelium. It is of note to mention that, contrary to what occurs in the pig (Corner, 1921), mitoses are just as numerous in the deeper portions of the glands as in the more superficial.

Each gland cell has clear protoplasm and the nucleus here again largely fills the cell. The thickness of the gland epithelium is from 0.020 to 0.021 mm.

There is at this stage an appreciable increase in the amount of infiltrated lymphatic material in the mucosa and through it, also, many blood vessels extend and come to lie just below the epithelium.

Polymorphs occur fairly plentifully at this stage, being found in the connective tissue of the mucosa, in the gland epithelium and in the uterine epithelium as well as being free in the gland and uterine lumina.

In another small female (*Bett.*, 4/12/29) the uteri were in a condition either of late pro-oestrous or early oestrous. She was a very small animal, obviously not long free of the pouch, and it is surprising to find her organs in a condition of preparatory activity. The two uteri are small, about the size given in the stage of anoestrus, left 7×3.2 mm., right 7×3.0 mm. The uterine wall shows a slight advance on the previous stage. The uterine epithelium consists of a single layer of columnar cells, but the cilia are much less numerous and are not so easily stained. There is a tendency for the epithelial cells to become crowded in places so that they become arranged at several heights. Occasional mitoses occur in the epithelial cells. The uterine epithelium has an average depth of 0.023 mm.

The mucosa measures on the average 0.30 mm. from the top of the folds to the muscularis, so that it is thicker than in the anoestrus stage. There has been a certain amount of infiltration of lymphatic material, so that the glands are now being forced somewhat farther apart. The inter-glandular connective tissue is becoming more attenuated and fluid laden.

Glands.—These present, in general, the same characteristics as in the previous stage, with a diameter from 0.054 to 0.060 mm. They are very strongly ciliated and their activity is shown by the presence, fairly commonly, of mitoses in the gland epithelium.

Stage 3. *Bett. F.*, 19/9/24. (Pl. xix, fig. 5.)

In this specimen the left uterus contained a small blastocyst in a very early unilaminar stage. There was also a well-grown foetus in the pouch. The uteri and blastocyst were fixed in picro-nitro-osmic solution.

In external appearance and in microscopic structure the two uteri are identical.

The uterine epithelium has now become appreciably thicker, measuring from 0.026 mm. to 0.04 mm. Mitotic divisions have by this time completely ceased and the number of nuclei present in the epithelium is now very large, so that they appear to overlap even in thin sections. They are arranged at about three levels. The free ends of the epithelium cells are slightly rounded as in the pig at this stage (Corner, 1921) and the protoplasm is finely granular. Cilia are not nearly so plentiful. The epithelium gives every evidence of being in a state of active secretion and the exposed surfaces of its cells are coated with amorphous material exuded from them into the uterine lumen.

A feature of the epithelium is that the distance between the nucleus and the base of the cell has increased, due to the intense vacuolation of the basal cytoplasm. This portion of the cytoplasm is quite distinct and owes its distinctive appearance no doubt to the absorption of fluid material from the underlying stroma, this material being on its way to the interior of the uterus.

The glands are still fairly crowded, but there is opportunity for lymphatic material to be well distributed through the mucosa. The lower portions of the glands are much convoluted and the coils are closely crowded. In their upper courses the glands are straight. The glands are ciliated right to their bases. The cilia are not so plentiful or so strong as in the previous stage. Mitoses in the gland cells have entirely ceased. The thickness of the gland epithelium is about 0.024 mm. The relative proportion of the amount of cytoplasm to nucleus in the gland cells is greater than in the previous stage, and there is a strong tendency for the cytoplasm to become vacuolated. The nuclei are in general quite basally situated in the gland epithelium, but there has commenced in this stage a phenomenon which seems to be of the greatest importance and which is much more marked in subsequent stages.

This consists in some of the gland nuclei leaving their basal positions and passing toward the gland lumen. In the process, they lose their staining qualities and sometimes are with difficulty distinguishable from the general cell protoplasm. In the process of desquamation which the gland cells undergo, especially in the next stage, these nuclei go to swell the amount of cellular secretion present in the gland lumina. This secretion, although fairly abundant just now in the deeper portions of the glands, is much more marked in subsequent stages. On occasions it is possible to see the very pale nuclei working their way into the lumina of the glands.

Stage 4. *Bett. A.*, 6/9/24. (Pl. xix, fig. 6.)

A small unilaminar blastocyst, somewhat more advanced than in the last stage, was present in the right uterus. The two uteri, which were identical in external appearance and in microscopical structure, were fixed in Bouin's solution.

The uterine epithelium.—This is appreciably lower than in Stage 3, measuring on an average 0.020 mm. in thickness. The changes initiated in the previous stage are continued in this.

Structurally, the uterine epithelium of this stage bears a very close resemblance to that of the pig eight days after ovulation (Corner, 1921, Plate 4, fig. 28). An interesting and prominent feature is the presence of abundance of narrow cells with dark-staining nuclei whose nature and function have caused much discussion. These are the so-called "intercalar cells", or "cells with pycnotic nuclei" to which Corner refers in the pig (1921), which Hill and O'Donoghue have recorded in the uteri of *Dasyurus* (1913, p. 146), and which are also shown by Hartman to occur in the uterus of *Didelphys* (1923, p. 375). They have been long regarded as being cells undergoing extinction but, in the case of *Bettongia*, they appear rather to be wandering cells which, in pushing their way between the epithelial cells, have been forced to take a narrow shape while they resume a more rounded one on arrival in the uterine lumen. Corner refers to darkly-staining rounded cells which force themselves between the epithelial cells at their bases in the case of the pig. The basement membrane at this stage is very indefinite and may be said to have disappeared.

No mitoses are observable in the epithelial cells either of the uterus or of the glands. In the latter the migration and alteration of the gland nuclei are in full activity.

The cilia have practically the same arrangement as in the last stage. They are not very common on the uterine epithelium and the ciliated cells are usually somewhat depressed below the general surface. The glands, however, are ciliated right to their bases.

Stage 5. *Bett. B.*, 30/8/24. (Pl. xix, fig. 7 and Pl. xx, fig. 8.)

A fully formed bilaminar blastocyst was found in the right uterus. The two uteri are identical in appearance and structure. They have both increased in size and turgidity.

Epithelium.—This shows a considerable advance on the previous stage. Due to the thickening of the mucosa, the formation of uterine folds and the general increase of area covered by the epithelium without any compensating new cell formation, the epithelium has become of a low columnar type, its thickness being now about 0.010 to 0.014 mm. The nuclei do not overlap any longer in the sections, but lie side by side. The exposed edges of the epithelial cells are plentifully coated with secretion and the whole layer is in an active secretory condition. Cell boundaries are not always distinct in this layer. Some of the cells are ciliated.

Leucocytes are abundantly present in some places, particularly in the superficial layers of the stroma. Polymorphs are to be found in the superficial epithelium, and in that of the glands, also in the stroma.

The subepithelial layer is particularly well defined at this stage, due to the large number of capillaries which now form its dominant feature.

Infiltration of the stroma with lymphatic material has gone on apace. Its arrangement is such that there is a superficial portion of the stroma which is rather spongy and in which the gland tubes are widely separated and are fairly straight.

Contrasted with this there is a deep compact layer of the mucosa not so much infiltrated and in which the glands are tortuous and more closely set.

There is also a considerable difference in the histology of the glands in these two regions of the mucosa.

In the deeper portion, the gland epithelium has increased greatly in thickness, to 0.040 mm. The cytoplasmic portion of the cell has grown largely in volume and is profusely vacuolated. In many cases the rounded nucleus is contained in a small mass of protoplasm connected to the cell wall by strands.

Migration of the nuclei is very active, and there seems to be no doubt that their substance passes into the lumen of the gland together with the frayed-off ends of the gland cells. Nevertheless, many of the gland cells still retain their ciliated condition.

In their superficial portions the epithelium of the glands is not nearly so thick (0.033 mm.). Further, the nuclei are smaller and deeply staining. The cytoplasm is but little vacuolated. The transition from the deeper portion of the gland to the more superficial region is somewhat abrupt.

Stage 6. *Bett.*, 2/9/24. (Pl. xx, figs. 9-13.)

A blastocyst of the primitive streak stage was present in the left uterus.

In this stage, although externally the two uteri are similar, microscopically they are very different.

Structure of the right (non-pregnant) uterus.—The epithelium shows considerable signs of disintegration and degeneration. Where intact it is similar to the epithelium of the last stage, but its connection with the underlying tissues is very loose, so that in patches it is liable to break away and float in the cavity of the uterus. Other degenerative processes are also in operation. Epithelial cells swell, their nuclei lose their staining properties and the whole cell either breaks away completely or even bursts, throwing the contained material into the uterine lumen. Vacuolar degeneration *in situ* is common. Associated with these processes is the presence of numbers of leucocytes in the epithelium. The place of the cast-off or degenerated epithelial cells is apparently taken by connective tissue cells of the mucosa, these cells moving up into place and forming a new single-layered epithelium.

Blood vessels are plentiful and the breaking away of the epithelial cells causes blood extravasations, but these are rare and not of great extent.

The mucosa is tremendously infiltrated with fluid material, so much so that it resembles a mass of fluid in which the blood vessels and glands are suspended.

The glands are also undergoing degeneration and reconstitution, these phenomena being confined at this stage to their more superficial portions. Here, vacuolar degeneration, desquamation and migration of the gland cells and nuclei are in progress, although not so actively as in the uterine epithelium. With these phenomena is associated the presence of leucocytes of various kinds, the number of which is remarkable.

The result of all this is that each gland becomes divided into two portions, a lower secretory portion, convoluted and lined by large vacuolated columnar cells with vesicular nuclei, and a more superficial duct-like portion, non-secretory, lined by smaller cells, with granular non-vacuolated protoplasm and containing small dark-staining nuclei. The separation of each gland into these two portions is very distinct.

Left (pregnant) uterus.—There are no signs of degeneration in the uterine epithelium. Each gland consists of two portions as in the non-pregnant uterus, but

the alteration has not gone so far, nor is the division between the two portions of each gland so abrupt. Leucocytes, though present, are not nearly so numerous as in the non-pregnant uterus at this stage.

The two uteri, pregnant and non-pregnant, at this time agree, then, in the division of each uterine gland into two portions, a superficial non-secretory and a deeper secretory portion. They agree also in the fact that the mucosa is largely infiltrated with lymphatic material. The non-pregnant uterus, however, shows a wide-spread destruction and regeneration of the superficial epithelium associated with the presence of numerous leucocytes. These features are absent in the pregnant uterus.

Stage 7. *Bett. E.*, 14/9/24. (Plate xx, fig. 14.)

The right uterus contained an embryo in the medullary plate stage.

The two uteri are very dissimilar in external appearance, the measurements being: right uterus 17×9 mm., the left 12×5.5 mm.

Left (non-pregnant) uterus.—The epithelium varies in thickness from 0.012 to 0.0121 mm. and in most places is completely restored, although here and there are still to be found signs of degeneration. The basement membrane in most places is very distinct. Leucocytes are much rarer than in the previous stage. In the glands the division into superficial non-secreting and deeper secreting portions is quite marked. In the latter portion the glands have a diameter of 0.48 mm. and possess large and vacuolated cells. More superficially they measure 0.32 mm. in diameter and the cells possess small darkly-staining nuclei and the cytoplasm is granular and but little vacuolated. Cilia are very plentiful.

Right (pregnant) uterus.—The cavity of the uterus is almost circular owing to the presence of the blastocyst which fits snugly against the epithelium, obliterating many of the folds. The blastocyst is separated from the epithelium by the shell membrane which, although very thin, has not yet disappeared. The blastocyst is orientated so that its embryonic pole is towards the mesial side of the uterus and so that the embryo is arranged transversely to the length of the uterus. The anterior end of the future embryo is placed towards the dorsal side. In order to retain as much as possible the true relations of the uterus and embryo, the organs with the contained embryo were fixed intact in Carnoy's solution.

Although the inner surface of the uterus is practically smooth, there are still a few grooves left and these are in the neighbourhood of the embryo. The grooves disappear at the lower pole of the vesicle.

The epithelium consists of a single layer of cells which are cubical in form and possess large spherical nuclei. There is a tendency for the epithelium here and there to thicken slightly and penetrate downwards between the subepithelial blood-vessels. Many of the epithelial cells possess the excretory processes which are characteristic of similar cells in the American opossum (Hartman, 1923, p. 374) and in the pig (Corner, 1921, p. 139). Corner considers these processes to consist of extruded cytoplasm, contrary to Geist, who believes that they represent secreted material on its way into the lumen of the uterus.

Whatever may be the case in the pig, it appears that in *Bettongia* the processes consist of amorphous material extruded actually from the epithelial cells.

Cilia are present, though rarely, on the surface of the uterine epithelium. Underlying the epithelium there is an almost continuous layer of capillaries which,

with the particular stroma cells, makes a very definite subepithelial layer. Between this and the overlying epithelium there is a narrow clear zone which consists of aggregated lymphatic material collected probably on its way to the lumen.

Glands are well developed and are ciliated right to their bases. The glands are actively secreting and many are greatly dilated. Each gland presents the same two divisions already referred to. A feature of the stroma is the presence of great numbers of deeply-staining granules which are specially congregated just below the surface epithelium.

Stage 8. *Bett G.*, 11/9/24. (Pl. xx, fig. 15; Pl. xxi, fig. 16.)

The two uteri measured as follows: right 21×11 mm., left 10×5.5 mm. The embryo contained in the right uterus measured approximately 3.5 mm. in direct length.

Left (non-pregnant) uterus.—The cavity of this uterus is compressed and its inner surface is marked by fairly deep longitudinal grooves.

The cells of the epithelium are now arranged to form a somewhat irregular columnar layer of medium height. Cilia are now found more plentifully distributed on the surface and take the stain more thoroughly. Blood-vessels have been largely withdrawn from the vicinity of the surface epithelium. Polymorpho-nuclear leucocytes are observable in the epithelium. The basement membrane and subepithelial layer are distinct. The stroma is still infiltrated with lymph. Occasionally there are leucocytes to be found in it.

Glands.—These have become much less active than in previous stages, although in some of them is to be found secreted material which often contains whole cells. Leucocytes are also to be seen in the gland lumina occasionally. In all except one region the gland cells take the character of non-secretory cells of low cubical type with dense nuclei. In these the average height of the cells is from 0.0132 to 0.0148 mm., whereas towards the mesial side of the uterus where the deeper parts of the glands still consist of vacuolated columnar cells, the height of the cells is on the average 0.020 mm. The glands are ciliated to their bases.

Right (pregnant) uterus.—In order to retain the embryo in its natural position, the right uterus was divided by a vertical longitudinal incision. The mesial half is shown from its inner aspect on Plate xxi, figure 16. The embryo in its membranes is contained in this mesial half. It is arranged fairly transversely, the head being dorsally directed. The anterior portion of the body is strongly bent on the remainder and is contained in the proamnion. In the figure the embryo, viewed from underneath, is hidden by the yolk-sac splanchnopleure (*y. spl.*) which is invaginated towards the observer into the cavity of the yolk-sac (*y. s. cav.*). The yolk-sac splanchnopleure passes up at the side of the embryo and is then carried outward towards the uterine wall where it unites with the chorion and is then deflected downwards as the yolk-sac wall. This is in extremely close contact with the inner surface of the uterine wall, so that the large cavity in the figure is the cavity of the yolk-sac, not of the uterus as would first appear. The upper portion of the omphalopleure consists of the vascular omphalopleure. The lower limit of this is shown by a light line representing the sinus terminalis (*s.t.*). The remainder of the yolk-sac wall consists of the bilaminar omphalopleure which is in close and intimate contact with the uterine epithelium.

As has already been suggested by Jenkinson (1913, p. 193), the amnion in Marsupials is formed by folds. In *Bettongia* it is the head-fold which appears

first. The foetal membranes of a corresponding stage have been figured by Selenka (1886-91, Plate xxxii, figure 3). The arrangement of the foetal membranes of *Bettongia* is that indicated by Semon in his description of the second marsupialian type (1894). It is similar to that of all Macropods so far described, except *Halmaturus ruficollis* in which Caldwell (1884) testifies to the presence of an allantochorion and of a union between the bilaminar omphalopleure and the uterine wall. With this exception the allantois in all Macropods is small, its vascular supply is poorly developed and no part of its wall reaches at any stage to the chorion.

At this stage there is, in *Bettongia*, a large proamnion, but it is not so voluminous as is shown in Selenka's diagram, in which more than half the body is enclosed in proamnion.

The chorionic ectoderm consists of a layer of cells which exceed greatly in size the cells of the uterine epithelium which are apposed to them. Their nuclei are round or oval and usually stain very darkly. The structure of these cells is rather characteristic, for the nucleus, placed in the centre of the cell, is surrounded by much vacuolated protoplasm. There is intense absorption going on in this layer. It will be referred to later. The chorionic mesoderm is a thin layer consisting of much smaller flattened cells, with correspondingly flattened nuclei, well spaced apart and connected by thin strands of protoplasm.

The trophoblast of the vascular omphalopleure is similar to that of the chorion, but the cells have a tendency to be somewhat larger. There are many places where the contact between this layer and the uterine epithelium is very intimate. The two are undoubtedly united in places, but can always be distinguished. There is nothing of the nature of an interpenetration of one layer by the other. The union occurs on the tops of the small folds which are so characteristic of the inner wall of the uterus. Into the deeper folds the vascular omphalopleure at this stage does not pass. The mesoderm in this region is very delicate, but is abundantly supplied with blood-vessels which make an almost complete layer underlying the trophoblastic ectoderm. The entoderm cells are usually flat and delicate, but are sometimes large, never, however, becoming as large as the ectoderm cells.

The trophoblast of the bilaminar omphalopleure resembles in general that of the other regions, but the cells of the entoderm of this region differ markedly from those elsewhere. Instead of being flattened, they are robust cells of the characteristic shape made familiar in the drawings of Selenka. These cells have somewhat narrow bases, but their apices are expanded and rounded. Typically each cell is separated from its neighbours by narrow spaces across which continuity is assured by delicate strands of protoplasm.

Maternal Structures.—The inner uterine surface may be distinguished into three regions, one in contact with the chorion of the embryo, a second in contact with the vascular omphalopleure, and a third in contact with the bilaminar omphalopleure.

The inner surface of the uterus is covered with fine corrugations due to the swollen condition of the blood-vessels which lie just below the epithelium. Sections of the uterus show that the mucosa is very variable in thickness. At the lower pole of the yolk-sac it may be as little as 0.15 mm., whereas it may be as much as 0.5 mm. in other places.

Uterine Epithelium.—In the region corresponding to the chorion of the embryo, the uterine epithelium is quite thin with round or oval nuclei fairly

deeply stained. Division between the cells is made out with difficulty. The layer is raised into numerous minute rugosities caused by the underlying blood-vessels. The nuclei being spaced widely apart in some places, there remains between them only a thin and delicate film of protoplasm covering the capillary. The epithelium of the other regions of the uterus shows very little departure in its structure from what has just been described. Occasionally in any region there may be found in the uterine epithelium a ciliated cell, its cilia being bathed by the secretion which fills the space between the epithelium and the trophoblast.

The Mucosa.—The connective tissue of the mucosa consists of a very delicate reticulum with stroma cells distributed at wide intervals. There is abundant fluid in the meshes of the net-work. Blood-vessels, sometimes of great size, are plentiful in the mucosa and their minute branches come to lie immediately below the epithelium as a definite and practically continuous layer of capillaries. The presence of these in abundance causes the corrugations of the epithelium previously referred to.

The glands are of small diameter, measuring on an average 0.056 mm. Their lumen is small and there appears to be little glandular secretion. Their epithelial cells possess small, deeply staining, basally situated nuclei. Many of the cells, basal as well as superficial, are ciliated but the cilia are very delicate.

Through the stroma are scattered leucocytes of various kinds and these are to be found especially just below the epithelium.

The Placenta.—The placenta is an organ consisting of the intimate apposition or fusion of the foetal membranes with the uterine wall for the purpose of carrying out physiological processes (and, it may be added, certain mechanical ones) destined for the well-being of the embryo (Assheton, 1909).

With this conception in mind, it can be stated at the outset that *Bettongia* possesses a very efficient placenta formed by the intimate apposition throughout its extent of the trophoblast to the uterine epithelium. The allantois remains small, but very efficient absorptive and nutritive functions are carried out in the regions of the chorion, vascular omphalopleure and bilaminar omphalopleure respectively. Actual fusion between maternal and foetal tissues at this stage is practically confined to the region of the vascular omphalopleure—a condition recalling that in *Dasyurus* and *Phascotarcos*—but this union is very slight and occurs at relatively few points. There is no actual penetration of maternal by foetal tissue. In the region of the chorion, the space between this membrane and the uterine epithelium is entirely filled by a liquid material, actively secreted by the maternal tissues and just as actively absorbed by the chorionic ectoderm. This secretion occupies all the spaces and folds between the two tissues. It is mainly a transudate from the mucosa, and to a very limited extent a secretion from the uterine glands. Beyond an occasional leucocyte, there is very little of a cellular nature in it. Here and there, however, occur patches of pigment, particularly in the neighbourhood of the mouths of some of the glands. It would be expected that this is the result of the breaking down of extravasated haematids, but I am not able to observe any such extravasations into the mucosa or the passage of haematids into the gland lumina.

A feature of this region, as it is of others, is the formation of pigment in the blood-vessels themselves. This, due probably to the degeneration of the red corpuscles, is confined to the superficial vessels and no doubt is of embryotropic significance.

In the region of the vascular omphalopleure (omphaloplacental region) the relationship of the trophoblast to the maternal epithelium is much more intimate than in the chorionic area, and there are numbers of places where actual union of the two layers occurs. Where this happens, the foetal and maternal blood-streams are separated by the endothelium of the foetal vessel, the trophoblast, the uterine epithelium and the endothelium of the maternal vessel. Sometimes connective tissue is interposed between the maternal vessels and the uterine epithelium. Usually there is a narrow space between the foetal and maternal tissues and the space is filled with secretion similar to that found in the chorionic area. In the omphaloplacental region, however, with this fluid medium there is abundance of other material. The same formation of pigment occurs in the superficial vessels of this region as in the chorionic area. Patches of similar pigment appear in the embryotropic secretion and are also in evidence in the cytoplasm of the trophoblast cells. Many of the leucocytes of the foetal circulation show dense masses of pigment in their substance. The activity of the absorption by the trophoblast cells of the fluid transudate is such that it is often impossible to define the boundary between the two media, the cytoplasm on the one hand and the secretion on the other. There is also to be found a considerable quantity of cellular debris, many leucocytes and often whole cells. These cells undergo immediate and intense disorganization so that, soon, all that is evident of the original cell is the nucleolus set in a pale non-staining mass of protoplasm. The whole of the colourable materials of the cell, with the exception of the nucleolus, seem to have been dispersed. These nucleoli form a very characteristic feature of the embryotrophe and of the contents of the megalokaryocytic trophoblast cells. Most of the cells which appear in this way in the uterine milk are cells of the uterine epithelium which have been loosened from their moorings and in this way have formed an integral part of the nutritive material of the embryo. This phenomenon is much more evident in the region of the bilaminar omphalopleure.

The cells of both layers of the bilaminar omphalopleure in the metrioplacental region are tremendously vacuolated. This points to the active absorption of carbohydrates in this portion of the yolk-sac placenta.

In many places in this region there are to be found clumps of cells projecting from the surface of the uterine epithelium. Sooner or later these become loosened and fall away into the secretion between the foetal and maternal epithelia. They soon lose their identity and in a short while the only recognizable part of each original cell is the nucleolus. As in the region of the vascular omphalopleure, these nucleoli can be recognized in the cytoplasm of the trophoblast cells.

Many leucocytes are to be seen in the embryotrophe of this region.

Evidence of active absorption is to be seen in the fact that the free apices of the cells of the yolk-sac entoderm are covered with caps of secreted material.

Stage 9. *Bett. B.*, 11/9/24. (Pl. xxi, figs. 17, 18, 19.)

Right uterus contains an embryo near full term with the following measurements: direct length 14.2 mm., head length 7 mm.

Description of non-pregnant (left) uterus.—The uterus has a lumen which is narrow and compressed, presenting narrow longitudinal grooves. This is a highly significant and important stage in the cycle of the pseudo-pregnant uterus, since active resorption and removal of the infiltrated lymphatic material are in progress.

Epithelium.—This consists of a columnar epithelium of medium height with the cells and contained nuclei fairly closely packed. The nucleus in each case fills most of the cell and is oval in shape. Occasionally the nuclei are arranged at more than one height. Mitoses occasionally occur. Here and there are to be seen also degenerating epithelial cells. No doubt their remains go to swell the secretion present in the uterine lumen. Cilia are only rarely present. The epithelium measures in average thickness about 0.048 mm.

Stroma.—Below the epithelium there is a marked condensation of the stroma to form a sub-epithelial layer. Everywhere the stroma contains abundance of lymph material, particularly at the apices of the folds. The blood-vessels of the mucosa are much swollen. Leucocytes, mainly of the large mononuclear type, are fairly plentiful in the stroma.

Glands.—It is in these structures that the greatest activity is shown at this stage, since they serve as the most important agents in the removal of the contained lymph from the stroma. The glands are of all diameters, ranging from 0.16 to as much as 0.80 mm. Usually the gland epithelium is high and strongly ciliated, but in the case of the much expanded glands the epithelium is low and cubical, an expression of the internal pressure to which these glands are being subjected. The oval, somewhat vesicular nuclei are mostly basally situated.

The cavities of the glands are filled with abundance of lymphatic material which is being poured into the uterine cavity. With this is to be found cellular debris associated with whole cells and portions of the gland epithelium.

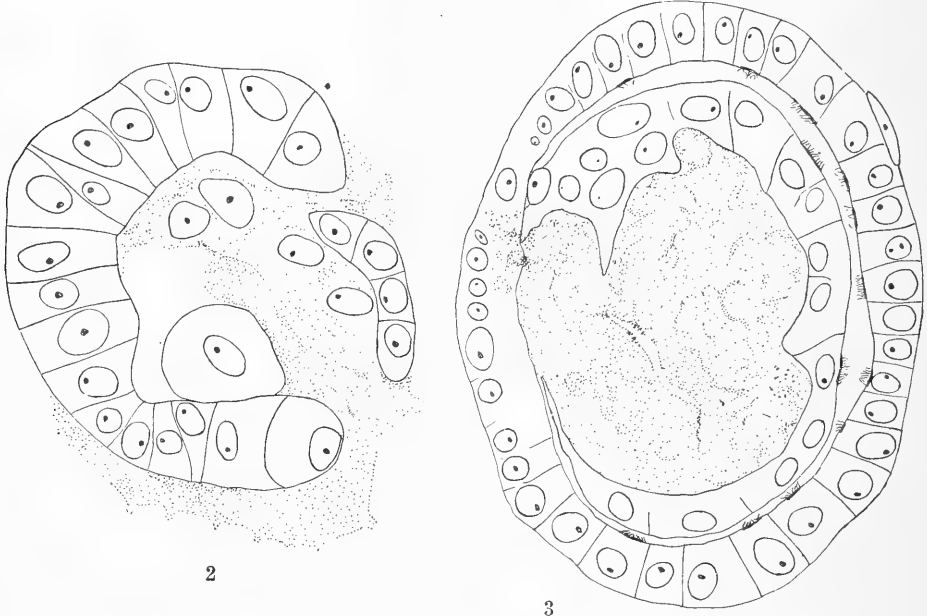
The weight of passage of the fluid lymphatic material into the glands is remarkable. In many cases it transudes in such a way as to cause little disturbance to the integrity of the gland epithelium. Often its passage is of such a kind as to cause the epithelium to break down and cells are thus carried into the gland lumina and added to the gland secretion. In Text-figure 2 one of these breaks is shown. Here the external pressure has caused a gap in the wall and the flood of lymph has carried some of the epithelial cells with it. In other cases, as is shown in Text-figure 3, a larger area of the epithelium becomes invaginated and at last loses its connection with the wall altogether. The appearance is then presented of a ball or short rod of coagulated secretion wrapped in an envelope of flattened and distorted epithelial cells contained within the gland lumen.

These phenomena recall very vividly the formation of cellular secretion by invagination of the gland walls as recorded by Kolster and Bonnet for the horse and dog (see Jenkinson, 1913, fig. 142). If a gland be unable to dispose of the secreted material quickly enough or should its duct for some reason become blocked up, its cavity becomes distended to the relatively enormous dimensions mentioned above.

Leucocytes are a prominent feature of the gland secretion and are to be seen in many places making their way through the gland epithelium.

Lymph also makes its way to the uterine lumen directly through the uterine epithelium, without, however, greatly disturbing the latter. Obviously the pressure which would force the lymph into the glands with such destructive effect is considerable, and one can only liken the process to that of water being squeezed from a sponge. It appears, therefore, as if the force is exercised by the contraction of the circular musculature of the uterus which at this stage must have been subjected to some considerable stimulus. It is of some significance that this should happen in the pseudo-pregnant uterus at a stage which corresponds to a few hours before parturition in the pregnant uterus.

Pregnant uterus.—This contained an embryo, near full term, of the measurements given above. The allantois is quite small and does not enter into relationship with the chorion.



Text-fig. 2.—One of the glands of the left non-pregnant uterus of specimen *Bett.*, 11/9/24. The pressure of the lymph has caused a break in the wall and some of the epithelial cells have been carried inward with the flow of lymph.

Text-fig. 3.—A gland from the same uterus as the gland shown in Text-fig. 2. Here the invading lymph stream has actually invaginated a portion of the gland wall. Notice the reversed position of the cilia of the invaginated epithelium.

The wall of the uterus is greatly folded and into the grooves and crannies so formed the wall of the vesicle follows. In some cases these grooves approach very closely to the muscularis, there being only a small thickness of mucosa left between the two. Here the mucosa may measure only 0.2 mm. in thickness, while to the top of the folds it may easily be ten times as much. The mucosa is very uniform in appearance, consisting of a homogeneous plasma-like mass in which the glands and blood-vessels appear to float. Stroma cells are very few and are much scattered. Leucocytes are present, some bearing pigment, and there are occasionally to be seen erythrocytes. The lymph plasma is particularly aggregated in the tops of the folds where it stains deeply with eosin. The blood vascular supply shows its best development in the superficial region of the stroma where it takes the form of a very rich and continuous layer of capillaries. In these there is to be found a similar formation of pigment to that which occurs in the previous pregnant stage. Here, however, it is not so marked.

Epithelium.—Opposite the chorion the maternal epithelial cells are very thin and strap-like, with nuclei which cause the cell to bulge at its centre. This layer

is for the most part, then, no more than a thin investment covering the sub-epithelial capillaries. In other regions of the uterus the epithelium presents much the same characteristics.

Glands.—These are small, measuring about 0.055 mm. in diameter. The nuclei of the gland epithelium are small and condensed. Ciliation is not very marked. Cilia are not always present and, where they are found, neither the cilia themselves nor their basal granules stain very well. Further, there is no great evidence of secretory activity in the glands. In some there is present a homogeneous liquid secretion, to which may be added occasionally cellular detritus. Sometimes an expanded gland is to be met with, but the impression given is that glandular secretion does not play a very important rôle in embryotropic processes at this stage. However, wherever a gland is found pouring its secretion into the uterine lumen, the trophoblast cells can be seen to be actively absorbing the secreted material by means of pseudo-podial processes.

Foetal structures.—Over the full extent of the vesicle, with very little exception, the trophoblast is closely and intimately applied to the uterine epithelium. It is a case of union without intergrowth. This particularly occurs in the region of the vascular omphalopleure. In some places, especially over the mouths of active glands, the maternal and foetal tissues are separated by spaces which are filled with secretion.

The Chorion.—The trophoblast cells here, as over the remainder of the vesicle, are of very great size. Their nuclei are also large and are chromatically rich. These cells are true megalokaryocytes and the presence in their cytoplasm of pigment, of vacuoles, and of various granules with the inclusion of broken down cells and of leucocytes points to the same active processes of absorption being carried on as in the previous stage. Occasionally, an extravasation of blood occurs and, where this happens, active ingestion of the haematids by the trophoblast cells occurs.

The mesoderm of this region is a flattened layer with the nuclei spaced at intervals.

In the mesoderm of the vascular omphalopleure is contained a continuous layer of blood-vessels, and it is probably in this region that the most active processes of absorption are being carried on. The two blood-streams, foetal and maternal, are separated by the two epithelia, themselves very thin, and the two endothelia, of even greater tenuity. To these may be added, but not always, a small proportion of maternal connective tissue. The enormous size of some of the megalokaryocytes is remarkable. Their contents are similar to those of the megalokaryocytes of the chorionic area.

Bilaminar omphalopleure.—Here the trophoblast presents the same features as in other regions. The entoderm cells are large and extensively vacuolated. This, as I have already suggested in the case of *Perameles* (1923, p. 150), is probably due to the absorption of carbohydrate in this region of the yolk-sac placenta.

Stage 10. *Bett. F.*, 29/8/24. (Post-partum.) (Pl. xxi, fig. 20.)

This is the animal in which the right uterus served as an example of the stage representing the condition of oestrus. In the pouch was a newly-born embryo measuring 14.8 mm. in direct length.

This uterus contains remnants of the foetal membranes which are being actively absorbed. Mostly they are more or less free in the uterine lumen where absorption is in progress by the aid of enormous numbers of polymorphonuclear leucocytes.

Maternal structures.—It is remarkable with what rapidity repair has been effected. In some situations the uterus is almost normal, while in others regeneration processes are being carried on with the utmost rapidity.

The epithelium has undergone a remarkable transformation from its condition just before parturition. In the latter stage, it consisted of thin flattened cells placed end to end, thus forming a thin investment for the underlying blood-vessels and connective tissue. Now, however, where thoroughly regenerated, the epithelium consists of fairly high plump cells with the nuclei arranged in two or even three layers. Where regeneration is in progress many of the original epithelial cells are undergoing degeneration *in situ*. This consists mainly in the absolute dissolution of the cell which soon becomes an amorphous darkly staining mass (Pl. xxi, fig. 20, *d.c.*).

Regeneration of the epithelium is brought about partly by the growth and multiplication *in situ* of a number of the original cells. Partly also it results from the immigration of underlying stroma cells. Such cells undergo marked hypertrophy and subsequent division (Pl. xxi, fig. 20, *str. c.*). The formation of new epithelium by radial growth from the gland mouths as recorded by Hill for *Perameles* (Hill, 1897, p. 422) does not occur in *Bettongia*.

Where the epithelium is practically normal the cells are fairly high and the nuclei are arranged at one, two or three heights. The cytoplasm is vacuolated while the nucleus is vesicular, its chromatin being confined to one or two conspicuous particles.

Active proliferation is still being carried on, mitoses being very frequent. Cilia are quite common and are very robust, their basal granules being easily stained.

Stroma.—Although in some places the stroma is still largely infiltrated, in others it has practically returned to its normal condition. In such situations the glands are quite closely packed. Further, the stroma cells form a fairly compact layer below the epithelium. Although there is no doubt that these cells have increased somewhat in size and in many cases undergone division, there is no evidence of as great a growth and multiplication as is instanced by Hill in the case of *Perameles* at a corresponding stage (Hill, 1897, p. 240). In the blood-vessels, there is some thickening of the walls and in some cases this increase in thickness is almost or completely sufficient to obliterate the lumen of the vessel.

The glands have undergone considerable alteration. The gland cells have increased in size and their protoplasm has become greatly vacuolated. The nuclei have now become larger and more vesicular with a well-defined nuclear membrane. The glands are in many cases still engaged in the removal of lymphatic material and cell remnants. They are well ciliated, cilia being best observed at or near the mouths of the glands. In their basal portions are to be found many polymorphonuclear leucocytes. These are also to be seen in the stroma, and in the vessels.

SUMMARY OF CONCLUSIONS.

1. Breeding Habits, etc.

(a). The breeding season of *Bettongia* is known with certainty to extend over ten months of the year, from the beginning of March to the third week in December.

(b). *Bettongia* is polyoestrous.

(c). Ovulation is spontaneous and unilateral, one ovum being discharged at each ovulation.

(d). Pregnancy is unilateral and under normal conditions occurs alternately in each uterus.

(e). Gestation and lactation periods are each of about six weeks' duration.

(f). When breeding is active, the gestation and lactation periods overlap, i.e., a new pregnancy may occur while there is still present a pouch foetus.

2. Pregnancy and "Pseudo-pregnancy".

(g). While one uterus is pregnant the contra-lateral one enters into and remains in a condition of pseudo-pregnancy. This condition of pseudo-pregnancy persists till parturition, probably being brought about by the same hormones which control the pregnant uterus.

(h). During the first half of pregnancy the pregnant and pseudo-pregnant uteri are to all intents and purposes identical, both macroscopically and microscopically. Although ovulation is unilateral, the two uteri undergo quite similar changes during pro-oestrus, oestrus and early pregnancy.

(i). Ciliation of the epithelium of the uterus and glands is strongly developed in anoestrus, but later the surface ciliation tends to become suppressed. Gland ciliation persists quite well through the whole cycle.

(j). The uterine epithelium proliferates actively during pro-oestrus and oestrus, with the result that the cells become greatly crowded and are arranged at several heights. Thereafter there is little or no new cell formation. The increase in the extent of the internal surface causes the epithelium to become definitely single-layered. Towards the end of pregnancy this layer becomes very delicate, with the nuclei spaced widely apart.

(k). Other features of pro-oestrus and oestrus are increase of vascularity, tremendous oedema of the mucosa with infiltration of lymphatic material, and, following upon this, active secretion by the glands of liquid material and of cellular debris, the latter resulting largely from thrown-off gland epithelial cells.

3. "Pseudo-pregnancy".

(l). From mid-pregnancy onward the pseudo-pregnant uterus decreases slightly in size. This is due very little to loss of infiltrated material. The large difference in dimensions between the two uteri is mainly due to the mechanical effect of the presence of a growing embryo in the pregnant uterus.

(m). Mid-pregnancy is marked by the occurrence of well-marked regeneration processes in the epithelium of the pseudo-pregnant uterus and of the superficial portions of its glands.

(n). Infiltration of the mucosa persists until just before the stage of parturition.

(o). In the later stages the glands gradually lose their secretory function, becoming more or less inactive.

(p). A few hours before parturition occurs the whole wall of the pseudo-pregnant uterus becomes greatly disturbed. This is apparently due to stimulation of the uterine muscles, whose contractions cause the infiltrated material held in the mucosa to break through the walls of the glands and so be removed.

(q). Immediately after parturition has occurred and while the breeding season lasts, the pseudo-pregnant uterus enters into the stage of pro-oestrus.

4. Pregnancy.

(i.) Maternal Structures.

(r). As in the pseudo-pregnant uterus, infiltration of the mucosa endures throughout and the glands appear to lose their secretory importance.

(s). Embryotrophic material is present in abundance and consists mainly of a transudate from the epithelium with included epithelial cells, cellular debris, leucocytes and haematids.

(ii.) Foetal Structures.

(t). The amnion in *Bettongia* arises by folds, of which the head fold appears first.

(u). The allantois remains small and no allanto-chorion is formed.

(v). An efficient placenta is developed by the close apposition of the trophoblast to the uterine epithelium. Actual union without penetration occurs, being most marked and appearing first in the region of the vascular omphalopleure.

5. Parturition.

(w). Parturition occurs when the embryo measures about 14.5 mm. in direct length.

(x). The foetal membranes are retained in the uterus at parturition and are absorbed with the aid of maternal leucocytes.

DISCUSSION.

The genus *Bettongia* belongs to what is acknowledged to be a very specialized family of marsupials, the Macropodinae, and for that reason may be expected to exhibit highly specialized characteristics superimposed upon others which can be recognized as primitive.

In this discussion, I will confine myself to three points: (a) the condition of polyoestrus, (b) the placental arrangements, (c) the control of pregnancy.

(a). *The condition of polyoestrus.*

In Hill's monograph on the development of the Native Cat, *Dasyurus* (1910), it is stated that *Dasyurus* has only one breeding season in the year. Later (1913), Hill and O'Donoghue repeated this statement, and drew the inference that the monoestrous condition is the primitive one. However, still later (1918), the result of investigations on the breeding habits of *Didelphys aurita* raised doubts in Hill's mind as to the accuracy of his statement for *Dasyurus*. What is of some

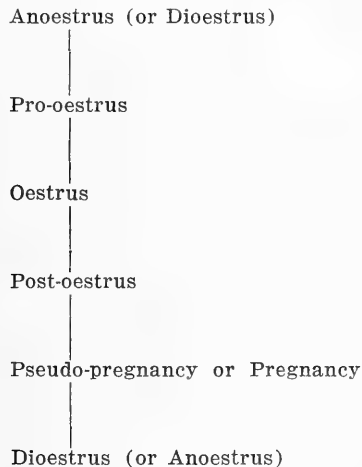
importance to us at the present juncture, also, is that he states, with regard to *Macropus ruficollis*, originally believed by him to be monoestrous, that it breeds "during August-September, and again during December-February, as soon as the young one has vacated the pouch or even before" (p. 102). This last statement shows that Hill had recognized the overlapping of the gestatory and lactatory periods in a Macropod.

As regards *Didelphys virginiana*, Hartman at first believed (1916) that this marsupial was monoestrous, but his later researches showed that in this belief he was wrong and that the Virginian opossum is definitely polyoestrous.

It is highly probable that *Dasyurus* is also polyoestrous, although I have no observations to offer on this point myself, and that the polyoestrous condition, as suggested by Hartman, is the more primitive.

The condition of polyoestrus as found in *Bettongia* offers considerable differences in detail from the conditions found in *Didelphys*. In the latter animal, at ovulation, a large number of ova are shed, some from each ovary. Should these be unfertilized, pseudo-pregnancy supervenes which lasts for some eleven days. After this comes a short dioestrous period which is followed again by the next pro-oestrus.

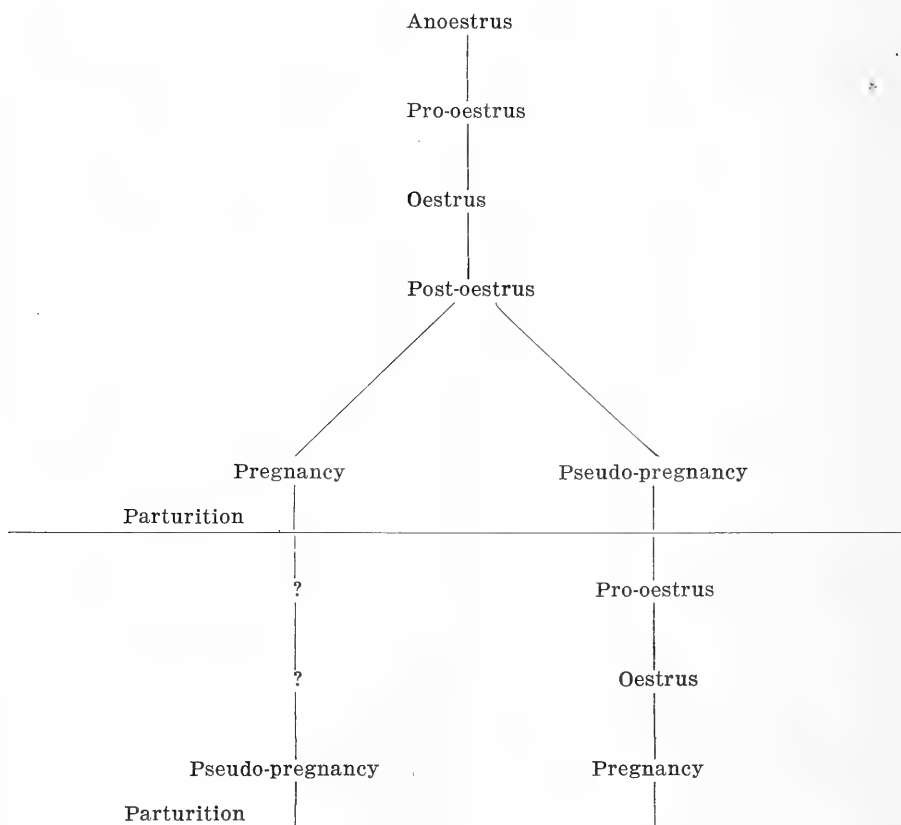
During the season, then, the cycle in *Didelphys virginiana* is as follows:



In *Bettongia* ovulation is unilateral and one ovum only is discharged. Except for this detail the non-pregnant cycle is not very different from that in *Didelphys*. After ovulation, in the non-pregnant female, pseudo-pregnancy of the two uteri supervenes (controlled apparently by the single corpus luteum) after which the organs return to the condition of dioestrus.

In a female undergoing successive pregnancies during the breeding season, the cycle becomes somewhat complex, since, while one uterus is pregnant, the other is pseudo-pregnant, and this goes on alternately throughout the season under normal conditions. The pseudo-pregnant uterus, so soon as parturition occurs

in the pregnant uterus, passes on to the pro-oestrous and oestrous stages. The cycle is therefore of the following type (commencing from anoestrus) :



Cycle of Pregnancy in Bettongia.

It will be seen from the above diagram that the cycle of pregnancy in *Bettongia* is very different from any yet described for a mammal and in fact is only possible in a monotocous marsupial. While the whole cycle is deserving of more intense and detailed study, it will also be seen that the post-partum changes undergone by the ex-pregnant uterus, at a stage in the cycle when the ex-pseudo-pregnant uterus is being influenced by pro-oestrous and oestrous stimuli, is, in the present state of our knowledge with regard to the origin of these stimuli, one particularly deserving of attention.

Finally, it may be conceded, I think, without difficulty, that in view of the nature of the cycle in *Didelphys*, the curious cycle found in *Bettongia* is a type of polyoestrus which must have been secondarily acquired simultaneously with the development of the monotocous condition from one primitively polytocous.

(b). *Placental arrangements in Bettongia.*

The evidence adduced by Hill (1897, 1899), Flynn (1923) and others is unquestionably in favour of the ancestral marsupial having been a placental

mammal. It is also unquestionable that *Bettongia* is a genus very far removed in many respects from the primitive type, and it might be expected that this specialization will be indicated in its placental arrangements. This is so, since in this marsupial the allantois remains quite small and an allanto-chorion, consequently an allantoplacenta, is never developed. Nevertheless, nutrition, respiration, and elimination of the waste-products of the foetus have to be arranged for and this is done by the development of a yolk-sac placenta of a very efficient type. This consists of the close apposition and, in places, of actual union, of the trophoblast with the prepared uterine epithelium. Definite union is particularly to be found in the region of the vascular omphalopleure. Between the foetal and maternal tissues, where separated, there occurs abundant "uterine milk" consisting of cell debris, leucocytes, haematids, lymph and other material, all being actively absorbed and ingested by the trophoblast cells.

As in other marsupials, at parturition, the foetal membranes remain behind in the uterus to be absorbed.

(c). *The control of pregnancy.*

It will be seen from the foregoing that the phenomenon of pregnancy (and pseudo-pregnancy) in *Bettongia* offers for solution interesting and complex problems, the elucidation of which may well help in the understanding of the sexual cycle in mammals in general.

The first half of pregnancy in this animal is characterized by identical changes in the two uteri, respectively pregnant and pseudo-pregnant. There are to be found, *inter alia*, definite identity in the alterations in the form of the epithelium of the uterine lining and of the glands, in the amount of lymph infiltration into the stroma and in the intensity of vascularization of the uterine tissue.

During the later stages of pregnancy, macroscopically and microscopically, the two uteri differ greatly. Macroscopically, the pregnant uterus increases greatly in size, this increase being due to the presence of the growing embryo. There is no increase in the amount of lymph infiltration over that found in the contralateral pseudo-pregnant uterus. At about mid-pregnancy, the surface epithelium, and that of the superficial portion of the glands, in the pseudo-pregnant uterus, undergo involution, but it is to these structures that involution is confined, for the stroma remains of the same turgidity and of the same vascularity until just near the stage of parturition. It would, therefore, seem as if two factors, at least, are concerned in the control of the uteri during pregnancy.

Detailed experimentation will be necessary before any certainty can be arrived at as to what these factors are and how they act.

As pointed out above, a further stimulus is evident just before parturition when the lymphatic contents of the wall of the pseudo-pregnant uterus are squeezed out and the wall collapses.

There are many other outstanding problems awaiting solution in this animal. The relation of pro-oestrus and oestrus to lactation, the overlapping of lactatory and gestatory periods, and the occurrence of ovulation (no doubt preceded by pro-oestrus and oestrus) in the immediate post-partum period are a few of the prominent questions whose solution, I am convinced, will help to a better understanding of the sexual cycle in the higher mammals.

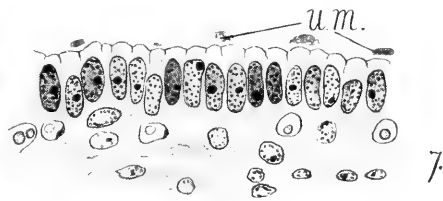
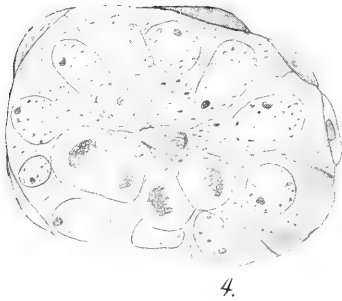
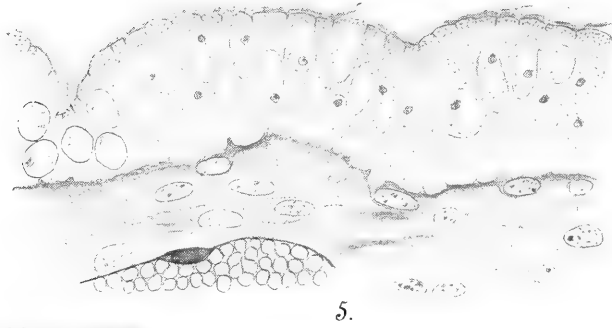
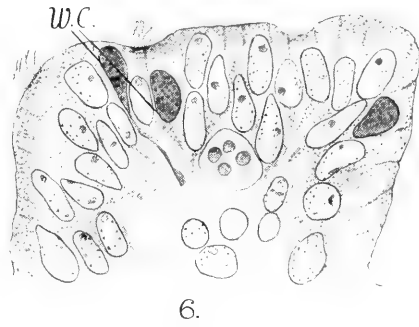
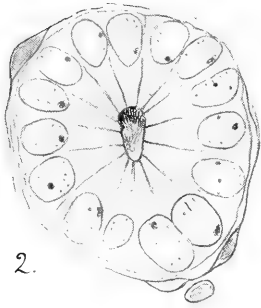
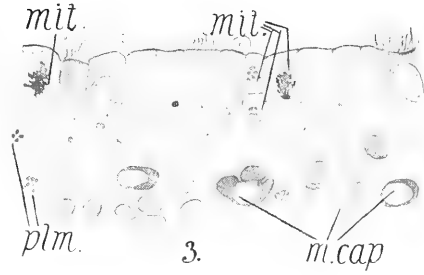
In speaking of the function of the corpora lutea, Parkes (1929, p. 175) says: "The ideal subject for experiments of this nature would be a small monotocous animal in which the ovary containing the corpus luteum could be readily removed, leaving intact the second ovary containing no corpus luteum, to carry on the other ovarian functions." In this, as in other respects (for example, the possession of two separate uteri), *Bettongia* seems to be eminently suitable, and for our knowledge of these and allied phenomena investigation and experimentation upon this animal hold great hope for the future.

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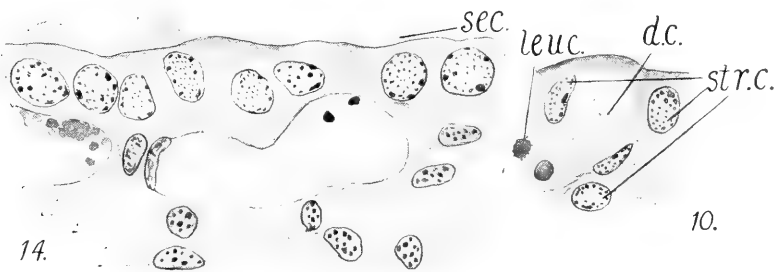
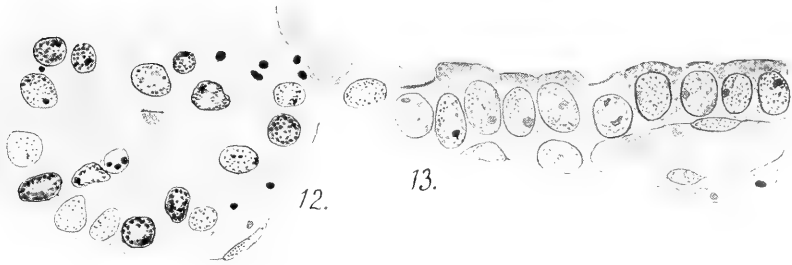
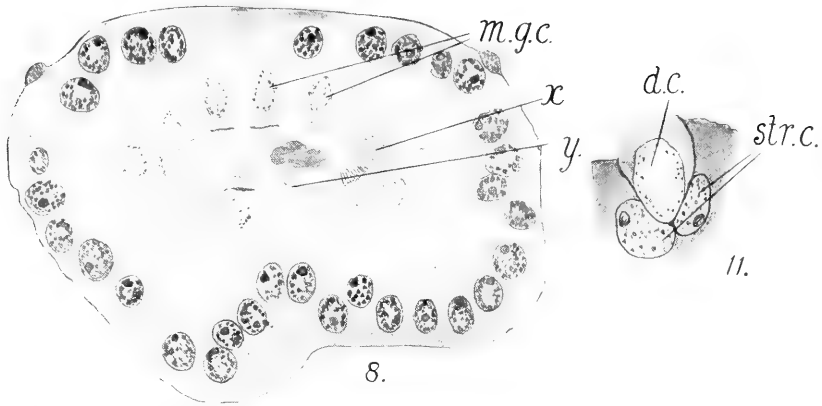
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EXPLANATION OF PLATES XIX-XXI.

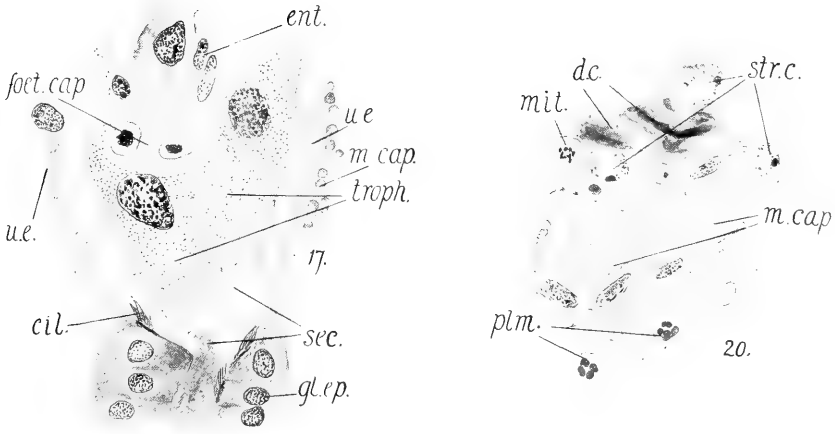
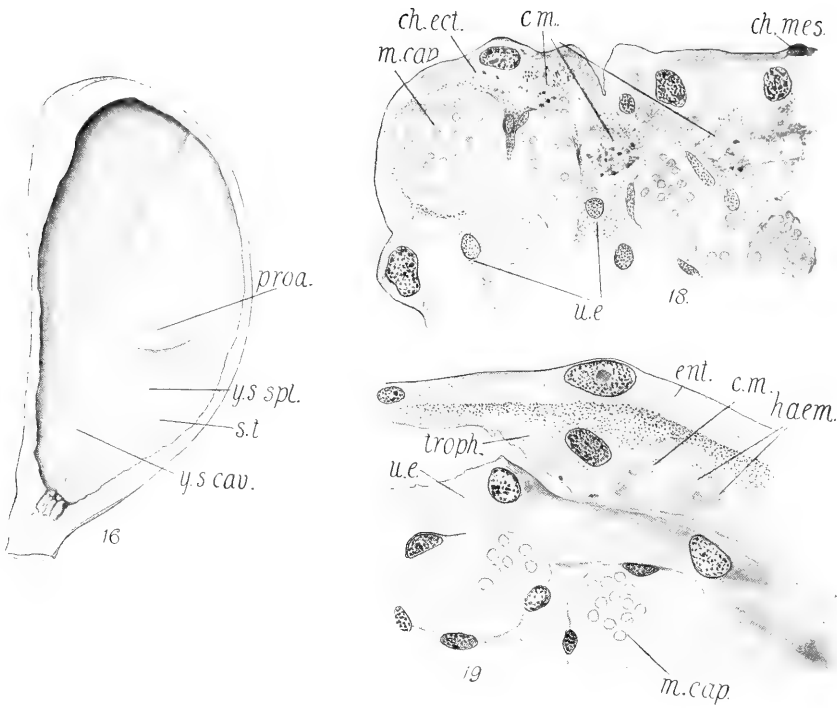
b.m., basement membrane; *cap.*, capillary; *ch. ect.*, chorionic ectoderm; *ch. mes.*, chorionic mesoderm; *cil.*, cilia; *c.m.*, cellular material in active ingestion by the trophoblast; *d.c.*, degenerating cell; *ent.*, entoderm; *foet. cap.*, foetal capillary; *gl. ep.*, gland epithelium; *haem.*, haematids; *leuc.*, leucocyte; *m. cap.*, maternal capillary; *mit.*, cell in mitosis; *mgc.*, migrating gland nuclei; *plm.*, polymorphonuclear leucocyte; *proa.*, proamnion; *sec.*, secretion; *s.t.*, sinus terminalis; *str. c.*, stroma cell; *troph.*, trophoblast; *u.e.*, uterine epithelium; *u.m.*, material secreted into uterine lumen (uterine milk);



T.T.F. del.



T.T.F. del.



T.T. del.

w.c., wandering (?) cell; *x* (fig. 8), remains of a degenerated gland nucleus as it passes into the gland lumen; *y.s.cav.*, yolk-sac cavity; *y.s.spl.*, yolk-sac splanchnopleure.

Plate xix.

Figs. 1, 2.—Stage 1. *Bett. E.*, 15/9/26. 1. Uterine epithelium with underlying stroma. 2. Transverse section of uterine gland.

Figs. 3, 4.—Stage 2. *Bett. F.*, 29/8/24 (right uterus). 3. Portion of the uterine epithelium and underlying stroma. 4. Cross-section of uterine gland.

Fig. 5.—Stage 3. *Bett. F.*, 19/9/24. Portion of uterine epithelium and underlying stroma of left uterus.

Fig. 6.—Stage 4. *Bett. A.*, 6/9/24. Portion of uterine epithelium and underlying stroma of right uterus.

Fig. 7.—Stage 5. *Bett. B.*, 30/8/24. Portion of uterine epithelium and underlying stroma (right uterus).

Plate xx.

Fig. 8.—Stage 5. *Bett. B.*, 30/8/24. Cross-section of a uterine gland showing inward movement of nuclei accompanied by degeneration. At *x* is shown the last remnants of a nucleus as it passes into the lumen. At *y* is a portion of a gland cell about to be desquamated into the gland cavity.

Figs. 9-13.—Stage 6. *Bett.*, 2/9/24. 9. Portion of the epithelium of the right, non-pregnant uterus showing degeneration of epithelial cells and the movement upward of stroma cells to help form a new epithelium. 10 and 11. Degeneration *in situ* of epithelial cells of the non-pregnant uterus, the latter figure showing the contents of the cell being thrown into the uterine cavity. 12. Cross-section of the upper portion of a gland in the non-pregnant uterus, showing active involution in this region. 13. Epithelium of pregnant uterus with underlying stroma.

Fig. 14.—Stage 7. *Bett. E.*, 14/9/24. Portion of the epithelium of the pregnant uterus with underlying stroma.

Fig. 15.—Stage 8. *Bett. G.*, 11/9/24. Portion of the epithelium of the non-pregnant uterus with underlying stroma.

Plate xxi.

Fig. 16.—Stage 8. *Bett. G.*, 11/9/24. Internal view of the mesial half of the pregnant uterus.

Figs. 17-19.—Stage 9. *Bett. B.*, 11/9/24. 17. Section showing active absorption, by the trophoblast cells of the vascular omphalopleure, of secretion from a uterine gland. 18. Section showing an area in which the chorion is fused to the uterine epithelium and in which active ingestion by the chorionic ectoderm of extravasated blood corpuscles and other cellular material is in progress. 19. Close apposition of the bilaminar omphalopleure to the uterine epithelium and ingestion by the former of haematids and other cellular material.

Fig. 20.—Stage 10. *Bett. F.*, 29/8/24. This shows degeneration of uterine epithelium and the movement upward of stroma cells to form new epithelium. Notice cells in mitotic division and the enlargement of the endothelial cells of the maternal capillaries.

NEW GUINEA AND AUSTRALIAN COLEOPTERA.

NOTES AND NEW SPECIES.

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

(Thirteen Text-figures.)

[Read 26th November, 1930.]

The close geographical relationship existing between the Australian Continent and the Austro-Malayan Islands gives a particular interest to the study of the New Guinea Fauna. Australian Museums can do good work in the furtherance of this study and Mr. A. M. Lea of the South Australian Museum is to be congratulated on his appreciation of this importance by the extensive insect collections from New Guinea that he has directed to the Adelaide Museum.

Our generous patron, Sir William Macleay, was well aware of the value of this study and the "Chevert" Expedition, organized by him, with its resultant additions to our zoological knowledge, set a notable example to our naturalists. He further contributed two papers on the entomology of New Guinea—"The Insects of the Macleay Coast" (1884) and "Insects of the Fly River (Coleoptera)" (1886).

The Tenebrionidae and Buprestidae (also one Dryopid) collected for the South Australian Museum have been sent me for determination. These scarcely bear out Macleay's remark as to the "limited Coleopterous Fauna of the Island", since there are 136 species of the first and 36 of the second, and these numbers are slightly increased by the examination of collections in the Australian Museum, Sydney, and the National Museum, Melbourne. The single member of the Dryopidae sent is especially interesting as being a close ally of the monotypic *Stetholus elongatus* Cart., from Dungog, New South Wales—a strongly differentiated genus, so far unrecorded elsewhere. The above were mostly collected by Mr. C. T. McNamara at Mt. Lamington, Buna District, and the Rev. L. Wagner in the Finschhafen District. The absence of named collections from the Austro-Malay Islands, together with the difficulty of obtaining much of the older literature dealing with this fauna, has prevented my doing as effective work as I could wish.

In the Tenebrionidae the thorough work of Gebien in "Résultats de l'Expédition Néerlandaise, 1920", together with that author's gifts of many specimens, including cotypes, to me, has made it possible to identify a considerable number. Except in a few cases, which seemed to me beyond doubt, I have thought it undesirable to describe species as new, since continual cases of proved synonymy show a wider range for insects than was formerly supposed. Thus a few beetles are known to range from India to Australia (see *Amarygmus morio* F. below). Again *Pentaphyllus bifasciatus* Geb., described from the Philippine Islands, was amongst those collected by Mr. McNamara on Mt. Lamington, S.E. Papua. The extension of the Australian genus *Stigmodera* to New Guinea is not surprising. I have seen others in the collection of Monsieur Théry.

I am indebted to Mr. J. L. Wassell for the drawing of *Stigmodera ariel* and details of other species.

Family BUPRESTIDAE.

STIGMODERA (CASTIARINA) APICENOTATA, n. sp. Text-fig. 1.

Oblong-ovate; head, pronotum, underside, and legs coppery-bronze, above with a reddish tinge, darker beneath; underside densely silvery-pilose; elytra yellow with the base narrowly, suture, two fasciae and the apex widely, violaceous blue-black, the apical mark with two small yellow spots; the premedial fascia bifurcate laterally, the anterior branch extending to the basal angle, the hinder branch also reaching margin; both fasciae enlarged at suture; antennae green.

Head excavate and channelled, densely punctate. Prothorax: Apex nearly straight, base lightly bisinuate, anterior angles obtuse, the posterior slightly produced and acute, rather strongly convex, widest at middle, sides evenly and widely rounded; disc densely and evenly punctate, the punctures larger and sparser near hind angles; medial line laevigate throughout and terminating behind in a small foveate puncture. Scutellum scutiform, concave and laevigate. Elytra of same width as prothorax at base, lightly enlarged at shoulder, moderately compressed behind this; apices with a small semicircular lunation between two short spines; subapical margins serrulate; striate-punctate, the striae punctures evident; intervals very convex at sides and apex, flatter near suture, with a few perceptible punctures; sculpture of underside obscured by dense pubescence.

Dimensions: 10-12 × 4-4.5 mm.

Habitat.—Queensland: Rockhampton.

Three examples, two ♂, one ♀, have an elytral pattern very like that of *humeralis* Kerr., especially in the case of the variation mentioned below, but differ from that species in the less elongate and attenuate form, the pronotum without yellow margins, and the more strongly pilose underside, besides the very differently shaped prothorax. In one example the premedial fascia is only represented by a diamond-shaped spot on the suture, and the arcuate shoulder mark.

Holotype and allotype in the South Australian Museum.

STIGMODERA (CASTIARINA) SUBGRATA Blkb. var. DISCOFLAVA Cart.

Two examples from Stanthorpe, Queensland, in the South Australian Museum deserve a varietal name as above. In these the metallic-green has invaded the greater part of the elytra leaving only the following yellow areas: the margins throughout, a discal triangular mark, representing the medial fascia, and a short narrow preapical fascia not reaching the yellow border nor quite extending to the suture.

STIGMODERA ARIEL, n. sp. Text-fig. 2.

Narrowly oblong; head, antennae, pronotum, scutellum, underside and legs bright metallic-green; elytra coppery-violet with two round spots near base; two premedial spots longitudinally oval, narrowly connected with a wide oblique lateral spot behind shoulder extending to sides; a short postmedial fascia extending to sides, widely interrupted at suture and two oval preapical spots yellow.

Head rather deeply excavate and canaliculate. Prothorax: Apex truncate, base moderately bisinuate, anterior angles depressed and obtuse, posterior acute, widest at base, thence arcuately converging to apex; disc closely, finely punctate, medial line suggested by sparser punctures; three lightly impressed foveae, one

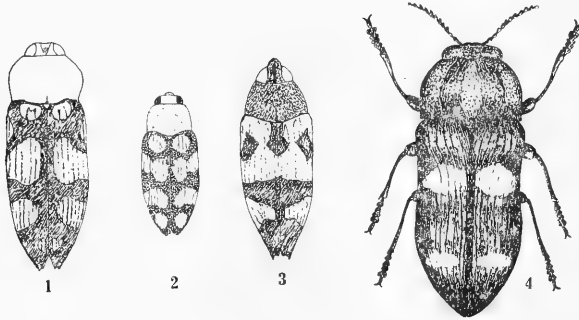
mediobasal, the other two symmetrically placed near middle. Elytra rather flat, striate-punctate; intervals only convex near apex, not perceptibly punctate; apices bispinose, with an oblique lunation, with a short sutural and rather long exterior spine; margins entire. Underside glabrous, finely punctate, apical segment rounded.

Dimensions: 7 × 2.5 mm.

Habitat.—New South Wales: Dorrigo (Dr. R. J. Tillyard).

A single example (? ♀) of a very distinct species which has been in my collection since 1912; I refrained from describing it earlier in the hope of obtaining more material. It is nearest *S. parva* Saund., in general facies, but differs from that species in narrower prothorax, the junction of the medial spot with lateral, and the extra preapical pair of yellow spots, the margins not widely yellow and the more distinctly bispinose apex.

Holotype in Coll. Carter.



- 1.—*Stigmodera (Castiarina) apicenotata*, n. sp.
- 2.—*Stigmodera ariel*, n. sp.
- 3.—*Stigmodera (Castiarina) bogania*, n. sp.
- 4.—*Stigmodera (Castiarina) dryadula*, n. sp.

STIGMODERA (CASTIARINA) BOGANIA, n. sp. Text-fig. 3.

Ovate attenuate in front and behind; head, pronotum and underside dark-bronze; elytra yellow, with black markings as follow: rather wide mark behind scutellum, terminating at basal fourth in a diamond-shaped spot, a comma-shaped post humeral mark, arcuately extending backwards from humeral callus to margin, a rather narrow, straight, postmedial fascia, extending the full width of elytra, having a bisinuate outline on each edge and a squarish apical patch.

Head rather narrow, strongly punctate, deeply excavate. Prothorax: Apex truncate, base lightly bisinuate, widest at base, sides arcuately narrowed to apex, all angles subacute; medial line smooth and depressed on basal half; rather irregularly punctate, closely in front, more sparsely at sides and base.

Elytra lightly enlarged at shoulders and behind middle, constricted at basal third, markedly attenuate behind; somewhat uniformly striate-punctate, intervals lightly convex on apical half; subapical margins entire, apices a little divergent and strongly bispinose, with long exterior spine.

Dimensions: 10 × 3.5 mm.

Habitat.—New South Wales: Bogan River (J. Armstrong).

A single ♂ example, generously presented by the above-named keen young entomologist, shows a species near *obscura* Saund., and *atricollis* Saund., but

differs from these by the narrowed prothorax and the attenuate apex, this unusually strongly bispinose, very much as in *caudata* Kerr., *insignis* Blkb., and *coeruleipes* Saund. It is probable that other examples will have the three premedial marks joined to form a fascia.

Holotype in Coll. Carter.

STIGMODERA (CASTIARINA) DRYADULA, n. sp. Text-fig. 4.

Head golden-green; pronotum blue with medial vitta and sides brilliantly golden; elytra peacock-blue with four transversely oval spots yellow, two premedial, two postmedial, the former the larger; underside golden-green; antennae and legs blue.

Head lightly channelled and excavate, forehead finely, closely punctate.

Prothorax lightly bisinuate at apex and base, sides lightly rounded, widest at middle, thence converging and depressed to apex, subparallel to base; anterior angles subacute, posterior rectangular; disc regularly and closely punctate, the punctures finer on medial vitta and larger on sides.

Elytra widest at shoulders, thence sinuately compressed and again widened, then narrowing to apex, each with a single sharp spine (forming continuation of third interstice), suture scarcely produced, finely striate-punctate, very small punctures in striae, intervals flat on greater part, the third, fifth, seventh and ninth sharply raised on apical third; subapical margins entire.

Dimensions: 7.5 × 2.5 mm.

Habitat.—New Guinea: Wareo, Finschhafen (Rev. L. Wagner).

A lovely little species, unique, suggesting *S. cydista* Rainb., by its golden-sided pronotum, and *S. pulchella* Cart., in colour but with yellow spots different in number and position.

Holotype in South Australian Museum.

STIGMODERA (CASTIARINA) QUADRIPLAGIATA, n. sp. Text-fig. 5.

Widely oblong-ovate; head (partly), prothorax, elytra and abdomen brick-red, with the following markings peacock-blue: head with forehead more or less suffused with blue, pronotum with an irregular and rather wide basal band, elytra with a similar basal band irregularly enlarged around the scutellum (in the ♂ this mark smaller than in the ♀ example), two large postmedial spots and apex wholly covered—this mark with anterior margin straight. Underside blue, except the prothoracic episterna and abdomen, which are red, the last with basal, and extreme apical, segment mostly blue. Legs blue, antennae green.

Head strongly punctate, widely excised between eyes. Prothorax widest behind middle, thence gently narrowed to base, more strongly so to apex, the latter slightly advanced at the angles, these acute (seen from above); base strongly bisinuate, with wide medial lobe and angular excisions; posterior angles rectangular; disc strongly and closely punctate, the punctures larger near base and sides; a marked medial sulcus and depression on basal half. Scutellum scutiform, concave and laevigate. Elytra of same width as prothorax at base, widening at shoulders, lightly compressed at anterior third, apices entire, separately rounded; subapical margins finely serrulate, striate-punctate; seriate punctures more distinct towards sides, intervals uniformly strongly convex throughout, and closely punctate; underside glabrous, prosternum coarsely, metasternum moderately, abdomen finely, punctate.

Dimensions: 15 × 6 mm.

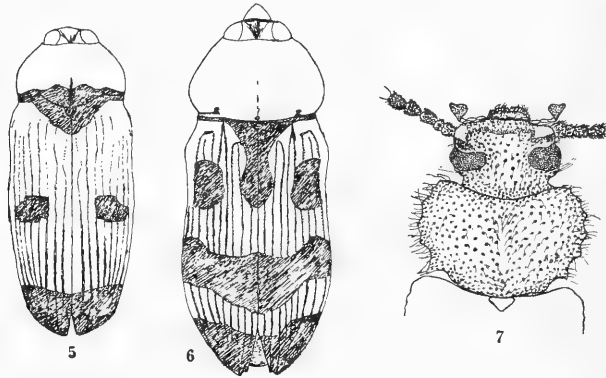
Habitat.—Queensland: Bowen (A. Simson).

A pair, the sexes of this fine species, is from the collection of the late Augustus Simson and is clearly distinct from *trimaculata* Saund., though the form of prothorax, and elytral pattern are somewhat alike. Its chief distinctions are (1) general colour brick-red instead of testaceous, (2) markings of upper surface are bright-blue instead of black, the pronotal spot of *trimaculata* is transferred to the base of the elytra, (3) the apices of elytra entire instead of being armed with a strong external spine and (4) the red abdomen. The base of pronotum appears also to be different, having "a narrow small median lobe" and, if Saunders' figure be correct, without marked excisions.

Holotype and allotype in the South Australian Museum.

STIGMODERA (CASTIARINA) MACKAYANA, n. sp. Text-fig. 6.

Oblong-oval, robust; head and prothorax bright greenish-bronze, the latter with a violaceous tinge in the middle; elytra yellow with bright violet markings as follows: basal margin narrowly, a wide sutural mark surrounding scutellum,



5.—*Stigmodera (Castiarina) quadriplagiata*, n. sp.

6.—*Stigmodera (Castiarina) mackayana*, n. sp.

7.—*Pseudolypros australiae*, n. sp.

produced and enlarged on basal fourth, two large oval spots on each side of this enlargement, an arcuate postmedial fascia extending to sides, much enlarged on suture and an arcuate apical mark; antennae, scutellum and prosternum bronze-green; abdomen red, here and there suffused with green, legs blue.

Head rather closely punctate, widely excavate between eyes. Prothorax: Apex lightly, base moderately, bisinuate, the former slightly advanced at middle, more so at angles, these acute, the base with a pronounced fovea at each excision; smooth medial line also terminated in a smaller fovea; posterior angles obtuse; sides subangulately widened at basal third, thence converging each way, more strongly in front; disc closely, unevenly punctate, the punctures larger and sparser near base and posterior angles, smaller and more crowded on anterior area. Scutellum pentagonal, punctate. Elytra slightly produced and subdentate at basal angles, of same width as prothorax at base, enlarged at shoulders, lightly compressed behind these; apices bidentate, exterior tooth longer, with a small arcuate lunation; subapical margins serrulate; striate-punctate, seriate punctures large, close and evident, intervals rather widely convex, more strongly so behind,

and closely punctate. Underside glabrous; prosternum finely, metasternum more strongly, punctate; abdomen minutely strigose, just perceptibly punctate.

Dimensions: 18 × 7 mm.

Habitat.—Queensland: Mackay.

A single example (? ♀) is from the South Australian Museum. In shape of prothorax, and pattern of elytra it is not unlike the figure of *S. blackburni* Cart. (*Trans. Roy. Soc. S. Aust.*, 1916, fig. 12), which is a wider species, without the sutural mark near scutellum, and with a differently-shaped apical mark. It is also near *rubriventris* Blkb.—a smaller western species with different apical markings and structure *inter alia*.

Holotype in the South Australian Museum.

Family TENEBRIONIDAE.

LEIOCHRODES VARIABILIS, n. sp.

Hemispherical, very nitid; head, pronotum, scutellum, underside and appendages black, except for a narrow lateral area of pronotum, epipleurae and two basal segments of antennae yellow or reddish; elytra fulvous with ten, variably large, black maculae as follows: an elongate dumb-bell-shaped sutural mark extending from base to apical declivity, followed, at short interval, by an apical sutural mark, like an inverted T, with transverse bar at apex; a large irregular shoulder mark, a subreniform latero-apical mark on apical half, separated narrowly from sutural marks, and two spots, one behind the other, between the lateral and sutural marks.

Head: Eyes rounded and rather prominent, antennae closely segmented, two basal segments short, third longer, subconic; the rest subequal. Prothorax: Apex and base very widely sinuate—base more obviously so—all angles rounded off, a very narrow, horizontal, lateral explanation, disc mirror-like without perceptible punctures. Scutellum transversely triangular, rounded behind. Elytra with some indistinct lines of punctures showing on pale area, otherwise without perceptible sculpture; a very narrow, horizontal border seen from above near shoulder only, this continuous to near apex, but concealed from above by convexity. Prosternum with fine, little-raised carina, channelled on each side; legs stout and short, femora not quite reaching sides—tarsi combined as long as tibia—clothed beneath with reddish hair; post tarsi with basal segment rather shorter than the rest combined.

Dimensions: 3-3.5 × 2.5-3 mm. (approx.).

Habitat.—Queensland: MacPherson Range—Queensland National Park (A. J. Nicholson and the author), Tambourine Mountain (H. Hacker); N. S. Wales: Clarence River (H. W. Cox).

The elytral pattern is very variable, the maculae tending to coalesce, so that in some examples only a few pale spots occur; but in most cases the typical pattern can be discerned. The epipleurae have the translucent redness seen in some thick glass bottles. It is apparently allied to *L. octomaculatus* Westw., from Borneo, from which its dark legs and different elytral pattern distinguish it. It occurs on the trunks of trees and readily escapes notice by its harmony with its surroundings. This is the species hitherto erroneously determined by me as *Derispia coccinelloides* Westw., a very different insect, from Ceylon, which must be eliminated from my Check-list (*Aust. Zool.*, 1926, p. 135), an example of which has recently been courteously sent on loan by my friend Gebien.

Leiochrodes suturalis West.—a widely distributed species throughout the Malayan islands and Australia—is the only other member of the genus so far

recorded from Australia. I have found this amongst fallen leaves and under wood refuse, always on the ground, from Sydney to North Queensland.

Pseudolypros australiae, n. sp. Text-fig. 7.

Brownish-black; nitid; margins of prothorax reddish; whole upper surface clothed with long, upright, pale-red hair.

Head rather strongly, not densely, punctate; form, also antennae, very much as in figure of *P. carinicolis* Geb., but forehead wider, apical segment of maxillary palpi securiform. Prothorax at its widest as wide as elytra, width less than twice the length, apex gently arcuate to the obtuse front angles; sides scalloped with five bays, the two apical equal and indistinctly separated by a minute tooth; the next two, at middle, wider and deeper, limited by distinct teeth, the fifth at base widest and deepest, limited by sharp, prominent, posterior tooth; margins sub-explanate; base strongly bisinuate, with wide medial lobe; disc rather flat, without medial line or fovea; cellulose-punctate, covered with round, almost contiguous punctures, these larger towards sides, here and there showing subrugose intervals. Scutellum large, transversely triangular. Elytra much wider than prothorax at base and sinuately adapted to it. Shoulders well rounded and slightly advanced; sides parallel, apex pointed, margins narrowly horizontal, extreme border entire, with a row of close large punctures within; the whole rather closely covered with punctures as on the pronotum, these smaller and slightly sparser near middle, towards sides showing some tendency to rugose intervals, without any sign of longitudinal or seriate arrangement. Legs hairy, abdomen wanting.

Dimensions: 7 × 3 mm.

Habitat.—North Australia: Newcastle Waters (T. G. Campbell).

A single example sent from the Division of Economic Entomology of the Council for Scientific and Industrial Research, Canberra, is interesting as being the first of the genus and second of its Subfamily (Heterotarsinae) to be recorded from Australia. Though the abdomen is mutilated, it is in a sufficiently good condition for description. The tarsi are very much as in Gebien's figures of the tarsi of *P. carinicolis*, but both pronotum and elytra are quite different, nor can the species be near any of the five tabulated in the "Résultats de l'Expédition Néerlandaise à la Nouvelle-Guinée".

Holotype in the Museum of the Division of Economic Entomology, Canberra.

PTEROHELAEUS WAGNERI, n. sp.

Ovate, very nitid black, legs piceous, apical segments of antennae, tarsi, pro- and epipleurae reddish.

Head closely and minutely punctate, epistoma truncate in front, obliquely widened at sides; antennae: 3 sublinear, longer than 4, 4-6 pyriform, 7-10 transverse, 11 subspherical. Prothorax nitid, only microscopically punctate, anterior angles produced, rounded at apex, posterior acute, margins widely explanate. Scutellum transversely triangular. Elytra wider than prothorax at base, lightly oval, explanate margins wide and slightly concave; irregularly and coarsely seriate-punctate, with about 14 lines of large rounded punctures of unequal size, besides a short scutellary row of small punctures and a submarginal row of coarse punctures, delimiting the explanation, the punctures of the four sutural rows smaller than the rest. Prosternum finely rugose, abdomen longitudinally strigose.

Dimensions: 11 × 7 mm.

Habitat.—New Guinea: Komba (Rev. L. Wagner).

Three examples sent, with other Tenebrionidae, for determination show a very distinct species, nearest as to nitid surface to *P. nitidissimus* Pasc., from which it differs strongly in its coarser sculpture and more oval form. It belongs to Macleay's Sub-Section iii. The only other species that I can find recorded from New Guinea is *P. papuanus* Geb., which belongs to Macleay's Section i.

Holotype and paratype returned to the South Australian Museum. One paratype in Coll. Carter.

HELAEUS PERLATUS, n. sp.

Widely, somewhat squarely, ovate; black, subnitid.

Head wanting. Prothorax (7×13 mm.): Base bisinuate, its margins serrulate, sides semicircularly narrowed from base to apex, apical processes wide and overlapping; extreme margins revolute and narrow, edges (seen sideways) undefined (sublaminate), posterior angles acutely falcate; lateral foliation wide and concave, the discal part less than half the total width at base; disc almost smooth, but minute granules can be seen with a lens, especially on the foliation; a strong medial carina bluntly rounded at highest point of convexity near base, the carina depressed at middle. Scutellum convex, widely triangular. Elytra narrower than prothorax at base, very convex, sides subparallel for the greater part, widely rounded behind; lateral foliation wide, extreme margin strongly raised throughout, edges (seen sideways) clearly defined and concave; disc with two strongly raised, parallel costae, starting from base, terminating on apical declivity, the suture also carinate throughout; a row of large punctures at the base, on each side of suture and costae, also within the extreme lateral margins; surface in general irregularly punctate, with minute pustules interspersed. Underside minutely and sparsely pustulose. Legs wanting.

Dimensions: 18×14 mm.

Habitat.—Western Australia: Eradu (near Geraldton) (H. J. Carter).

I found several fragments of this species in September, 1926, of which the above is sufficiently perfect to warrant its description. Clearly distinct by the combination of size, squarish form and high convexity, it is nearest in general facies to the obovate *H. occidentalis* Cart., in Section iii of my Revision (These Proc., 1910, p. 93). The elytral costae are 3.5 mm. apart.

Holotype in Coll. Carter.

ONOSTERRHUS HACKERI, n. sp.

Widely ovate, black, opaque above, nitid beneath; antennae and tarsi piceous red, in one example (? male) a thin line of red tomentum on hind tibiae.

Head and pronotum not perceptibly punctate, epistoma truncate, its angles rounded off, its sides sinuately connected with curve of canthus, and with two large shallow depressions within front margin, antennae rather slender, 3 less than twice as long as 4, 5-8 triangular, 9-10 round, 11 oval. Prothorax widest at middle, apex arcuate-emarginate, base bisinuate, sides well rounded without definite sinuation; lateral border thick, raised and widely channelled within, anterior angles rather widely acute, the posterior produced and rather sharply dentate; apex and base without border, base with triangular excision half-way between scutellum and hind angles. Scutellum transversely triangular. Elytra nearly as wide as long, wider than prothorax at base, a very narrow margin, invisible from above; without definite sculpture of any kind, even the usual line

of lateral punctures absent, or scarcely indicated in one example. Mentum widely subovate, tooth of submentum flattened, broadly widened at apex and pointing obliquely forward; sterna and epipleurae smooth, abdomen longitudinally strigose.

Dimensions: 13-14 × 8-9 mm.

Habitat.—South Australia: Tarcoola (H. Hacker).

Three examples examined, two of which have been long in my cabinet. The third was sent from the Zoologische Museum, Hamburg, for determination. It is nearest *O. acuticollis* Cart. in form, but is easily distinguished by the much thicker margins of pronotum, its less sharply produced anterior angles, the absence of the lateral row of punctures on the elytra and its more opaque surface. It is shorter and wider than *O. lugubris* Blkb. *O. duboulayi* Cart., from Western Australia, has sinuate sides to the prothorax, besides being much larger and with a nitid surface.

Holotype and allotype in Coll. Carter. Paratype in Hamburg Museum.

NEOTHECA, n. gen. Cnodaloninarum.

Body elongate, subcylindric, winged, surface non-metallic.

Head very much as in *Chariotheca*, eyes round (seen from above) and prominent, cheeks narrower than eyes; mentum with scarcely perceptible keel near base, last segment of maxillary palpi securiform, of labial palpi ligulate. Antennae short, basal segments slender and short, 3 slightly longer than 4; 7-10 oval, increasingly transverse, 11 much the largest, oval. Prothorax subquadrate, apex subtruncate between lightly advanced anterior angles (feebly advanced in middle); base feebly bisinuate, sides a little rounded and explanate with reflexed border, apex without border, base with very narrow border. Elytra striate-punctate. Epipleurae continuous to apex. Prosternum convex, its process—with corresponding triangular receptacle in the mesosternum—short. Legs rather short and stout, front tarsi having apical segment nearly as long as the rest; post tarsi with first shorter than fourth, second longer than third.

A genus with the general form of *Thesilea* or of certain *Chariotheca*, but differing in its expanded sides of prothorax and non-metallic surface.

Genotype, the following species.

NEOTHECA FUSCA, n. sp. Text-fig. 8.

Cylindric, head and pronotum subnitid black, the latter sometimes reddish at sides and apex, elytra, underside and legs reddish-brown, tarsi, antennae and palpi pale-red.

Head short and wide, labrum prominent, epistoma rounded and continuous with the horizontal antennal orbit, separating groove indistinctly impressed, antennae not extending to middle of prothorax; surface densely punctate. Prothorax transverse, rather flat, width to length as 5 to 3; anterior angles advanced and a little obtuse; widest about middle, sides more rounded anteriorly, posterior third nearly straightly, sometimes a little sinuately, narrowing to base; hind angles obtuse, a moderately wide lateral border, extreme margin showing small crenulate irregularity near middle—seen more clearly from below—disc densely cellulose-punctate, subrugose near apex and sides, with a tendency to longitudinal coalescence of the punctures. Scutellum semicircular, laevigate. Elytra rather convex laterally, little wider than prothorax, shoulders oblique, humeral swelling inconspicuous; sides parallel, jointly rounded at apex, striate-punctate, the striae narrow, in general shallow but deepened on apical declivity; the seriate punctures

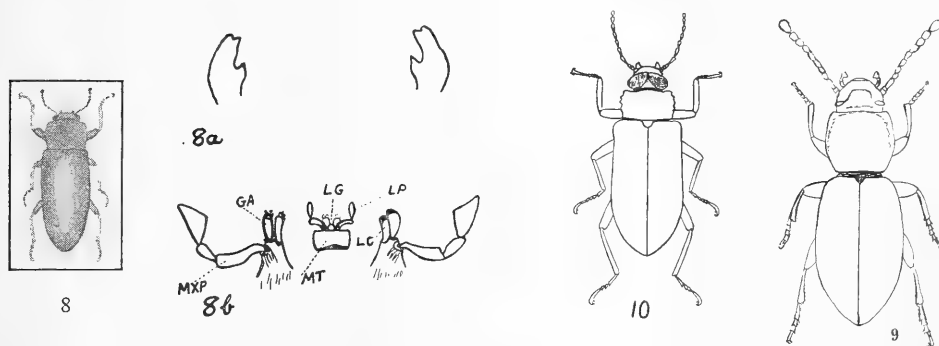
elongate, evenly spaced and evident to apex; intervals wide, strongly punctate, nearly flat at the middle, moderately convex at base and strongly so towards apex. Tibiae slightly curved; underside punctate, pro-, meso-, and metasternum strongly and closely, abdomen finely and less closely, femora also closely, punctate.

Dimensions: 7-9 × 2.5-3.5 mm.

Habitat.—New Guinea: Mt. Lamington, 1,300-1,500 feet (Buna District) (C. T. McNamara).

Twenty-nine examples sent from the Adelaide Museum were not referable to any genus known to me. I therefore sent an example to my friend Gebien who courteously replied: "Evidently a new genus of Cnodalonidae somewhat related to *Thesitea*". The smaller examples examined were males.

Holotype and paratypes in South Australian Museum.



8.—*Neothecha fusca*, n. sp. 8a, Mandibles (× 12); 8b, Mentum and Maxilla (× 16). *ga*, galea; *lc*, lacinia; *lg*, ligula; *lp*, labial palp; *mt*, mentum; *mXP*, maxillary palp.

9.—*Licinoma oblonga*, n. sp.

10.—*Ebenolus serraticollis*, n. sp.

LICINOMA OBLONGA, n. sp. Text-fig. 9.

Elongate, subcylindric, nitid bronze-black, glabrous. Legs, antennae and tarsi (except under surface) black.

Head with sparse round punctures on front and near eyes, with deep, rhomboidal impression on forehead, its suture straight; eyes large and transverse, antennal joints oval, 3 a little longer than 4, enlarging from 7 outwards, 11 wider than and half as long again as 10. Prothorax not much wider than head; truncate at apex, slightly arcuate at base, widest in front of middle, sides feebly arcuate and considerably narrowed to base; front angles depressed and rounded, posterior widely obtuse, lateral margin narrow, bearing a few setae; disc very finely closely and evenly punctate, a shallow depression at centre near base, within this a short smooth portion of a medial line; a large setiferous puncture well within each hind angle. Scutellum small. Elytra elongate-oblong, two and a half times as long as the prothorax; humeri subobsolete, punctate-striate, seriate punctures small and little obvious, intervals minutely punctate, slightly convex and of uniform width, strongly so at sides and apex, the third with two setiferous punctures at wide intervals on hinder half. Underside smooth; tibiae of male lightly curved, fore tibiae with narrow fringe of tomentum.

Dimensions: 9-12 × 3-4 mm.

Habitat.—South Queensland: Bunya Mountain (H. J. Carter).

Three examples (one much larger than the other two) taken by myself, October, 1919, during the visit of the Ornithologists' Union to this beautiful range. The species is nearest to *L. elata* Pasc., which is of a paler bronze, with red antennae and tarsi, prothorax more widened and rounded at middle and more coarsely punctate *inter alia*.

Holotype in Coll. Carter.

LICINOMA TRICOLOR, n. sp.

Elongate-ovate; head black, pronotum dark metallic-green, very nitid, elytra bright violet-bronze, antennae opaque-black, femora nitid black, tibiae and tarsi piceous-red, apical segments of latter red.

Head strongly, unevenly punctate, with an oval frontal impresssion. Antennae shorter than in *L. splendens* mihi, 8-10 nearly round, 11 pyriform. Prothorax: Apex and base subtruncate, anterior angles feebly advanced and subacute—seen from above—posterior angles obtuse, widest in front of middle, sides well rounded, a narrow lateral margin, slightly explanate only near front angles, bearing 3 or 4 setae; a shallow medial depression (not sulcate) near base, medial line further indicated by a brassy line of lesser punctures, seen in favourable light. Surface finely and closely punctate. Elytra slightly wider than prothorax and nearly twice as long, striate-punctate, the punctures only seen as crenulations on the insides of intervals; striae well marked; intervals 3 and 5 slightly wider than the rest in one example, in three others the 5th interval only obviously wider than the rest; intervals apparently impunctate, the third with a single seta on apical declivity. Hind tarsi with first segment about as long as the fourth.

Dimensions: 11-12 × 3-3.5 mm.

Habitat.—Northern New South Wales: Rivertree (E. Sutton), Boonoo-Boonoo (F. A. Perkins).

Four examples show a species that seemed at first a dark variety of *splendens* Cart., to which it is closely allied, but the following differences warrant, I think, specific distinction: (1) obvious colour differences—dark antennae and legs, less brilliant pronotum and bronze elytra, (2) shorter and different antennae, (3) prothorax widest in front of middle (at middle in *splendens*), its apex proportionally wider—apex to base 6 : 5 in *splendens*, 7 : 5 in *tricolor*, and (4) elytral intervals not of uniform width.

Holotype in Coll. Carter.

AMARYGMUS INSIGNIS, n. sp.

Oval, convex, nitid coppery-bronze, underside nitid-black, legs piceous, antennae and tarsi red, the last flavo-setose.

Head finely and closely punctate, eyes large, interspace narrower than in *A. morio* F., antennae slender, 4-11 subequal in length, successively and lightly thickened to apex. Prothorax bisinuate at apex and base, all angles obtuse, the anterior widely so, sides well rounded, widest behind middle, thence arcuately converging to apex and almost straight to the base; disc uniformly, closely and finely punctate. Elytra rather widely oval, shoulders obtusely angulate; striate-punctate, each with eight well impressed striae set rather closely with small punctures, the intervals nearly flat towards the centre, becoming convex laterally and on apical half, strongly so on the declivity, these uniformly and finely punctate, the interstitial punctures finer than the pronotal. Underside glabrous,

abdomen strigose, tibiae straight, with short, hairy clothing beneath, hind tarsi with basal segment as long as the rest combined.

Dimensions: 15 × 9 mm.

Habitat.—New Guinea: Mt. Lamington, 1,300–1,500 feet alt. (C. T. McNamara).

Eleven examples are before me that cannot fit any recorded description, including Gebien's valuable table of New Guinea species. It may be readily identified by comparison with the common *A. morio* F., which I found confused with it (on the same card), but which presents the following marked distinctions:

<i>A. insignis</i> , n. sp.	<i>A. morio</i> F.
<i>Colour</i> brighter bronze	darker
<i>Dimensions</i> 15 × 9 mm.	11–12 × 6 mm.
<i>Antennae</i> slender	moderately stout
<i>Pronotum and elytral intervals</i> more clearly punctate	much less clearly punctate
<i>Elytral strial punctures</i> smaller	larger
<i>Hind tibiae</i> straight	strongly curved
<i>Hind tarsi</i> first segment as long as rest combined	first segment much shorter than rest combined

In colour and size it is near *Chalcopterus perforans* Geb., which is amongst those sent from Finschhafen, New Guinea, but the sculpture is very different.

Holotype in South Australian Museum.

Amarygmus curvipes Geb. (*alienus* Blkb.) is abundantly distinct from *A. morio* F., by larger size, more oblong form, opaque surface, coarser elytral punctures—especially the intervals. The post tarsi also have the first segment as long as the rest combined (shorter in *morio*). Two examples in my collection are from Nar-nar-noon, and the Grampians, Victoria. I have not seen *morio* from regions south of tropical Queensland. The locality of *tasmanicus* appears dubious. Gebien's name is unfortunate since the tibiae are not evidently curved.

AMARYGMUS HOSSFELDI, n. sp.

Very convex, widely oval; head, pronotum, underside, legs and tarsi nitid-black, the last aureo-setose, antennae piceous, the apical segments paler, elytra metallic dark-green with purple sheen on middle area.

Head finely and rather closely punctate, eyes widely separated, interspace equal to first antennal segment. Antennae moderately robust, 3 longer than 4, 5–11 subequal in length, the apical five successively, lightly enlarged. Prothorax: Apex nearly straight, the very wide anterior angles only feebly produced, sides arcuately narrowed from base to apex, base weakly bisinuate; posterior angles obtuse; disc finely, not closely, punctate, showing smooth spaces along medial line and, to less extent, elsewhere. Elytra strongly convex, widest at shoulders, thence ovately narrowed to a rather sharp apex, striate-punctate, the striae wide and containing very large oval punctures continuous to apex, becoming even larger laterally, about 30 in a row; intervals wide, moderately convex and minutely punctured. Prosternum tumid and glabrous, abdomen indistinctly strigose; prothorax lightly arched, others straight; hind tarsi: segment 1 = 4; 2 = 3 and short.

Dimensions: 13 × 8 mm.

Habitat.—New Guinea (Paul Hossfeld).

A single example shows a species distinct from those in the lists of Gebien (L'Expédition Néerlandaise, 1920) and Blair (*Trans. Zool. Soc. Lond.*, 1915), with a sculpture almost as coarse as in the Australian *Chalcopteris catenulatus* Blkb.

Holotype in South Australian Museum.

CHALCOPTERUS NITIDUS, n. sp.

Oval; head, pronotum, scutellum, underside, legs, tarsi, and tarsal clothing black, elytra blue—in some aspects with purplish gleams—surface very nitid.

Head finely punctate, eyes widely separated, interval rather less than in *affinis* Bless., without sulcus; antennae very similar to *affinis* Bless. Prothorax very convex, apex arcuate, base lightly bisinuate, widest at base, this twice as wide as apex, sides arcuately converging to the front, all angles obtuse, the posterior deflexed and wide; disc very minutely punctate, without medial line or fovea on its mirror-like surface. Scutellum laevigate. Elytra wider than prothorax at base, slightly obovate, seriate-punctate, the serial punctures small, round and close, slightly larger and more distant laterally, intervals flat and microscopically punctate. Meso- and metasternum minutely punctate, abdomen rather strongly longitudinally strigulate. Hind tarsi with basal segment longer than the rest combined.

Dimensions: 11 × 7 mm.

Habitat.—Western Australia: Balladonia, Norseman (Miss Baesjou).

Two examples in the Australian Museum are very distinct from its nearest allies in my tabulation, *sparsus* Blkb., and *clypealis* Blkb., by the combination of colour difference, fine sculpture and nitid surface. In the last, however, it is less brilliant than *lucidus* Cart., or *meyricki* Blkb. The seriate punctures are very much as in *purpureus* Germ., but the intervals are much less strongly punctulate, the punctures being visible only under a strong lens. The convex prothorax is also distinctive.

Holotype in Australian Museum.

EBENOLUS SERRATICOLLIS, n. sp. Text-fig. 10.

Elongate-oblong; nitid greenish-bronze above, nitid-black beneath, legs and basal segments of antennae red, apical segments of antennae opaque-black.

Head finely closely punctate, epistoma rounded in front, eyes large, prominent, almost contiguous in front, interspace strongly widened behind, this area flat and punctate; antennal orbits raised and "ear-like"; antennae moderately robust, 3-5 sublinear, 3 longer than 4; 6-9 much wider than preceding, subconic; 10-11 wanting. Prothorax subrectangular, slightly widest at middle, strongly transverse, width nearly twice the length; apex and base subobsoletely bisinuate, the former sulcate within a narrow explanate border; anterior angles obliquely truncate, posterior sharply rectangular; anterior two-thirds of sides with about four unequal serrations, the largest near middle, thence narrowed, but nearly straight, to hind angle; a reflexed basal border, with three large foveae, equally placed within it; disc rather sparsely and irregularly punctate, the punctures coarser and rugose towards sides; medial line impressed throughout; widened on basal half. Elytra considerably wider than and about four times as long as prothorax, shoulders rounded and rather tumid; sides parallel for the greater part, jointly rounded at apex, coarsely striate-punctate, the large, rectangular, closely-ranged punctures occupying most of the surface; the narrow intervals impunctate, third,

fifth and seventh more strongly raised than the rest. Underside almost impunctate, abdomen finely strigose; post tibiae with basal third lightly hollowed interiorly, widened beyond this; post tarsi having basal segment rather longer than second and third combined, much shorter than fourth.

Dimensions: 9 × 4 mm.

Habitat.—New Guinea: Mt. Lamington (Buna district), 1,300–1,500 feet (C. T. McNamara).

A single example is remarkable for its serrated and unusually transverse pronotum. It cannot be fitted to any in Gebien's table, though apparently nearest to *E. plicicollis* Geb., of which the colour is black, the form narrow, and the pronotum without impressed middle line. In the elytral sculpture it must be near *E. sculptipennis* Geb., which differs in size, colour and pronotal structure.

Holotype in the South Australian Museum.

Allecula papuensis Macl.—Having examined the type of this I find that it is an *Ebenolus* and, further, that it is identical with *E. wollastoni* Blair var. *anthracinus* Geb. The species must, therefore, be known as *Ebenolus papuensis* Macl., var. *anthracinus* Geb.

EBENOLUS ARUENSIS, n. sp. Text-fig. 11.

Elongate, subcylindric; nitid-black above and below, appendages also black, the front margins of basal segments of antennae and claws of tarsi only red.

Head: Labrum prominent, epistoma rounded in front, strongly, rather closely punctate, antennal sockets prominently raised and squarely rounded; eyes occupying greater part of head, on front half only separated by the narrowest line, on basal half by a narrow triangular area sulcate in middle; antennae long and slender, sublinear, 3–5 subequal, 6–11 wider and longer than preceding, subequal in length, 8 slightly the widest. Prothorax subquadrate, transverse, width less than 1½ times length, apex and base subtruncate, the former feebly arcuate, the latter feebly bisinuate; anterior angles rounded, posterior subacute; sides nearly straight, feebly sinuate on basal half, narrowly bordered throughout, basal margin raised; disc strongly, irregularly punctate, with some smooth nitid areas, medial line only indicated by a depression near apex. Elytra wider than and about four times as long as prothorax, parallel for the greater part, separately rounded at apex, striate-punctate, the striae narrow, seriate punctures fine, close and evenly placed—more widely so outwardly; sutural intervals a little raised, the rest wide and flat except near apex. Underside lightly punctate; hind tibiae arcuate near base, hind tarsi wanting.

Dimensions: 10 × 3 mm.

Habitat.—Aru Island (H. Elgner).

A single ♂ example shows an elongate, narrow species not very near any in Gebien's table.

Holotype in South Australian Museum.

STRONGYLUM PUSILLUM, n. sp.

Cylindric; nitid-black above, basal segments of antennae reddish, underside and legs piceous, tarsi red.

Head: Labrum prominent, epistoma rounded and strongly punctate, antennal sockets obliquely raised, not prominent; eyes close, interspace in front less than

length of second antennal segment, considerably widened behind; front strongly punctate; antennae sublinear, 3-5 subequal, much narrower than the succeeding, 6-11 subequal in length and width. Prothorax laterally convex, subquadrate, width less than $1\frac{1}{2}$ times length; apex and base truncate, each with raised border narrowly sulcate within; sides depressed, notably widened (scarcely angulate) near middle and subsinuate behind; anterior angles rounded, posterior rectangular; disc with large round punctures, irregularly placed, an impressed middle line on basal half. Elytra much wider than and four times as long as prothorax, sides parallel, apices jointly rounded; striate-punctate, the striae as wide as intervals; seriate punctures large and close, intervals convex, near suture strongly so, also impunctate. Underside punctate, mid and hind tibiae a little curved, post tarsi with first longer than fourth but shorter than 2, 3 and 4 combined, second twice as long as third.

Dimensions: 5 × 1.6 mm.

Habitat.—New Guinea: Finschhafen (Rev. L. Wagner).

A single example (? ♂) is in size only comparable with *angulatum* Geb., and *infans* Geb., in Gebien's tabulation; both differently coloured, with much more widely separated eyes, the former also with angulate sided pronotum.

Holotype in South Australian Museum.

STRONGYLUM WAGNERI, n. sp. Text-fig. 12.

Head and pronotum subnitid-black, elytra nonmetallic nitid-brown; underside very nitid brownish-black, coxae, legs and abdomen reddish; antennae with five basal segments red, the apical segment yellow, the remainder dull black; tarsi red.

Head: Labrum produced, epistoma truncate, closely punctate; eyes separated by the length of first antennal segment in front, more widely behind; antennal sockets moderately raised; front finely sulcate and strongly punctate; antennal segments more or less obconic, 3-5 subequal, 6-10 longer and much wider, especially at apices, but equal in length *inter se*, 11 elongate ovate, of same length as preceding. Prothorax convex, slightly wider in front than behind, apex lightly produced forward in middle, otherwise nearly straight; base feebly bisinuate, sides subangulate in middle, with short wide tooth, otherwise nearly straight, widely margined at apex and base, anterior angles rounded off, posterior subrectangular; disc closely and strongly punctate, lightly rugose in places, without impressed medial line. Scutellum black, nitid, triangular. Elytra lightly obovate, much wider than, and four times as long as, prothorax, shoulders widely rounded, without tumidity, apices jointly rounded; sides slightly enlarged behind middle; striate-punctate, striae wider than intervals, containing large, close punctures continuous to apex; intervals ribbed (costiform) and themselves microscopically punctate. Prosternum and propleurae strongly punctate, metasternum and abdomen very nitid and impunctate; all tibiae straight, post tarsi 1 = 4; 2 = 3.

Dimensions: 8-10 × 3-3.5 mm.

Habitat.—New Guinea: Finschhafen (Rev. L. Wagner).

Five examples examined show little sexual differentiation. The species has a similar facies to *S. punctithorax* Cart., and must also be near *S. keyanum* Geb., but the latter is larger and differently coloured. *S. punctithorax* has much finer and sparser sculpture of the pronotum and is without the lateral tooth.

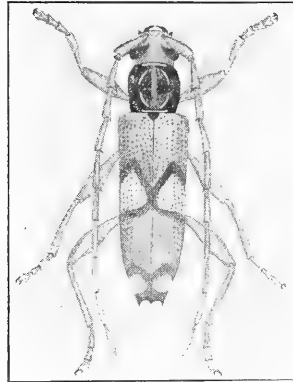
Holotype in South Australian Museum.



11



12



13

- 11.—*Ebenolus aruensis*, n. sp.
 12.—*Strongylium wagneri*, n. sp.
 13.—*Coptocercus scripticollis*, n. sp.

Synonymy.

1. *Gonocephalum hispidocostatum* Fairm. = *G. costipenne* Cart. = *G. costatum* Cart. (nom. praeocc.).
2. *Bradymerus crenatus* Pasc. = *granaticollis* Frm.
3. *B. raucipennis* Blkb. = *seriatus* Geb.
4. *Platydema deterrentum* Wlk. = *laticorne* Frm. = *annamitum* Frm. = *malaccaum* Mars. = *Ceropria valga* Pasc.
5. *Ceropria janthinipennis* Chev. = *peregrinus* Pasc.
6. *C. maculata* Geb. n. nom. = *bifasciata* Cart. = *quadriplagiata* Geb.
7. *Diaclina nitida* Cart. = *immaculata* Geb.
8. *Diphyrhynchus nicobaricus* Redt. = *apicalis* Champ.
9. *Uloma corpulenta* Geb. ♀ = *Acthosus pascoei* Geb. ♂.
10. *Doliema* (?) *nitidula* Macl. (*Ipsaphes*) = *D. spinicollis* Frm.
11. *Graptopezus crenaticollis* Macl. (*Nyctozeilus*) = *G. costipennis* Blair.
12. *Zophophilus curticornis* Frm. ♀ = *raptor* Geb. ♂ = *Meneristes dentipes* Cart. ♂.
13. *Chariotheca planicollis* Frm. (*Thesilea*) = *oblonga* Blanch. (*Thesilea*) = *cupripennis* Pasc. = *impressicollis* Frm.
14. *C. cupripennis* Macl. (*Prophanes*) = *C. punctiventris* Geb.
15. *Pezophenus submetallicus* Macl. (*Prophanes*) = *rutilans* Geb.
16. *Amarygmus convexiusculus* Macl. (1886) = *niger* Geb., n. nom.
17. *A. morio* F. = *aeneus* Ol. = *cupreus* Guér. = *ruficrurus* Blanch. = *foveoseriatus* Frm. = *foveostriatus* Frm. = *inornatus* Macl. = *picipes* Frm. (*Dietytus*) = *tasmanicus* Blkb. = *uniformis* Blkb.
18. *Amarygmus cuprarius* Web. = *A. mutabilis* Geb.
19. *Notostrongylium rugosicolle* Cart. = *Strongylium horridum* Geb.
20. *Strongylium gravidum* Macl. = *S. tuberipenne* Frm. var.
21. *Ebenolus papuensis* Macl. (*Allecula*) = *wollastoni* Blair var. *anthracinus* Geb.

No less than twenty-nine species of Tenebrionidae are now known to occur on both sides of Torres Straits.

Also the following generic synonymy holds (*vide* Gebien):
Zophophilus Fairm. = *Sphenothorax* Geb. = *Teremenes* Cart.

Fam. CERAMBYCIDAE.

COPTOCERCUS SCRIPTICOLLIS, n. sp. Text-fig. 13.

Head and prothorax black, the latter with a short line of white pubescence within the apical and basal border, more or less connected by two sinuate longitudinal lines of similar pubescence forming a subovate pattern. Elytra red, with an irregular medial fascia and subapical maculae testaceous; antennae, legs and underside red.

Head pubescent, with sparse longer hair on muzzle, punctate at base; antennae longer than body, segments 3-6 externally spinose. Prothorax: Sides lightly rounded, with a subobsolete, round, lateral tubercle, strongly constricted at base, scarcely so at apex; disc with four—in one example five—feebly raised nodules, densely punctate, with sparse long hair at sides, besides discal pubescence. Scutellum large, triangular, clad with white pubescence. Elytra: Shoulders rather square and slightly tumid; sides subparallel, slightly converging behind; apices with long, sharp, external spine, sutural angle just perceptibly produced, surface strongly punctate, the punctures coarse and close near base, finer and more distant behind the pale fascia, subobsolete on apical fourth; each elytron with a single raised interval; surface sparsely clothed, especially on sides and apex, with long, whitish hair.

Dimensions: 13-16 × 3-4 mm.

Habitat.—Victoria: Portland (M. L. Hauschild), second example labelled "New Holland".

Two examples, both ♂, were sent from the Zoologische Museum, Hamburg, with other longicorns, for determination. In my Revision of the Group it would stand near *C. vicinus* Hope, from which it differs in its pronotal pattern and structure. The elytral fascia has a forward prolongation at middle of each elytron; it is interrupted at suture and continuous to the sides.

Holotype in Hamburg Museum.

PORITHODES PUSTULATA, n. sp.

Castaneous; apical third of elytra, also the whole abdomen, dark-brown, except for a small triangular white mark across external apices of elytra.

Head impunctate; a small nitid pustule at each angle of clypeus; antennae longer than body, 3 longer than 4; 4-10 subequal in length, but successively finer; 3-5 spinose on outside. Prothorax longer than wide, widest about middle, lateral outline a little irregular but scarcely nodose; disc with five well-raised nodules, the middle one elongate. Elytra two and a half times as long as prothorax and wider than it at shoulders; sides subparallel, apices truncate; each with a traceable subcostate impression from the shoulders to the apical third; basal two-thirds with sparse, irregular pustules, the lateral area indistinctly punctate, the whole elytra finely pubescent. Prosternum concave in front of coxae, this accentuated by abrupt convexity of apical area; femora clavate.

Dimensions: 15 × 4 mm.

Habitat.—Queensland: Clermont, Peak Downs (Dr. K. K. Spence), and also in the Hamburg Museum.

Two examples examined, both ♂. The truncate apices and irregular-sided pronotum may suggest generic distinction, though I consider this undesirable. Pustules are also found on the elytra of *P. spinipennis* mihi, though differently placed.

Holotype in Coll. Carter. Paratype in Hamburg Museum.

The six species described may be tabulated as follows:

Porithodes Auriv.

- | | |
|---|--|
| 1. Apices of elytra spinose | <i>spinipennis</i> Cart. |
| Apices of elytra truncate | <i>pustulata</i> , n. sp. |
| Apices of elytra rounded | 2 |
| 2. Pale area of elytra confined to apical third | <i>apicalis</i> Lea |
| Pale area of elytra not so | 3 |
| 3. Apex of elytra dark | <i>plagiata</i> Blkb. |
| Apex of elytra pale | 4 |
| 4. Greater part of elytra pale | <i>parenthetica</i> Lea |
| Fascia and apex only pale | <i>fasciata</i> Auriv.; <i>obliqua</i> Lea |

Fam. DASCILLIDAE.

DASCILLUS OBLONGUS, n. sp.

Elongate-oblong; nitid reddish-brown, antennae, tarsi and underside red; upper surface sparsely clad with short pale hair, adpressed on pronotum, upright on elytra, this abraded except near margins, also base of pronotum.

Head: Eyes large, round and prominent, separated by the width of one eye; antennae long, extending nearly half the length of elytra, segments 3-10 sharply triangular, forming a strong serration, 11 narrowly lanceolate. Prothorax widest at base, its outline from above subconic with a slight anterior sinuation, narrowing and convex towards apex, its extreme apex bluntly rounded, and about the width of forehead (between eyes), a narrow, horizontal margin visible at basal third, anterior margins decurved, posterior angles acute; base rather strongly bisinuate, its margins finely serrulate; disc with shallow punctures, a large oval depression at base, within this two deeper foveae symmetrically placed. Scutellum large, subpentagonal. Elytra oblong, slightly wider than prothorax at shoulders, feebly enlarged behind middle, apices rounded; striate-punctate, the striae rather deep, the punctures therein small, close and transverse; intervals lightly convex, closely punctate towards base, transversely elongate for the greater part; procoxae approximate; underside with silky pubescence.

Dimensions: 9 × 3 mm.

Habitat.—New South Wales: E. Dorrigo (W. Heron).

A single specimen before me is certainly conspecific with *D. serraticornis* mihi, but longer, narrower and with stronger striation and elytral sculpture. Both are doubtfully referred to *Dascillus*, though clearly allied to *D. brevicornis* Macl. Its general facies is that of an Elaterid.

Holotype in Coll. Carter.

ON PLACENTATION IN REPTILES. II.

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(Plates xxii-xxviii; ten Text-figures.)

[Read 29th October, 1930.]

Contents.

Introduction.

Description of allanto-placentation in (a) *Egernia cunninghami*, *E. whitei* and *E. striolata*; (b) *Tiliqua scincoides* and *T. nigrolutea*; (c) *Lygosoma (Hemiergus) quadridigitatum*; (d) *Mabuja multifasciata*; (e) *Lygosoma (Liolepisma) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum*.

Description of early stages in the development of the allanto-placenta in *Lygosoma (Liolepisma) entrecasteauxi*.

Theoretical considerations.

Summary and conclusions.

INTRODUCTION.

The placentation of eight scincid lizards from Australia and one from Java is described here. The lizards include three species of the genus *Egernia*, *E. cunninghami*, *E. whitei* and *E. striolata*; the large skink *Tiliqua nigrolutea*, commonly called the "blue tongue" lizard in south-eastern Australia; the semi-subterranean skink *Lygosoma (Hemiergus) quadridigitatum*; the skink *Mabuja multifasciata* collected in Java; and three species of the genus *Lygosoma*, subgenus *Liolepisma*, *Lygosoma (Liolepisma) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum*.

Unfortunately specimens of the other two Australian species of *Egernia*, *E. kingii* and *E. stokei*, were not available for examination.

A stage in the development of the placenta in *Tiliqua scincoides*, the most common "blue tongue" in New South Wales, Australia, has already been described by Professor T. Flynn (1923). The stage described here for *T. nigrolutea* is probably later than that described by Flynn for *T. scincoides*.

Both *Lygosoma (Hemiergus) decresiensis* and *L. (Hemiergus) quadridigitatum* are viviparous, but stages in the development of the placenta suitable for description were only available in *L. (Hemiergus) quadridigitatum*, those in the other species being too young.

I have to thank Professor A. N. Burkitt of the Department of Anatomy, University of Sydney, for the specimens of *Mabuja multifasciata* which he brought from Java in 1929.

Placentation has already been described for two skinks of the subgenus *Liolepisma*, *L. (L.) entrecasteauxi* (Harrison and Weekes, 1925) and *L. (L.) weekesae* (Weekes, 1929). The placentae in these two small skinks were shown to be essentially similar, although differing in the degree of their specialization (Weekes, 1929). The placentae in *L. (L.) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum* are identical, but there is a marked difference between the degree

of specialization of the placenta in these lizards and that of the placenta in *L. (L.) entrecasteauxi* and *L. (L.) weekesae*.

The allanto-placentation alone is described here and the description of the maternal and foetal tissues surrounding the yolk-sac is reserved for a later date.

The reptiles for which placentation has so far been described are the lizards of the family Scincidae: *Chalcides tridactylus* (Giacomini, 1891), *C. ocellatus* (Mingazzini, 1891), *Tiliqua scincoides* (Flynn, 1923), *Lygosoma (Liolepisma) entrecasteauxi* (Harrison and Weekes, 1925), *L. (Hinulia) quoyi* (Weekes, 1927), and *L. (Liolepisma) weekesae* (Weekes, 1929); and the snakes *Denisonia superba* (Weekes, 1929), and *D. suta* (Weekes, 1929).

The reptiles for which placentation is here described are the following lizards of the family Scincidae: *Egernia cunninghami*, *E. whitei*, *E. striolata*, *Lygosoma (Liolepisma) ocellatum*, *L. (L.) metallicum*, *L. (L.) pretiosum*, *L. (Hemiergis) quadridigitatum*, *Tiliqua nigrolutea*, and *Mabuja multifasciata*.

I have also examined embryos from other viviparous species, the snakes *Notechis curtis* (Australia), *Tropidonotus sirtalis* (North America), *Pseudechis porphyrae* (Australia) and the lizard *Sceloporus torquatus* (Texas). The specimens are unfortunately not in a satisfactory state of preservation for description, so that the fact of their viviparity can alone be recorded here. The number of species of reptiles for which viviparity is recorded is rapidly increasing and it is remarkable that so many lizards are, upon examination, proving to be viviparous. It will be interesting to see how many different types of placentae occur among the viviparous reptiles. The majority of the examinations so far made have revealed only simple types of placentae.

I have been able to collect a series of young embryos of *L. (L.) entrecasteauxi* and the account of the development of the allanto-placenta in this lizard promised by Professor Harrison and myself in 1925 is included here.

I wish to thank the University of Sydney for a grant which enabled me to collect in Tasmania in January, 1929, and also to thank the Linnean Society of New South Wales for a grant which enabled me to collect within New South Wales. I further wish to take this opportunity of expressing my gratitude to Professor J. P. Hill, Department of Anatomy and Embryology (University of London), University College, in whose department this work was completed, for the help he has given me, and particularly for the opportunity of obtaining the photomicrographs which appear in this paper.

EGERNIA CUNNINGHAMI, E. WHITEI AND E. STRIOLATA.

Material.

The habitat of *Egernia* ranges from low to comparatively high altitudes. Specimens of *E. whitei* were collected from La Perouse, Sydney, at sea-level; from Cooma, 260 miles south of Sydney, at a height of about 2,700 feet above sea-level; from the Jenolan district, 140 miles west of Sydney, at a height of about 4,000 feet, and from the New England Plateau, north-eastern New South Wales, at a height of about 5,000 feet. Specimens of *E. striolata* were collected from north-eastern New South Wales, at a height of about 600 feet, and also from the Jenolan district at 4,000 feet. Specimens of *E. cunninghami* were collected in great numbers from Tarana on the western slopes of the Blue Mountains, about 120 miles west of Sydney, at a height of about 3,000 feet, and this lizard was also found at Sydney at sea-level. It will be seen that *Egernia* is fairly widely distributed, at least throughout eastern New South Wales, and other records show

that it is also distributed over the western region. Specimens of *E. whitei* were also collected in Tasmania, but neither *E. cunninghami* nor *E. striolata* was seen there.

The female lizards collected contained embryos ranging from the early stage in development where the embryo lies flat upon the yolk-sac with no amnion or allantois formed, to the stage immediately prior to the birth of the foetus.

The material was stained with Ehrlich's haematoxylin and counterstained with eosin.

Placentation.

The gestation period of these lizards begins in the spring and covers about three months. At Tarana ovulation occurred in *E. cunninghami* during the last week in November in 1927 and it also occurred during the same week in other species of lizards found in the same locality and obviously controlled by the same climatic conditions. Ovulation occurred at least two weeks earlier in the same species found in the Jenolan district, which is on the eastern slope of the Blue Mountains, about 40 miles south of Tarana, and which has an earlier spring than the Tarana district. The direct influence of climatic conditions upon the ovulation and maturation of the eggs in the lizards was thus demonstrated.

In lizards examined at Tarana during the first week in November, the ova present in the ovaries were so small that it was at first thought that the lizards were oviparous and that the eggs had been laid. However, an examination of the ovaries revealed no burst follicles, and in the lizards collected in the second week of November the ova were noticeably larger. By the end of November they were in the oviducts, ovulation having taken place during the last week. There is no record of the time of ovulation in either *E. whitei* or *E. striolata* as the ova were in the oviducts in all the specimens collected.

In *E. cunninghami* the number of eggs in one lizard varies from five to nine and in *E. whitei* and *E. striolata* from three to five, the right oviduct usually containing one more egg than the left, a condition prevalent among lizards. The eggs are round, soft and creamy-yellow. Those in *E. cunninghami* are the largest and measure about 20 mm. in diameter, while those in *E. whitei* and *E. striolata*, smaller lizards, measure only about 10 mm. in diameter. They are surrounded by a thin transparent membrane, but there is no trace of shell. In early stages in the development of the embryo a little albumen collects at the base of the yolk-sac.

The embryonic pole of the egg lies in a position dorsal with regard to the parent and the embryo develops in the region immediately beneath the main longitudinal blood-vessels, so that on opening up the ventral body wall of the parent the eggs must be turned over to bring the embryos into view. This position is constant and the embryos, which are surrounded by only a very thin uterine wall, are thus given a certain amount of protection by the overlying backbone of the parent. The eggs in the uterus cause it to become expanded into a series of regular swellings which Giacomini (1891) called "incubatory chambers". Each uterus is vascularized by one main longitudinal artery and vein, which lie along its dorsal surface (Text-fig. 9a, *M. Ut. A.*; *M. Ut. V.*). The main artery supplies branch arteries which pass transversely round each incubatory chamber to the region underlying the base of the yolk-sac of the contained egg and each vein receives blood from transverse branches which also come from the region of the uterus underlying the base of the yolk-sac and which roughly alternate with

the branch arteries. A similar condition in *L. (L.) entrecasteauxi* is illustrated by Figure 4 on Plate xxvii.

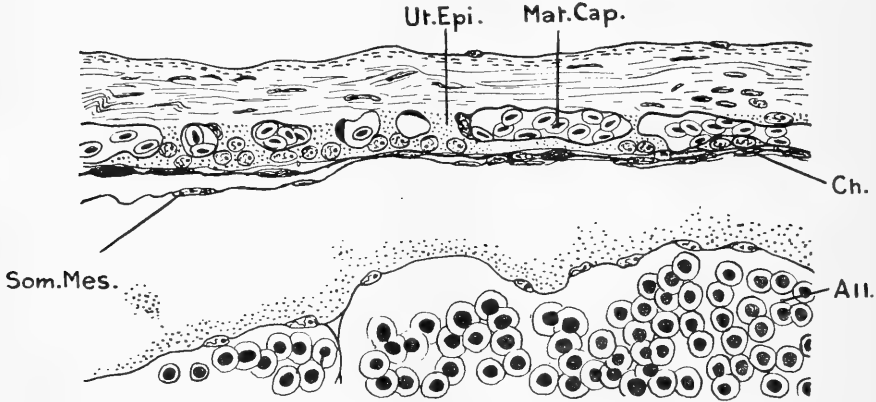
The uterine wall at the time of ovulation consists of the tissues usually found in lizards: the external coat of longitudinal muscle, the internal coat of circular muscle, the mucosa with scattered glands embedded, and the single layer of lining epithelium. Before ovulation the epithelial cells lining the oviduct are fairly uniform in structure and height, with definite dividing walls and with their free margins ciliated. The maternal capillaries lie for the most part at the bases of the epithelial cells although many are scattered throughout the mucosa.

Since the three species, *E. cunninghami*, *E. whitei* and *E. striolata* have the same type of placentation, no distinction will be made between them in this description. The mature allantoplacenta in these species of *Egernia* is very simple and fundamentally similar to that already described for *Lygosoma (Hinulia) quoyi* (Weekes, 1927). The maternal capillaries invade the epithelium lining the lumen of the uterus and are more or less exposed at the maternal placental face; the allantoic capillaries are concentrated at the surface of the chorio-allantoic membrane, which is attached to the uterus, and the maternal and foetal blood-streams are thus in close apposition (Text-fig. 3).

The youngest embryo examined lies flat upon the yolk-sac, with no indication of amnion formation. The epiblast cells have extended for a short distance over the dorsal surface of the yolk-sac and are firmly attached to the overlying shell-membrane which is about as thick as the epiblast layer. Even at this early stage there are the beginnings of the modification of the structure of the uterine wall for placentation. The maternal capillaries can be seen pressed against the epithelial cells and those cells immediately in contact with them are flat and about half their original size. The dividing walls of the epithelial cells are not as definite at this stage as they are in the non-pregnant condition. This modification of the structure of the uterus is restricted to that part surrounding the embryonic pole of the egg.

At the next important stage in the development of the placenta the embryo lies on its left side on the yolk-sac, the chorionic membrane is established and the allantois is represented by a small, insignificant, bladder-like protuberance at the posterior end of the embryo. The structure of the uterine wall is further modified for placentation and this modification extends for some distance beyond the embryonic region, to the region overlying the yolk-sac. The maternal capillaries have now definitely invaded the uterine epithelium and lie almost completely embedded in it, but there is still a layer of epithelial cytoplasm separating them from the underlying ectoderm cells of the foetal chorionic membrane (Text-fig. 1; Pl. xxii, fig. 1). The uterine epithelium in sectioned material has the appearance of a nucleated syncytium (Text-fig. 1); however, an examination of the surface view of the uterine wall reveals dividing cell-walls which show that the epithelium is not definitely syncytial. In the embryonic region the shell membrane has disappeared from between the uterine wall and the chorionic membrane, having been absorbed by the underlying chorionic ectoderm cells, which thus come into contact with the surface of the overlying uterus and some of which are at this stage actually attached to the uterine surface. These chorionic ectoderm cells are slightly larger than at the earlier stage described, but are still flat and tapering and are already characterized by the deeply-staining nuclei which are so prominent at later stages. From the description of these two stages in the

development of the placenta it can be seen that the modification of the uterus for allantoplacentation is independent of the presence of an underlying allantois, since at the first stage described there is no allantois present, and at the second stage the allantois is but a small swelling at the posterior end of the embryo.

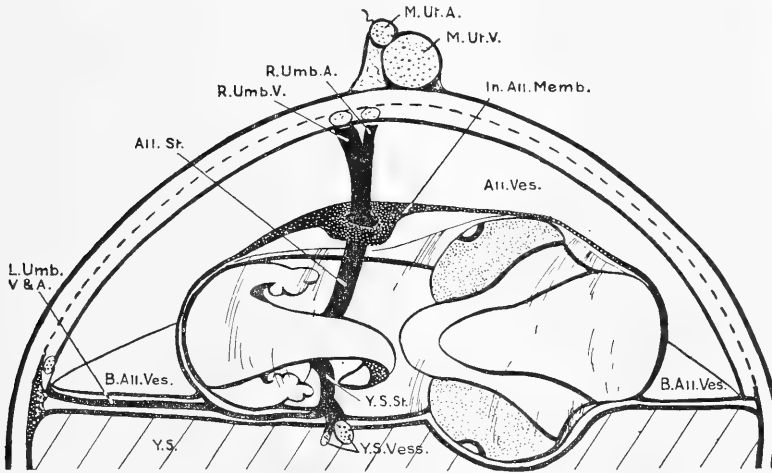


Text-fig. 1.—Section of uterine wall of *E. cunninghami* with apposed chorionic membrane of embryo. The maternal capillaries have begun invasion of uterine epithelium. $\times 400$. *All.*, allantois; *Ch.*, chorionic membrane; *Mat. Cap.*, maternal capillary; *Som. Mes.*, somatic mesoderm; *Ut. Epi.*, uterine epithelium.

At this stage the area vasculosa has extended over approximately one-third of the yolk-sac surface. The method of the extension of the extra-embryonic blood-vessels round the yolk-sac resembles that described for the lizards *L. (Hinulia) quoyi*, *T. scincoides* (Weekes, 1927), *L. (L.) weekesae* and *L. (L.) entrecasteauvi* (Weekes, 1929), and for the snakes *Denisonia superba* and *D. suta* (Weekes, 1929). Over the dorsal and embryonic region the blood-vessels form on the surface of the yolk-sac over the thick hypoblastic layer, but at the side of the yolk-sac the extra-embryonic mesoderm dips into the substance of the sac, cutting off a fairly thick layer of yolk-containing endoderm cells from the main bulk of the sac. The mesoderm continues to grow round the sac embedded in its substance and, on the splitting apart of the "somatic" and "splanchnic" layers of mesoderm and the formation of the extra-embryonic coelome, the outer strip of yolk-sac is cut off and entirely isolated from the main sac. The mesoderm spreads immediately beneath the chorionic ectoderm as well as into the substance of the yolk-sac, so that when the allantois extends into the extra-embryonic coelome and unites with its outer wall, a composite membrane is formed composed of chorionic ectoderm, mesoderm, yolk-sac endoderm, "somatic" mesoderm, allantoic mesoderm and allantoic endoderm. This membrane can no longer be correctly called chorio-allantoic membrane and the term "chorio-omphalo-allantoic membrane" was suggested and used in a previous paper (Weekes, 1929). Also the membrane which consists of chorionic ectoderm, mesoderm, yolk-endoderm and "somatic" mesoderm is referred to in this paper as the "omphalo-chorion" or the "omphalo-chorionic membrane." In the embryos of every viviparous reptile so far examined by me, the extension of the extra-embryonic circulation follows this plan and, according to Dr. H. Hrabrowski (1926), it follows the same plan in the

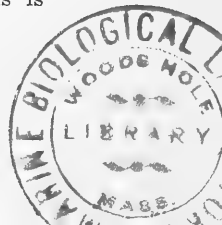
ovoviviparous lizard *Lacerta agilis*, as well as in the viviparous species *Lacerta vivipara* and in the slow-worm *Anguis fragilis*. A more detailed account of this phenomenon is in course of preparation.

At the time of the establishment of the chorio-allantoic membrane there are no further obvious modifications for allanto-placentation in the uterine wall, and the chorio-allantoic membrane simply consists of an outer layer of flattened chorionic ectoderm cells attached to the uterine face and an inner layer of mesenchymatous tissue which carries the allantoic blood-vessels and which is bounded by a single layer of tapering endoderm cells.



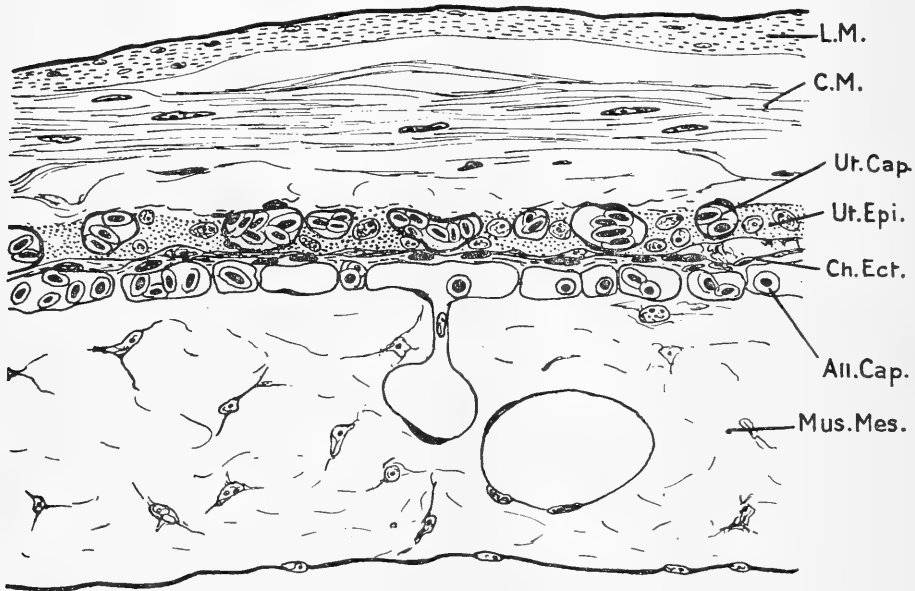
Text-fig. 2.—Section through egg and surrounding uterine wall showing a well developed embryo of *E. cunninghami* on yolk-sac, the relations between embryo and allantois, and extent of allanto-placental region indicated by broken line. $\times 4$. *All. St.*, allantoic stalk; *All. Ves.*, allantoic vesicle; *B. All. Ves.*, boundary of allantoic vesicle; *In. All. Memb.*, inner allantoic membrane; *L. Umb. V. & A.*, left umbilical vein and artery; *M. Ut. A.*, main uterine artery; *M. Ut. V.*, main uterine vein; *R. Umb. A.*, right umbilical artery; *R. Umb. V.*, right umbilical vein; *Y.S.*, yolk-sac; *Y.S. St.*, yolk-sac stalk; *Y.S. Vess.*, yolk-sac vessels.

When the placenta is mature the chorio-allantoic membrane is well established and the embryo is about four weeks old (Text-fig. 2). The uterine epithelium is thinner and the maternal capillaries are more or less exposed at the surface of the uterus, also the vascularization of the uterus is noticeably richer (Text-fig. 3; Plate xxii, fig. 2). The allantoic capillaries are concentrated at the surface of the chorio-allantoic membrane and are covered only by a thin layer of much flattened chorionic ectoderm cells so that the capillaries come into fairly close contact with the overlying maternal capillaries (Text-fig. 3). The chorionic ectoderm cells insert protoplasmic protuberances into the maternal tissue, so that it is difficult to tear away the foetal from the maternal tissue. At this stage there may be a thick sheet of mesenchymatous tissue, strengthened by numerous muscle fibres, underlying the allantoic blood-vessels in the chorio-allantoic membrane. This tissue is especially characteristic of *E. cunninghami*, in which the allantois is



much larger than that in either *E. whitei* or *E. striolata*, its outer wall therefore needing more support (Text-fig. 3; Pl. xxii, fig. 2).

The placentation occurs over the entire chorio-allantoic membrane (Text-fig. 2) and, as the allantois extends with the shrinking of the yolk-sac, the area of placentation is correspondingly extended. Although in the lizards the allantois only extends as the yolk-sac decreases in size, in the snakes examined it completely encircles the yolk-sac at early stages in the development of the embryo when the yolk-sac comprises the main bulk of the egg in the incubatory chamber (Weekes, 1929).



Text-fig. 3.—Section of mature allantoplacenta of *E. cunninghami*. $\times 400$.
All. Cap., allantoic capillary; *C.M.*, circular muscle; *Ch. Ect.*, chorionic ectoderm;
L.M., longitudinal muscle; *Mus. Mes.*, muscular mesenchymatous tissue;
Ut. Cap., uterine capillary; *Ut. Epi.*, uterine epithelium.

From this description it will be seen that the placenta is fundamentally simple and closely resembles that in *L. (Hinulia) quoyi* in that it is chiefly characterized by closely apposed maternal and foetal blood-streams. It might perhaps be as well to stress the fact that, although the foetal tissue is attached to the maternal tissue, there is no invasion of the maternal tissue by the foetal tissue, the attachment being only superficial, and in no lizard has any such invasion been so far observed. It seems possible that this simple type of placenta may be the type most commonly found among reptiles, as it occurs in nine of the seventeen species for which placentation has so far been described. The presence of such a comparatively large yolk-sac in each of the three species and the simplicity of the structure of the placenta seem to indicate that the placenta may function chiefly for respiration. It is proposed in the coming breeding season to see how far this assumption is correct.

The modification of the maternal and foetal tissues surrounding the yolk-sac in E. cunninghami, E. whitei and E. striolata.

It is not proposed to discuss at any length the structure and function of the maternal and foetal membranes surrounding the yolk-sac. Only a brief description will be included here, since these tissues must be more fully studied before a satisfactory understanding of them can be obtained.

The base of the yolk-sac of embryos of *Egernia* in fairly advanced stages of development seems to be a collecting ground for all kinds of debris which includes degenerating shell-membrane, albumen, scattered corpuscles and loose cells. These substances form a pad of material which varies in thickness with the individual egg and which can be lifted away from the yolk-sac on dissecting away the uterine wall after fixation. This accumulation of materials seems to influence to some degree the structure of the overlying chorionic ectoderm cells for usually where the pad is thickest, that is, at the base of the yolk-sac, the chorionic ectoderm cells are pressed closely against it and are much flattened. At the sides of the sac, where the deposit, although present, is much less plentiful, the chorionic ectoderm cells are enlarged and columnar. The enlargement does not occur uniformly over the yolk-sac but in irregular patches, so that an area of enlarged cells may suddenly abut on a region where the cells are normal in size. The uterine epithelium underlying the yolk-sac also shows the same patchy modification. The epithelial cells of the uterine wall immediately underlying an area of enlarged chorionic ectoderm cells are usually correspondingly enlarged and are curious in that they are extraordinarily narrow (Pl. xxiii, fig. 1). Where the chorionic ectoderm cells are not modified, the underlying epithelial cells of the uterine wall are as a rule also unmodified, but although this is usually so, areas of enlarged uterine epithelial cells have been observed underlying an area of chorionic ectoderm cells of normal structure. The difficulty of obtaining a satisfactory explanation of the structure of the maternal and foetal tissues surrounding the yolk-sac is thus demonstrated. Another interesting point is that, while such apposed areas of thickened maternal and foetal epithelial tissues usually have at least a small accumulation of materials between them, areas do occur where there is no trace of such substance (Pl. xxiii, fig. 1). Why the maternal and foetal epithelial tissues should be so modified is a curious and interesting problem. The comparatively large yolk-sac in these species of *Egernia* is full of yolk and this makes it somewhat difficult to believe that an omphaloplacenta for the absorption of food is necessary, especially at the comparatively early stages in the development of the embryo, when the specialization of the maternal and foetal tissues surrounding the yolk-sac is most marked. If the region is omphaloplacental, the reason for the irregular distribution of the specialized areas is a problem.

TILIQUA NIGROLUTEA AND T. SCINCOIDES.

Specimens of *Tiliqua nigrolutea* were collected from Tasmania at sea-level and at a height of about 3,000 feet. They contained young in fairly advanced stages of development and unfortunately earlier stages are not available. At the stages examined the structure of the allantoplacenta is identical with that of the allantoplacenta of the three species of *Egernia* described above, as a comparison of photomicrographs 3 and 2 on Plate xxii and Text-figures 4a and 3 will show, and therefore it is not considered necessary to describe the placenta any further.

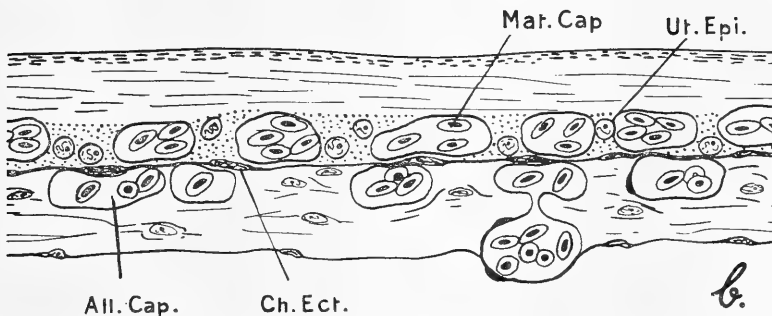
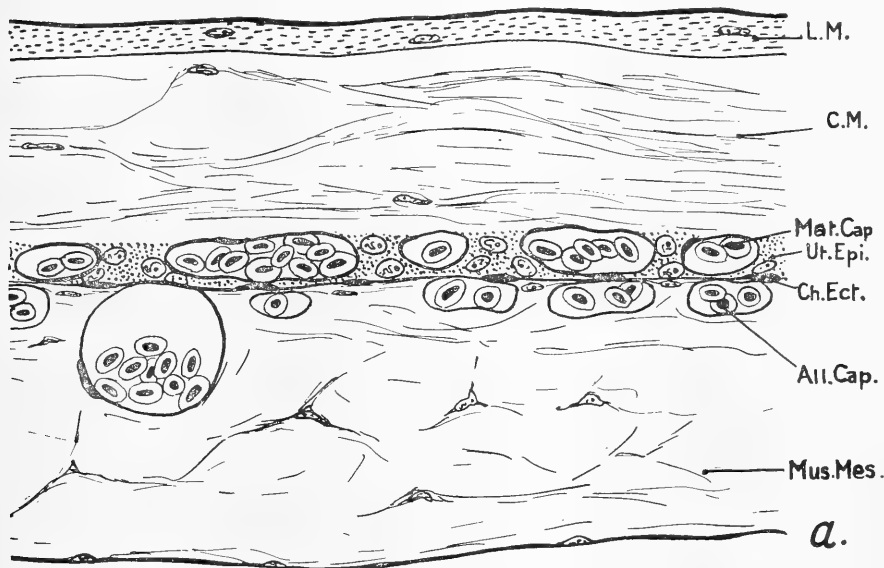
The structure of the maternal and foetal tissues surrounding the yolk-sac is also very similar to that of these tissues in *Egernia*, except that in *T. nigrolutea* the surface of the uterine wall is often folded and the omphalo-chorionic membrane is thrown into corresponding folds which fit loosely into the shallow grooves between the uterine folds. Occasionally a similar folding occurs in *Egernia*, but it is not as characteristic as in *Tiliqua*.

The extension of the blood-vessels around the yolk-sac is on the same plan as in *Egernia*, where a wide strip of yolk-containing endoderm is separated from the main bulk of the yolk-sac.

Professor T. Flynn (1923) described a stage in the placentation of the "blue tongue" lizard, *Tiliqua scincoides*. He writes (1923, p. 76): "Possessing as I do but one definitely placental stage, it is not easy to say with exactness what alterations have taken place in the various foetal and maternal structures which enter into the formation of the allantoic and maternal placenta. The union between chorion and the uterine epithelium is very intimate. Uterine epithelium apparently consists of a single layer of very flattened cells, while the chorionic ectoderm has proliferated greatly, is much vacuolated, resembling a typical plasmodium, and is formed in the main of markedly enlarged cells with large nuclei connected together by amoeboid processes. With this previously prepared tissue the allantois fuses by its placental surface. This is not at this stage a complete union but occurs at a large number of points." Flynn gave no accompanying figures of the histological relations of the placental region, so it was difficult accurately to compare the placentation he described with that of other lizards. However, I collected specimens of *T. scincoides* during the breeding season of 1928 and was able to make observations of the placentation. The placentae examined were all taken from embryos in advanced stages of development and are considered to be mature. Flynn does not mention the maternal circulation. From my observations, the maternal capillaries are seen to be concentrated at the surface of the uterus and the "single layer of very flattened cells", which Flynn speaks of, represents the remains of the deeper layer of uterine epithelium which partially degenerated as a result of its invasion by the capillaries. At the stage examined I could find no trace of the "typical plasmodium of markedly enlarged cells" (chorionic ectoderm cells). Although the nuclei are fairly large and deeply staining, the cells themselves are not markedly enlarged but are flat and tapering and even degenerated in places, allowing the allantoic capillaries to come into contact with the overlying maternal tissues (Text-fig. 4a). As this stage differed in this respect from that described by Flynn, it is assumed that his must have been a younger stage than was available to me, since at all later stages examined the placenta remained as described.

Flynn also described an even earlier stage, but unfortunately the maternal structures had not been kept and the evidence afforded by the uterine wall was not available to him. In this stage, where the allantois is but a small diverticulum of the hind gut, the chorionic ectoderm cells in the immediate region of the embryo have begun to proliferate and are considerably enlarged. Through the courtesy of the Department of Zoology, University of Sydney, I was able to examine Flynn's slides of this stage and to figure it (Harrison and Weekes, 1925). It is interesting that such a modification was not met with during the examination of the various stages in the development of the placenta of those other lizards which have a similar type of mature placenta. However, as there are no signs of such proliferation in the mature allanto-placenta of *T. scincoides*, it seems justifiable to deduce

that the condition is transitory, the proliferation possibly only serving to facilitate the attachment of the foetal to the maternal tissue, and that the mature placenta corresponds in all essentials to that in the lizards *L. (Hinulia) quoyi*, *E. cunninghami*, *E. whitei* and *E. striolata*.



Text-fig. 4a.—Section of mature placenta of *T. nigrolutea*. $\times 400$.
 4b.—Section of mature allantoiplacenta of *L. (Hemiergis) quadridigitatum*.
 $\times 400$. *All. Cap.*, allantoic capillary; *C.M.*, circular muscle; *Ch. Ect.*, chorionic ectoderm; *L.M.*, longitudinal muscle; *Mat. Cap.*, maternal capillary; *Mus. Mes.*, muscular mesenchymatous tissue; *Ut. Epi.*, uterine epithelium.

LYGOSOMA (HEMIERGIS) QUADRIDIGITATUM.

Specimens of *Lygosoma (Hemiergis) quadridigitatum* were collected from Tarana and the Jenolan district in the summer of 1928, together with specimens of *E. cunninghami* and other lizards. This lizard measures about six inches in length and is narrow and snake-like, its fore and hind limbs having degenerated.

It always lives in the dark, mostly under logs or tree stumps. The ovulation and fertilization of these lizards took place during the last week of November in 1928, and the young were born at the end of February. The eggs in the oviducts are distinctly oval, in accordance with the narrow snake-like body of the parent. A little albumen is present and a thin shell-membrane surrounds the eggs. In early stages in the development of the embryo the shell-membrane over the embryonic region is absorbed and the remainder collects with the albumen at the base of the yolk-sac.

The embryo lies on its left side on the yolk-sac and the allantoic stalk passes immediately upward to expand into the allantoic vesicle. The allantois is vascularized by two main umbilical arteries and veins and the yolk-sac is vascularized by two main arteries and one main vein which unite in the yolk-sac stalk before passing into the embryo. The allantois does not grow round the yolk-sac, but only expands as the yolk-sac decreases in size. The uterus is vascularized by one main longitudinal artery and vein on its dorsal surface and each of the vessels has transverse branches which pass round the uterus to the region underlying the bases of the yolk-sacs of the contained eggs. In all these respects *L. (Hemiergus) quadridigitatum* resembles other lizards examined, but it has been thought advisable to include a brief description as this is the first account of the intra-uterine relations of this subgenus *Hemiergus*.

Allantoplasentation occurs over the whole of the uterine surface embraced by the chorio-allantoic membrane. The allantoplasenta is fundamentally similar to that found in *L. (Hinulia) quoyi*, *E. cunninghami*, *E. whitei* and *E. striolata*, and a description is therefore considered unnecessary. Since *L. (Hemiergus) quadridigitatum* is a small lizard and has comparatively small embryos, the thick band of mesenchymatous tissue underlying the chorionic ectoderm of the chorio-allantoic membrane found in the larger lizard *E. cunninghami* is absent (Text-fig. 4*b*).

MABUJA MULTIFASCIATA.

Mabuja multifasciata is yet another viviparous skink and is a fairly large lizard, the mature adult measuring about 10 inches in length. Only mature stages in the development of the allantoplasenta are available for examination. The allantoplasenta is essentially similar to that described above for *Egernia*, *T. nigrolutea* and *T. scincoides*, in which the area of allantoplasentation extends over the whole surface of the uterus embraced by the chorio-allantoic membrane and is characterized by the partial degeneration of maternal and foetal epithelial tissues over the placental face and the close apposition of maternal and foetal blood-streams.

LYGOSOMA (LIOLEPISMA) OCELLATUM, L. (L.) METALLICUM AND L. (L.) PRETIOSUM.

Material.

Each of these three species of lizard is a comparatively small skink about four or five inches in length, and all three occur in great numbers in Tasmania. According to the available records *L. (L.) ocellatum* and *L. (L.) metallicum* are apparently restricted to Tasmania. Specimens from Victoria recorded as *L. (L.) pretiosum* were examined and found to be really a new species now called *Lygosoma (Liolepisma) weekesae* (Kinghorn, 1929). As this is the only record of *L. (L.) pretiosum* from the mainland of Australia it seems possible that this lizard may also be restricted to Tasmania. The three species are the most common

skinks in Tasmania and no difficulty was experienced in collecting numbers of them, whether at sea-level or at a height of 4,000 feet.

The lizards were collected during January, 1929, and were kept alive until the birth of the young, which occurred for the most part during the first and second weeks of February; however, some young were born in the middle of January from lizards collected at sea-level in northern Tasmania, where spring and consequently the beginning of the gestation period are earlier than in the high regions in the south. The embryos in the lizards collected were all fairly well developed and were at about the middle of their gestation period.

Placentation.

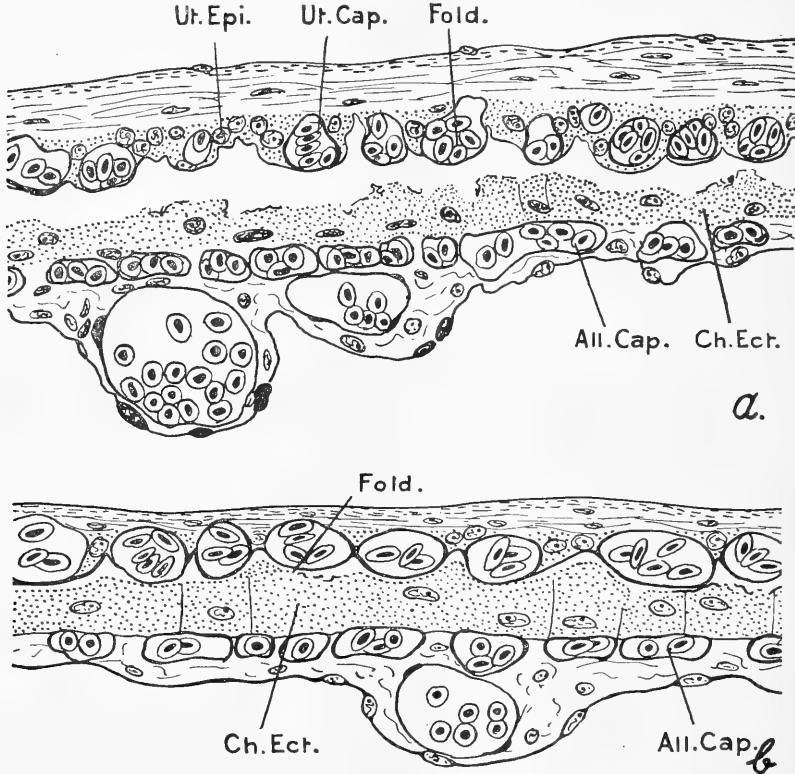
The placentation and the anatomical relations between the embryo, its membranes and its yolk-sac are the same in the three species and in this description no distinction is made between the species. The females carry from three to seven young, five being the usual number and, as in other viviparous lizards examined, the right uterus usually holds one more egg than the left. The embryo lies on its left side on the yolk-sac, with its long axis parallel to that of the parent. The general disposition of the embryo on its sac and of the foetal membranes and umbilical and yolk-sac blood-vessels has been described for two other species of this subgenus, *L. (L.) entrecasteauxi* (Harrison and Weekes, 1925) and *L. (L.) weekesae* (Weekes, 1929) and it is sufficient to say here that in these respects *L. (L.) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum* correspond in all essentials with the two related species.

There are the remains of shell-membrane at the base of the yolk-sac. At the early stage examined the embryo and its allantoic vesicle occupy about half the incubatory chamber and the yolk-sac is reduced and occupies the other half. The chorio-allantoic membrane is firmly established, the allantoic vesicle completely filling the extra-embryonic coelome as far as the upper surface of the yolk-sac. The area of allantoplacentation extends over the whole surface of the chorio-allantoic membrane.

Perhaps one of the most striking features of the allantoplacenta in these forms is the extreme thinness of the uterine wall, as illustrated by Figure 3 on Plate xxiii. The chorio-allantoic membrane is usually pressed against the uterine surface, but the epithelial cells of the chorionic membrane are not actually attached to the maternal face of the placenta. In Figures 2 and 3 on Plate xxiii the apposition is not close, but the separation of the tissues occurred during their preparation for sectioning. There are often large areas where the apposition is close (Text-fig. 5*b*). The uterine wall is covered with a series of small folds which, although small, are nevertheless quite characteristic, and distinguish this type of placenta from that described above for *Egernia* and *Tiliqua*. Each fold consists of one maternal capillary with a thin endothelial coat surrounded by a layer of uterine epithelium in which the cell walls are difficult to distinguish. That part of the epithelium which immediately underlies the capillaries is thin and usually without nuclei, the nuclei being congregated in the thicker epithelium between the capillaries (Text-fig. 5*a*; Pl. xxiii, fig. 2).

The chorio-allantoic membrane is vascularized by numerous small capillaries and larger vessels which immediately underlie the chorionic ectoderm. In section the chorionic epithelium has almost the appearance of a deeply staining syncytium with large nuclei embedded (Pl. xxiii, fig. 2); however, in surface view the cell walls are distinct and the ectoderm is seen to be truly cellular. Over most of the

placental region the chorionic epithelium is pressed closely against the folds in the uterine wall and extensions of the epithelial cells grow into the grooves between the folds, so that the whole has the appearance of dove-tailing. Often in section the groove appears to be completely filled with the extension from one large epithelial cell (Text-fig. 5*b*) which may attach itself to the maternal tissue



Text-fig. 5*a*.—Section of mature allantoplacenta of *L. (L.) ocellatum*. $\times 400$.
5*b*.—Section of mature allantoplacenta of *L. (L.) ocellatum* showing apposition of maternal and foetal tissues. $\times 400$. *All. Cap.*, allantoic capillary; *Ch. Ect.*, chorionic ectoderm; *Ut. Cap.*, uterine capillary; *Ut. Epi.*, uterine epithelium.

so that, if the maternal and foetal tissues are separated in the process of sectioning, the free margins of the epithelial cells may be jagged and torn (Pl. xxiii, fig. 2). This type of placenta is obviously simple and its significance will be discussed later.

SOME EARLY STAGES IN THE DEVELOPMENT OF THE ALLANTOPLACENTA IN THE SCINCID LIZARD, *LYGOSOMA (LIOLEPISMA) ENTRECASTEAUXI*.

Material.

In the paper on the placentation of *Lygosoma (Liolepisma) entrecasteauxi* by the late Professor Harrison and myself (Harrison and Weekes, 1925), a late stage in the development of the placenta was described and an account of earlier stages promised. At the beginning of the breeding season of 1925 specimens of *L. (L.)*

entrecasteauxi containing very young embryos were collected from Mount Kosciusko, Australia, and were kept alive during the rest of the gestation period, about eleven weeks. Lizards were opened and the young removed at intervals of a few days during that period and a fairly complete series of developmental stages is therefore available. At the earliest stage examined, the beginnings of placentation are already evident and therefore, although this stage is comparatively a very early one in the development of the embryo, it will be necessary to examine even earlier stages before the account of the development of allanto-placentation in this lizard can be completed. A description of available stages is included here since, in the discussion of the placentation in the other lizards described in this paper, reference is made to the early development of the placentation in *L. (L.) entrecasteauxi*.

Placentation.

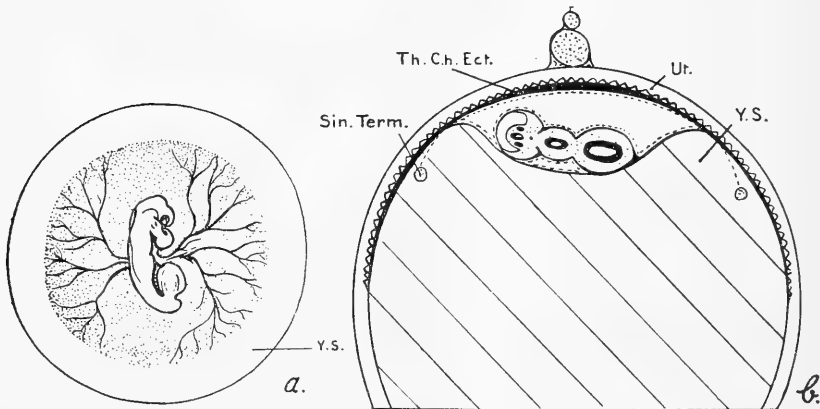
As stated, the mature allanto-placentation has already been described and illustrated (Harrison and Weekes, 1925). Included here is one of the photomicrographs published in that paper which illustrates very satisfactorily the general disposition of the main maternal allanto-placental region in surface view (Pl. xxvii, fig. 4). This placental region is roughly elliptical in shape and the coiled folds in the uterine wall stand out distinctly in the photomicrograph. The maternal circulation is also clearly shown; the darker region lying longitudinally in the middle of the placental region represents the two main maternal blood-vessels, the longitudinal artery and vein, slung in a fold of mesometrium, and the numerous vessels running transversely are branches from these two main vessels, the narrower arteries (Pl. xxvii, fig. 4, *Br. A.*) roughly alternating with the thicker veins (Pl. xxvii, fig. 4, *Br. V.*).

Further illustrations of the mature allanto-placenta of material collected since the publication of the above paper are given as Figure 4 on Plate xxvi, Figure 3 on Plate xxvii and Figure 5 on Plate xxviii. Figure 4 on Plate xxvi illustrates the histological structure of the mature elliptical allanto-placenta, for a detailed description of which reference should be made to the above-mentioned paper. It is sufficient to say here that the folds lining the uterus are complicated when compared with those in the allanto-placentae of other species of lizard; that each fold is filled with capillaries and lined by a single layer of enlarged, cuboid, ciliated, epithelial cells, which have the appearance of being secretory; that the chorionic ectoderm cells pressed against maternal folds are enormously enlarged and ciliated; and that the general form of the ridges impresses itself upon the chorionic surface which is thus marked off into a series of bays and prominences, the prominences loosely fitting into the grooves between the maternal folds. Figure 3 on Plate xxvii is a photograph of the foetal elliptical allanto-placenta. The dark elliptical area consists of greatly thickened chorionic epithelium overlying a richly vascularized allantois. This elliptical region lies immediately beneath the maternal elliptical region illustrated on the same plate.

Description of the Allanto-placentation of Embryos in Lizards collected and examined on 11th November, 1925.

It is impossible to judge accurately the age of the embryos examined on 11th November, 1925, since the times of the fertilization of the ova are not known and the date of the fixation of the embryos can alone be recorded. It must be stressed

that the dates given are for the breeding season of 1925 only, since the beginning of the breeding season varies each year and roughly corresponds with the coming of spring. The embryos examined are, with few exceptions, at similar stages of development, the breeding season being a fairly regular one. The embryos have reached the stage in their development illustrated by Text-figures 6a and 6b, where the amnion and chorion are formed, but where the allantois is only a small protuberance at the posterior end of the embryo. The embryo lies on its left side on the surface of the yolk-sac in a position dorsal with regard to the parent and immediately beneath the main maternal longitudinal blood-vessels.



Text-fig. 6a.—The stage of development of majority of embryos of *L. (L.) entrecasteauxii* examined 11th November, 1925. $\times 10$. 6b.—A diagrammatic representation of section through egg and surrounding uterine wall at this stage. $\times 14$. *Sin. Term.*, sinus terminalis; *Th. Ch. Ect.*, thickened chorionic ectoderm; *Ut.*, uterus; *Y.S.*, yolk-sac.

At this stage there is a thin shell-membrane and a little albumen at the sides and base of the yolk-sac, but in the dorsal and embryonal region there is only the remains of degenerating shell-membrane embedded in a thin coagulum of what may be maternal secretion containing loose cells and corpuscles. A surface view of the placental area was obtained by removing the dorsal half of an incubatory chamber and staining and mounting it whole as shown in Plate xxvii, figure 1. In surface view there are as yet no indications of the elliptical allanto-placental region which is so well defined at later stages. In the previous paper (Harrison and Weekes, 1925, p. 474) we said "we reserve a full statement of the details of maternal circulation for a future occasion when we shall have earlier developmental stages for examination and comparison. Here we give merely a brief outline of the arrangement of the vessels in the uterine wall. A large artery and vein run longitudinally along the dorsal side of the uterus, slung in a fold of the mesometrium, and standing out as a prominent ridge bisecting the allanto-placental area . . . the vein receives a single large branch vein from each placental area to which latter the artery sends out a single branch . . ." An examination of early stages has shown that, as in other lizards examined, the branch arteries and veins which run transversely round the uterus pass directly into the single large artery and vein which lie in a longitudinal direction along

the dorsal surface of the uterus and not first into separate branch vessels from each placental area. The interpretation published in 1925 was incorrect.

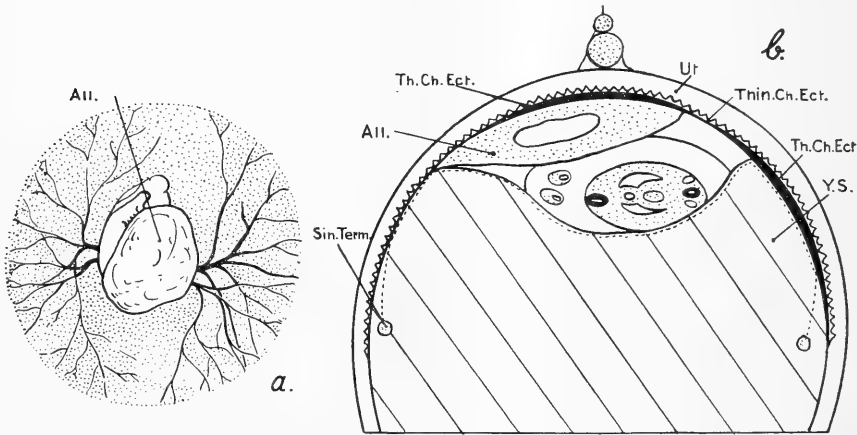
At the early stage under consideration the arrangement of the vessels is essentially similar to that at later stages and, except for a marked enrichment of the blood supply and a consequent enlargement of the vessels, the maternal circulation conforms to the same plan throughout the gestation period. There are small branch vessels which feed the elliptical allantoplacenta alone and which are most evident at later stages of its development. Whether they are all formed in the uterus at early stages of development or whether they are formed throughout the gestation period is difficult to determine, since at early stages they are narrow and indistinct and it is not easy to separate them from the general background of the uterus which contains an extraordinarily rich capillary network. From the evidence available it seems probable that many of the vessels are formed throughout the gestation period. A comparison of Figures 1 and 4 on Plate xxvii shows the marked enrichment of the blood supply during the gestation period.

In section the uterine wall of the earliest stage available is very thin and contains few glands, those present being flattened and obviously not functioning (Plate xxiv, fig. 2). No folds are noticeable when a surface view of the uterus is examined, but in sectioned material they are quite distinct although small. The absence of any indication of an elliptical allantoplacental area on the surface of the uterus is due to the more or less uniform distribution of the small folds over the entire under surface of the uterus surrounding the dorsal half of the egg (Text-fig. 6*b*). There may be a few smooth areas on the face of the uterus in this region, but these later become covered with folds. Over the smooth region the uterine epithelium is a single layer of fairly regular long and narrow cells which are to a large extent separated from each other, have swollen apices, and appear to be secretory (Text-fig. 8*a*; Pl. xxiv, fig. 1). In the ridged regions each small ridge contains a small capillary which is surrounded by epithelial cells, arranged in a fan-like manner, which have the same histological structure as the cells lining the smooth portions of the uterus (Pl. xxiv, fig. 2). It is interesting that the folds are so widely distributed when first formed. At this stage the chorionic membrane extends for a comparatively short distance over the yolk-sac and in the immediate embryonic region the chorionic epithelium is thickened (Text-fig. 6*b*), but the epithelial cells, although comparatively large, are only about one-tenth of the size they eventually attain. The dividing cell walls are distinct, the cell cytoplasm stains deeply and the cell apices are swollen. These cells have probably absorbed the shell-membrane from their immediate vicinity, as do the chorionic ectoderm cells in the early developmental stages of other viviparous lizards examined.

*Description of the Allantoplacentalation of Embryos in Lizards examined on
20th November, 1925.*

At the next important stage in the development of the allantoplacenta, the allantois covers the posterior end of the embryo and the chorio-allantoic membrane is established (Text-fig. 7; Pl. xxvi, fig. 1). Stages intermediate between this and the previous stage described are available, but beyond the acquisition of a complete covering of folds over the under surface of the uterus surrounding the dorsal half of the egg and the further extension of the extra-embryonic ectoderm and the extra-embryonic circulation over the yolk-sac, there are no further

important developments to be observed. In the surface view of this second stage there are still no signs of an elliptical placental region on the uterine wall; in sectioned material, however, the folds are seen to be more numerous and slightly larger, the increase in the size of each fold being caused by the enlargement of the epithelial cells and the swelling of the contained capillary which is not only larger at this stage, but is also rounded and packed with corpuscles. The folds are pressed close together so that they appear square in cross-section (Text-fig. 8*d*; Pl. xxiv, fig. 3; Pl. xxvi, fig. 1) and their general outline resembles that described for the folds in early developmental stages of the allantoplacenta of *L. (L.) weekesae* (Weekes, 1929, p. 49). With the growth of the embryo and the expansion of the allantoic vesicle the uterus is stretched and the folds again become separated. Figures *a*, *b*, *c* and *d* of Text-figure 8 illustrate the four main steps in the development of the folds up to this stage.



Text-fig. 7*a*.—The stage of development of majority of embryos of *L. (L.) entrecasteauxi* examined 20th November, 1925. $\times 10$. 7*b*.—A diagrammatic representation of section through egg and surrounding uterine wall at this stage. $\times 14$. *All.*, allantois; *Sin. Term.*, sinus terminalis; *Th. Ch. Ect.*, thickened chorionic ectoderm; *Thin. Ch. Ect.*, thin chorionic ectoderm; *Ut.*, uterus; *Y.S.*, yolk-sac.

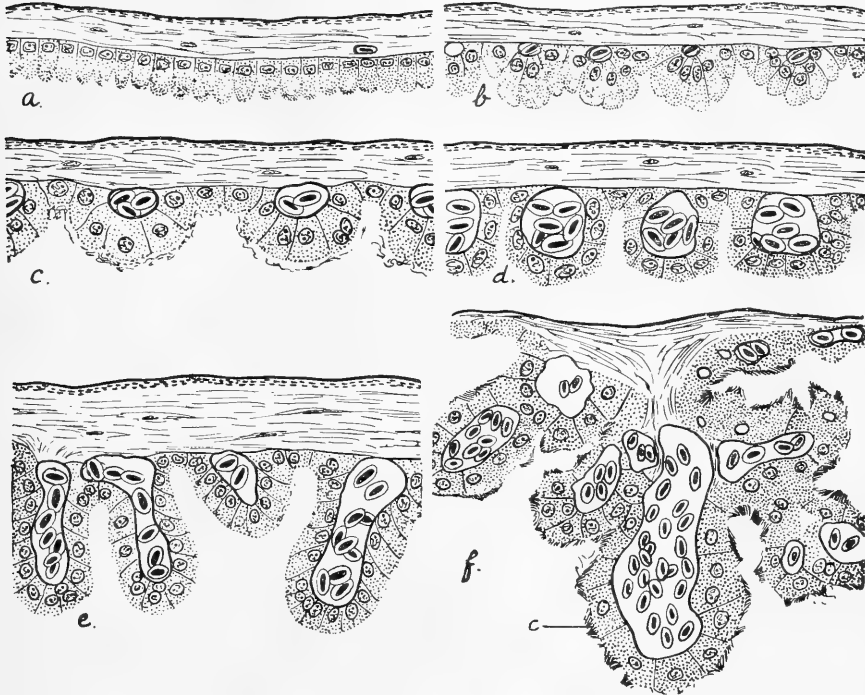
The thickening of the chorionic epithelium extends for some distance over the surface of the yolk-sac and there may be thin areas interspersed among the thick areas (Text-fig. 7*b*), although there is no apparent reason for this patchy arrangement. The allantoic mesenchyme contains many capillaries and fresh blood channels are being formed. Figure 3 on Plate xxv is a photomicrograph of part of the allantoplacenta at this stage, included here to show the collection of material between the uterus and the chorionic ectoderm.

Description of the Allantoplacentation of Embryos in Lizards examined on 28th November, 1925.

It is not until the embryo and its allantois occupy a third of the incubatory chamber that the next important steps in the development of allantoplacentation are evident. At this stage an elliptical faintly opaque area can be seen in the

dorsal region of the incubatory chamber. This is the beginning of the mature elliptical allanto-placentation which is about half its ultimate size (Pl. xxvii, fig. 2).

As may be expected, an examination of the sectioned material reveals a further specialization of the maternal folds particularly at the dorsal region of the incubatory chamber beneath the main longitudinal blood-vessels, where many of the folds are deep and narrow and perhaps more closely packed than at



Text-fig. 8.—Stages in development of maternal folds in allanto-placentata of *L. (L.) entrecasteauxi*. a-e $\times 450$; f $\times 340$. c, cilia.

the last stage described. The folds in the uterine wall surrounding the elliptical area (Text-fig. 10b, *Sm. Plac. R.*), are now flattened (Pl. xxviii, fig. 1) and this flattening is the first step in their degeneration which is complete by the time the mature placenta is established (Pl. xxviii, fig. 3).

The chorionic epithelium underlying the deep narrow folds is definitely thicker than that in surrounding regions, but the epithelial cells are not yet ciliated (Pl. xxvi, fig. 2).

The most important advances, then, in the development of the allanto-placentata at this stage are (1) the appearance of the opaque, elliptical area on the dorsal surface of the incubatory chamber, due to the further specialization of the folds in the uterine wall in the region of the main uterine longitudinal blood-vessels, (2) the beginning of the degeneration of the folds in the uterine wall overlying the sides of the egg, and (3) the further thickening of the chorionic

epithelium immediately beneath the more specialized maternal folds. With the concentration of the specialization of maternal and foetal tissues into an elliptical area at the dorsal region of the incubatory chamber and egg respectively, the beginnings of the main region of allantoplcmentation are made.

The further development of the elliptical allantoplacenta is from this stage (28th November, 1925) quite straightforward until, in specimens examined at the end of the first week of December, the elliptical placenta is well defined, its clearer definition being due to its greater opacity which is caused by the general enlargement and further folding of the ridges and the thickening of the underlying chorionic epithelium (Pl. xxvi, fig. 4). The elliptical placenta is considered to be mature at this stage, since there is no further noticeable specialization during the rest of the gestation period. The amount of folding of the uterine wall varies with the individual specimen as a comparison of Figure 4 on Plate xxvi with Figure 5 on Plate xxviii shows. The epithelial cells lining the folds are now enlarged, cuboid and ciliated. The specialization of the chorionic epithelium is restricted to the region immediately underlying the maternal folds, so that an area of thickened chorionic epithelium underlies the elliptical maternal placenta. The chorionic ectoderm cells attain enormous proportions and are ciliated (Pl. xxv, fig. 2). A comparison of Figure 4 on Plate xxiv with Figure 2 on Plate xxv shows the marked enlargement of these cells. The fairly complicated fold shown as Figure 1 on Plate xxv arose out of a further development of a simple fold such as is shown in section by Figure 2 on Plate xxiv.

The structure of the tissues of the uterus and the chorio-allantoic membrane in the smooth regions adjoining the mature elliptical ridged placental area deserves special comment. The flattening and degeneration of the folds, which are already noticeable in those specimens examined on 28th November (Pl. xxviii, fig. 1), continue (Pl. xxviii, fig. 2) until, at the end of the first week of December, there are no longer even traces of the former folds, and the maternal epithelium lining the uterine face has actually degenerated so that there is only a thin layer of epithelial cytoplasm underlying the maternal capillaries (Pl. xxviii, fig. 3). The foetal tissue is attached to the maternal tissue by the chorionic epithelial cells which are also flattened and which taper over the allantoic capillaries. This region, which has been referred to in a previous paper (Weekes, 1929) as the "smooth region of allantoplcmentation", to distinguish it from the elliptical ridged region, is obviously allantoplacental, the secretion and absorption of gases and perhaps nutriment being facilitated by the close apposition of maternal and foetal blood-streams. The structure of the smooth allantoplacental region is strikingly similar to that of the mature allantoplacenta described for *L. (Hinulia) quoyi*, *E. cunninghami*, *E. whitei*, *E. striolata*, *T. nigrolutea* and *T. scincoides*.

In the development of the allantoplacenta of *L. (L.) entrecasteauxi* there is, then, first the occurrence of small folds on the entire under surface of the dorsal half of the incubatory chamber and the enlargement of the chorionic ectoderm cells of the chorionic membrane in this region. There follows the enlargement and further complication of the folds and their concentration into an elliptical area on the under surface of the dorsal region of the uterus in the region of the main longitudinal artery and vein and the further thickening of the chorionic epithelium immediately underlying the enlarged uterine folds. Finally, the folds in the regions surrounding the elliptical area degenerate and the chorionic ectoderm lining the underlying chorio-allantoic membrane also degenerates, so

that a second region of allantoplacentation is established where the thinness of the maternal and foetal epithelium allows the close apposition of maternal and foetal blood-streams.

THEORETICAL CONSIDERATIONS.

In an earlier paper (Harrison and Weekes, 1925) it was claimed that the occurrence of similar types of placentae in two not very closely related Scincid genera, *Lygosoma* and *Chalcides*, indicates the independent evolution of the placenta in each. The results of continued investigation into reptilian placentation have further established the claim of the independent evolution of similar types of placentae among reptiles. The occurrence of similar types of placentae in the lizards *E. cunninghami*, *T. nigrolutea* and *L. (Hinulia) quoyi* can, to my mind, only be explained by this hypothesis, since it would be obviously unsatisfactory to attempt to relate these forms more closely, because of their similar placentae, in spite of the obvious anatomical differences between them. Further substantiation is given by the difference in the placentation of members of the same genus *Chalcides* and by the fact that both oviparous species and viviparous species with fairly well developed placentae occur in one and the same subgenus, *Liolepisma*.

The facts thus far established by a study of reptilian placentation point to the conclusions, (i) that placentation as a functional adaptation to environment has arisen independently many times in the course of evolution among reptiles, and (ii) that the phenomenon of parallel development of similar types of placentae among reptiles is common.

It is interesting that all the lizards for which placentation has been recorded belong to the family Scincidae, but no significance is attached to this fact, since it is known that members of other families are viviparous and these may prove to be placental upon examination. Miss J. Procter, Curator of Reptiles, Zoological Gardens, London, has called my attention to a viviparous chameleon, the investigation of which should be interesting.

The possibility of tracing various stages in the evolution of the more specialized types of placentation suggested itself after a study of what are now considered to be simpler types. The placentation first examined was that of *L. (L.) entrecasteauxii* (Harrison and Weekes, 1925) and, in the beginning, attention was mainly given to the elliptical area of allantoplacentation so prominent in the dorsal region of the incubatory chamber. Later, after an examination of the placentation of *L. (Hinulia) quoyi* (Weekes, 1927), it was noticed that the histological structure of, and the relationship between, the uterine wall and the apposed chorio-allantoic membrane over the non-ridged area in *L. (L.) entrecasteauxii* (Pl. xxviii, fig. 3) were almost identical with those in the mature placenta of *L. (Hinulia) quoyi*. In both these regions of allantoplacentation the maternal and epithelial tissues partly degenerate and the maternal and foetal blood-streams are closely apposed. This resemblance, together with the simplicity of the structure of the placenta in *L. (Hinulia) quoyi*, suggested that perhaps the placentation in *L. (L.) entrecasteauxii* may have evolved from a type similar to that now occurring in *L. (Hinulia) quoyi*. This is not a remarkable or even an important supposition, as obviously the placentation in *L. (L.) entrecasteauxii* must have developed out of some very simple form of placenta, and it would be difficult to visualize a more simple or natural expression than that which occurs in *L. (Hinulia) quoyi* and also in *E. cunninghami*, *E. whitei*, *E. striolata*, *T.*

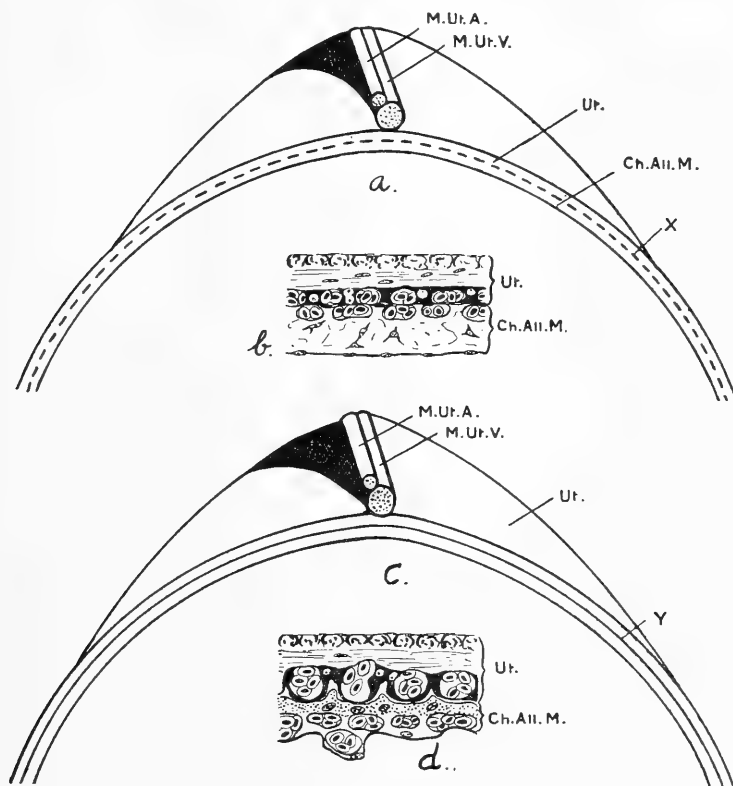
nigrolutea, *T. scincoides*, *L. (Hemiergus) quadridigitatum* and *Mabuja multifasciata*.

Giacomini (1906) described a condition for *Chalcides ocellatus* in which the richly vascular maternal and foetal tissues are closely apposed and which he considered too simple to be called placental. Giacomini's description of the apposed tissues could very well be applied to the corresponding condition in *L. (Hinulia) quoyi*, *E. cunninghami*, *E. whitei*, *E. striolata*, *T. scincoides*, *T. nigrolutea*, *L. (Hemiergus) quadridigitatum* and *Mabuja multifasciata*; however, early stages in the development of the embryo in these lizards show that this condition is brought about by a definite change in the structure of the uterine wall and the chorio-allantoic membrane, and that the foetal tissues are actually attached to the maternal tissues and that some exchange, even if only of gases, obviously takes place between them. This condition, therefore, to my mind, rightly deserves the name placenta in spite of the obvious simplicity of its structure.

A study of the eggs, as well as a consideration of the simplicity of the placenta in *L. (Hinulia) quoyi*, *E. cunninghami*, *E. whitei*, *E. striolata*, *T. scincoides*, *T. nigrolutea*, *L. (Hemiergus) quadridigitatum* and *Mabuja multifasciata*, suggests, to my mind, that these lizards have possibly adopted viviparity and this form of placentation comparatively recently, since the eggs, when compared with those of oviparous lizards of the same adult size, do not show an obvious reduction in yolk-content and the yolk in some species is even surrounded by a little albumen. But when the eggs of *L. (L.) entrecasteauxi* and *C. tridactylus*, lizards with a comparatively specialized placenta, are examined, the reduction of the yolk-content is obvious, the eggs of *L. (L.) entrecasteauxi* being barely two-thirds the size of eggs of oviparous species of the same adult size, while those of *C. tridactylus* (Giacomini, 1891, p. 333) measure only about 2.5 to 3 mm. in diameter compared with at least 8 mm. in oviparous species of the same adult size. This reduction suggests, to my mind, that a comparatively long time must have elapsed since this form became viviparous. The suggestion might be made that *L. (L.) entrecasteauxi* and *C. tridactylus* adopted viviparity at the same time as the above-mentioned lizards, but that their specialized type of placenta has been developed and the yolk-content of their eggs reduced more rapidly. Whether the adaptation was synchronous or not has no important bearing on the conclusions that the type of placenta in *L. (Hinulia) quoyi* is simple and that in its evolution the placenta in *L. (L.) entrecasteauxi* possibly passed through a stage similar to that now represented by the mature placenta in *L. (Hinulia) quoyi*.

The discovery in *L. (L.) weekesae* (Weekes, 1929) of an allantoplacenta which is of the same type as that in *L. (L.) entrecasteauxi*, although not as well specialized, was not unexpected. In *L. (L.) weekesae* there is the same well-defined elliptical allantoplacenta in the dorsal region of the incubatory chamber and the same smooth allantoplacental region characterized by closely apposed maternal and foetal blood-streams as in *L. (L.) entrecasteauxi*. The maternal folds in the elliptical placental region are essentially similar to those in *L. (L.) entrecasteauxi*, but the ridges are simpler and not so deeply folded and the sheet of chorionic epithelium underlying the maternal ridges is not so thick. Indeed, the mature placenta in *L. (L.) weekesae* greatly resembles a stage in the development of the placenta in *L. (L.) entrecasteauxi* just before it reaches maturity, and so close is this resemblance that it was necessary to refer to the labels on the slides

of sectioned material in order to distinguish the species. This resemblance suggests rather obviously that in its phylogeny the placenta in *L. (L.) entrecasteauxi* passed through a stage now represented by the mature placenta in *L. (L.) weekesae*. A comparison of Figure 4 on Plate xxviii, Figure 3 on Plate xxvi and Text-figures 10a and 10b will show clearly enough the grounds for this assumption. It may be suggested that, since *L. (L.) entrecasteauxi* and *L. (L.) weekesae* are closely related lizards (Kinghorn, 1929), they may have come from the same placental stock, the specialization of the placenta having progressed further in one than in the other. This would naturally mean that their placentae



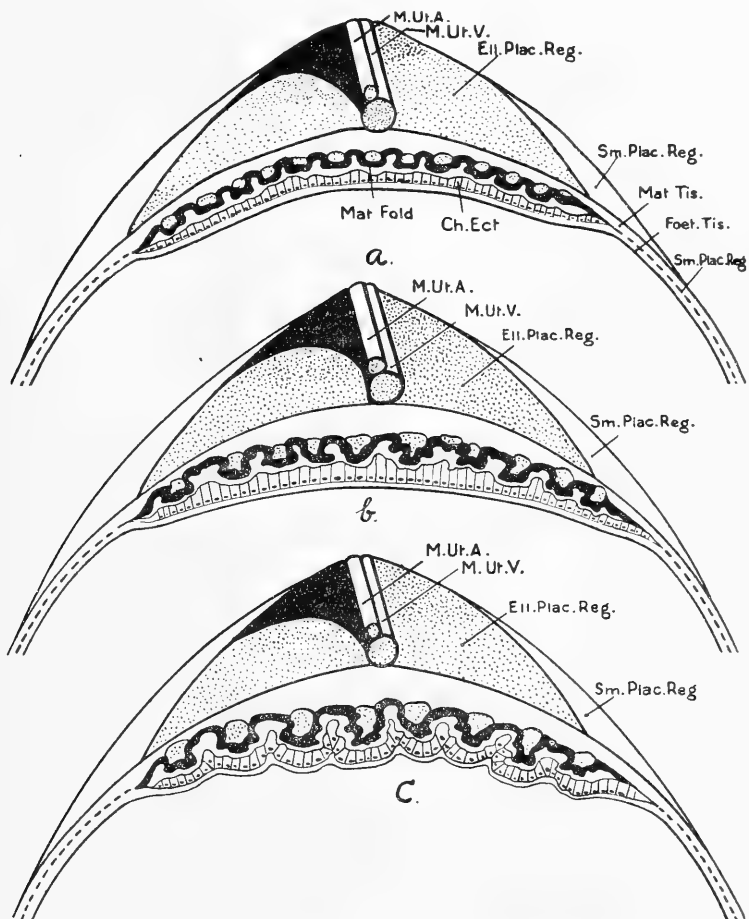
Text-fig. 9a.—A diagrammatic representation of part of incubatory chamber with apposed chorio-allantoic membrane, illustrating the simple type of allanto-placenta found in the lizards *L. (Hinulia) quoyi*, *E. cunninghami*, *E. whitei*, *E. striolata*, *T. scincoides*, *T. nigrolutea*, *L. (Hemiergis) quadridigitatum* and *M. multifasciata*. The attachment of foetal to maternal tissue is indicated by the broken line X. $\times 10$. 9b.—Portion of allanto-placenta shown in Figure 9a magnified to show histological structure. 9c.—A diagrammatic representation of part of incubatory chamber with apposed chorio-allantoic membrane, illustrating type of allanto-placenta found in lizards *L. (L.) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum*. The separation of foetal from maternal tissue is indicated by unbroken line Y. $\times 12.5$. 9d.—Portion of allanto-placenta shown in Figure 9c magnified to illustrate its histological structure. Ch. All. M., chorio-allantoic membrane; M. Ut. A., main uterine artery; M. Ut. V., main uterine vein; Ut., uterus.

are related and have not been independently evolved. Indeed, it would perhaps be strange if such instances of placental relationship did not occur among a group so widely adopting viviparity and the general conclusion of the independent evolution of similar types of placentae among the reptiles is not challenged by such an instance.

The placenta in *L. (L.) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum* may now be considered. This placenta is slightly more highly specialized than that in *L. (Hinulia) quoyi*, since the maternal capillaries, instead of remaining level with the surface of the maternal placental face as they do in *L. (Hinulia) quoyi*, bulge to form the folds described above and the chorionic ectoderm cells, which are much flattened in *L. (Hinulia) quoyi*, are enlarged and fit into the shallow maternal grooves between the folds. However, these are not fundamental differences and, to my mind, the placenta in *L. (L.) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum* may be regarded as a further specialization of the condition in *L. (Hinulia) quoyi*, and, since it is suggested that the placenta in *L. (L.) entrecasteauxi* may possibly have come from an original type such as is now found in *L. (Hinulia) quoyi* (Text-fig. 9a and 9b), it is interesting to see if there are any suggestions in the ontogeny of the placenta in *L. (L.) entrecasteauxi* of it having passed through such a stage in its phylogeny as is now represented by the mature placenta in *L. (L.) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum* (Text-fig. 9c and 9d). It will be recalled that, at the earliest stage in the development of the placenta in *L. (L.) entrecasteauxi* examined, small folds occur over the entire under surface of the uterus surrounding the embryo, and that it is only at later stages that they become restricted to the elliptical area on the dorsal region of the incubatory chamber. The presence of small folds over the entire under surface of the uterus in contact with the chorio-allantoic membrane does, to my mind, suggest the placentation in *L. (L.) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum* and the structure of the shallow folds in *L. (L.) entrecasteauxi* and of those in the three above-mentioned lizards is also fundamentally similar, in that each fold contains one small capillary and is lined by a layer of uterine epithelium.

A consideration of these facts does seem to suggest that in its phylogeny *L. (L.) entrecasteauxi* has passed through a stage of development essentially similar to that now represented by the mature placenta in *L. (L.) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum*, and it may be possible that the type of placentation in these three lizards may eventually attain the comparatively high degree of specialization already acquired by the placenta in *L. (L.) entrecasteauxi*. For, with the concentration of the folds into an elliptical area beneath the main longitudinal uterine blood-vessels, and with the further definition of the folds and their acquisition of a lining layer of epithelial cells, and with the enlargement of the underlying epithelial cells, the type of placentation in *L. (L.) weekesae* is attained (Text-fig. 10a); with the further gathering together of the simple villous ridges into more complicated folds and the further enlargement of maternal and foetal epithelial cells, the type of placenta in *L. (L.) entrecasteauxi* is attained (Text-fig. 10b); here it is interesting to note that a folding of the foetal tissues to fit into the maternal grooves, thus providing a greater absorption surface, would result in the type of placentation found in *C. tridactylus* (Text-fig. 10c). Although the facts revealed from a study of reptilian placentation are, to my mind, highly suggestive that such a course as is outlined above has been

followed, no definite claim is made that such was the course followed. It may be considered inadvisable to speculate at all as to the possible course of the evolution of types of reptilian allantoplacentae, but after all the placentation, even in *C. tridactylus*, is so simple when compared with placentation among Eutherian mammals that there is little scope for dangerous speculation.



Text-fig. 10a.—A diagrammatic representation of allantoplacentation in *L. (L.) weekesae*; 10b in *L. (L.) entrecasteauxi*; and 10c in *C. tridactylus*. 10a, $\times 12.5$; 10b and 10c, $\times 15$. *Ch. Ect.*, chorionic ectoderm; *Ell. Plac. Reg.*, elliptical placental region; *Foet. Tis.*, foetal tissue; *Mat. Tis.*, maternal tissue; *Mat. Fold*, maternal fold; *M. Ut. A.*, main uterine artery; *M. Ut. V.*, main uterine vein; *Sm. Plac. Reg.*, smooth placental region.

It would naturally be wrong to expect the type of placentation found in *L. (Hinulia) quoyi* to give rise exclusively to the types found in *L. (L.) ocellatum*, *L. (L.) weekesae*, *L. (L.) entrecasteauxi* and *C. tridactylus*, as a consideration of the placentation of the two snakes *Denisonia superba* and *D. suta* (Weekes, 1929) will show. In the two snakes, although the smooth placental region is similar

in structure to that in the lizards *L. (L.) weekesae*, *L. (L.) entrecasteauxi* and *C. tridactylus*, the ridged placental region is essentially different. In the snakes the uterine folds are deeper and the foetal tissue is folded round and attached to them, and the degeneration and flattening of maternal and foetal tissues lead to the close apposition of maternal and foetal blood-streams. This structure is obviously different from that of the ridged region of the two lizards, where the free maternal folds are clothed by enlarged cubical epithelial cells and the underlying foetal tissue is also covered by enlarged ciliated epithelial cells.

After a consideration of all the forms of placentae so far recorded among reptiles, there can only be recognized the following types:

i. The extremely simple type found in *L. (Hinulia) quoyi*, *E. cunninghami*, *E. whitei*, *E. striolata*, *T. nigrolutea*, *T. scincoides*, *L. (Hemiergus) quadridigitatum*, *M. multifasciata* and most probably *C. ocellatus*.

ii. The type found in the snakes *D. superba* and *D. suta*.

iii. The type found in varying degrees of specialization in *L. (L.) weekesae*, *L. (L.) entrecasteauxi* and *C. tridactylus*.

iv. It is difficult to place the type found in *L. (L.) ocellatum*, *L. (L.) metallicum* and *L. pretiosum* since, although the placenta is very simple, it has differences which separate it from type i, and, on the other hand, although it has characteristics in common with type iii, its very simplicity prevents it, at least for the present, from being included in this group. It may, therefore, be temporarily regarded as a fourth type.

SUMMARY AND CONCLUSIONS.

The present communication consists of a description of early stages in the development of the allantoplacenta of *Lygosoma (Liolepisma) entrecasteauxi* and of the mature allantoplacenta in the lizards *Egernia cunninghami*, *E. whitei*, *E. striolata*, *Tiliqua nigrolutea*, *T. scincoides*, *Lygosoma (Hemiergus) quadridigitatum*, *Mabuja multifasciata*, *Lygosoma (Liolepisma) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum*.

In early stages of development in these lizards a thin shell-membrane and sometimes a little albumen is present surrounding the egg. The shell-membrane does not hinder the establishment of the allantoplacenta, as it collects at the base of the yolk-sac at a comparatively early stage in the development of the embryo.

It is shown that the lizards *E. cunninghami*, *E. whitei*, *E. striolata*, *T. nigrolutea*, *L. (Hemiergus) quadridigitatum* and *M. multifasciata* have the same type of allantoplacenta which is quite simple and is characterized by closely apposed maternal and foetal blood-streams separated by degenerated maternal and foetal epithelium.

The three lizards *L. (L.) ocellatum*, *L. (L.) metallicum* and *L. (L.) pretiosum* have also a similar type of allantoplacenta which is characterized by the presence of small folds on the surface of the uterine lumen and by the enlargement of the related chorionic ectoderm cells, processes of which extend into the shallow crypts between the folds. This area of placenta extends over all the surface of the uterus embraced by the chorio-allantoic membrane.

It is claimed that parallel development of similar types of allantoplacenta among reptiles is common.

A possible course of evolution of such comparatively highly specialized types of allantoplacenta as are found in the lizards *L. (L.) entrecasteauxi* and *Chalcides tridactylus* is discussed.

EXPLANATION OF PLATES XXII-XXVIII.

All., allantois; *All. B.V.*, allantoic blood vessel; *All. Cap.*, allantoic capillary; *All. End.*, allantoic endoderm; *Br. A.*, branch artery; *Br. V.*, branch vein; *C.*, cilia; *C.M.*, circular muscle; *Ch. All. M.*, chorio-allantoic membrane; *Ch. Ect.*, chorionic ectoderm; *Coag.*, coagulum; *Corp.*, corpuscles; *Ect.*, ectoderm; *Ell. Plac. R.*, elliptical placental region; *Emb.*, embryo; *Enl. Ch. Ect. C.*, enlarged chorionic ectoderm cells; *Foet. B.V.*, foetal blood-vessels; *Foet. Cap.*, foetal capillary; *Flat. Ch. Ect.*, flattened chorionic ectoderm; *Flat. F.*, flattened fold; *Gl.*, gland; *L.M.*, longitudinal muscle; *M.Y.S.*, main body of the yolk-sac; *M. Ut. A.*, main uterine artery; *M. Ut. A. & V.*, main uterine artery and vein; *M. Ut. V.*, main uterine vein; *Mes.*, mesenchyme; *Mus. Mes.*, muscular mesenchyme; *N.D. Fold*, narrow deep fold; *Plac.*, placenta; *Ut.*, uterus; *Ut. Cap.*, uterine capillary; *Ut. Epi.*, uterine epithelium; *Ut. Fold*, uterine fold; *Ut. W.*, uterine wall; *Sec.*, secretion; *Som. Mes.*, somatic mesoderm; *Sm. Ut. Fold*, small uterine fold; *Y.S.*, yolk-sac; *Y.S. End.*, yolk-sac endoderm; *Y.S. Ves.*, yolk-sac vessels.

Plate xxii.

- 1.—Photomicrograph of section of uterine wall, and the apposed chorion and underlying allantois of a very young embryo of *E. cunninghami*. × 300.
- 2.—Photomicrograph of section of mature allantoplacenta of *E. cunninghami* showing the maternal capillaries more or less exposed at the maternal placental face. × 300.
- 3.—Photomicrograph of section of mature allantoplacenta of *T. nigrolutea*. × 300.

Plate xxiii.

- 1.—Photomicrograph of transverse section through part of base of yolk-sac of *E. cunninghami* showing the surrounding foetal and maternal tissues and the peculiar position of the yolk-sac blood-vessels.
- 2.—Photomicrograph of part of mature allantoplacenta of *L. (L.) ocellatum*. × 350.
- 3.—Photomicrograph of allantoplacenta of *L. (L.) ocellatum* showing general disposition of placenta. × 50. The small size of the folds is noticeable when they are compared with those of *L. (L.) entrecasteauxi* shown as fig. 4 on Plate xxvii.

Plate xxiv.

- 1, 2, 3 and 4.—Photomicrographs of sections of uterine wall of *L. (L.) entrecasteauxi* showing folds in uterus in various stages of development. × 350.

Plate xxv.

- 1.—Photomicrograph of section of one uterine fold from a mature allantoplacenta of *L. (L.) entrecasteauxi*. The cilia lining the epithelium are matted together with what is probably maternal secretion. × 350.
- 2.—Photomicrograph of section of foetal tissue of mature allantoplacenta of *L. (L.) entrecasteauxi*. × 350.
- 3.—Photomicrograph of section of young allantoplacenta of *L. (L.) entrecasteauxi* included here to show the accumulation of materials between maternal and foetal tissue. × 350.

Plate xxvi.

- 1, 2, 3 and 4.—Photomicrographs of sections of the allantoplacenta of *L. (L.) entrecasteauxi* in four of its main stages of development. × 50.

Plate xxvii.

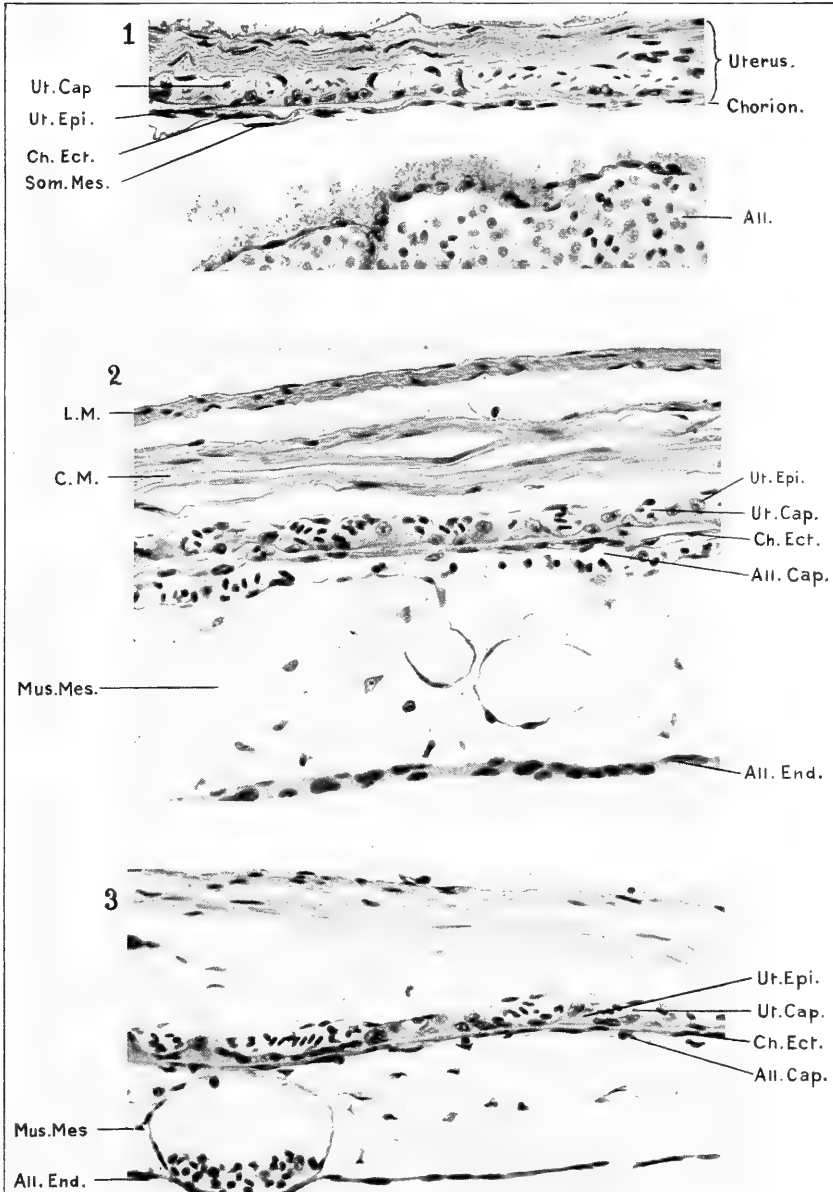
- 1.—Photomicrograph of dorsal half of incubatory chamber of *L. (L.) entrecasteauxi*, examined 11th November, 1925. × 8.
- 2.—Photomicrograph of dorsal half of incubatory chamber of *L. (L.) entrecasteauxi*, examined 28th November, 1925. × 8.
- 3.—Photomicrograph of foetal portion of mature elliptical allantoplacental area of *L. (L.) entrecasteauxi*. The dark elliptical region consists chiefly of thickened chorionic epithelium. × 8.
- 4.—Photomicrograph of dorsal half of incubatory chamber showing mature elliptical allantoplacental region of *L. (L.) entrecasteauxi*. × 8.

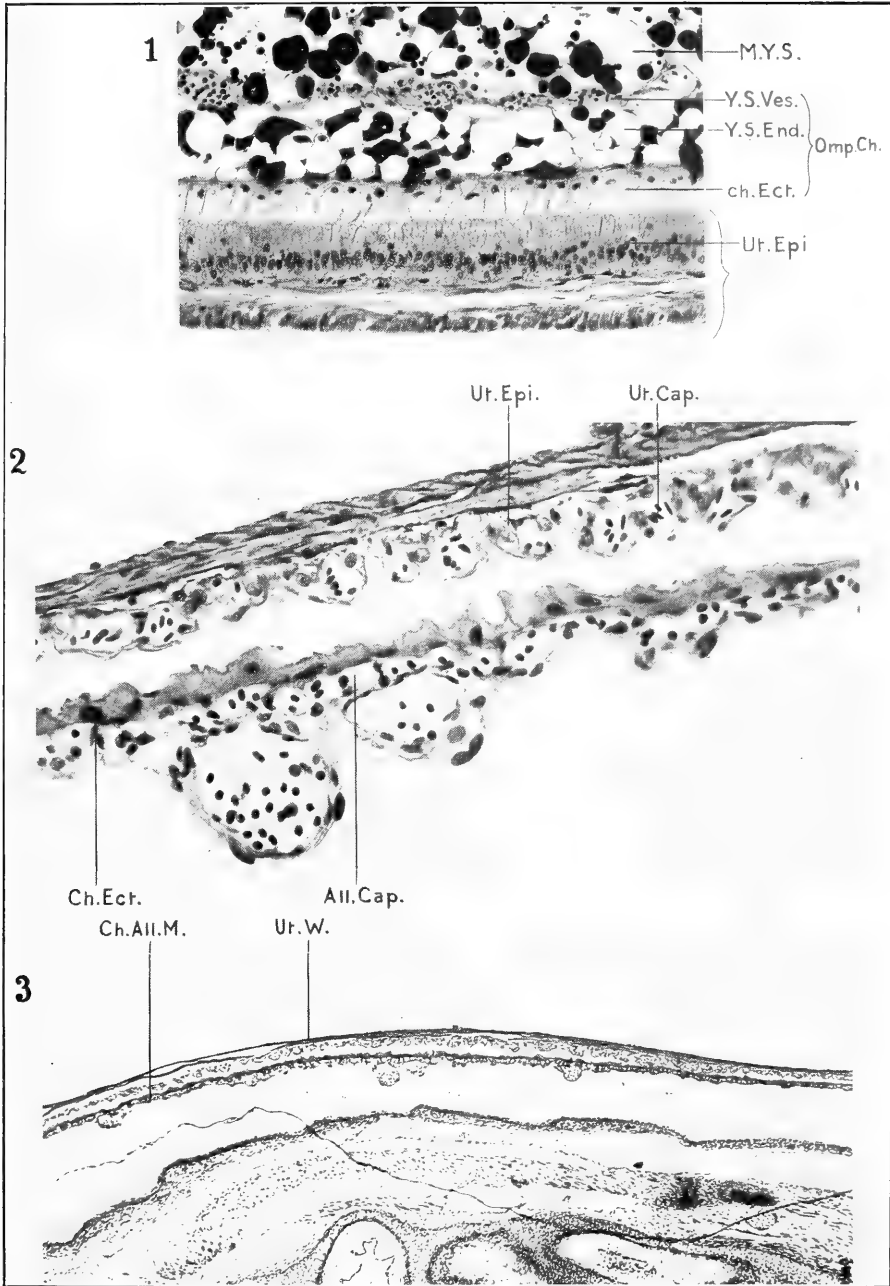
Plate xxviii.

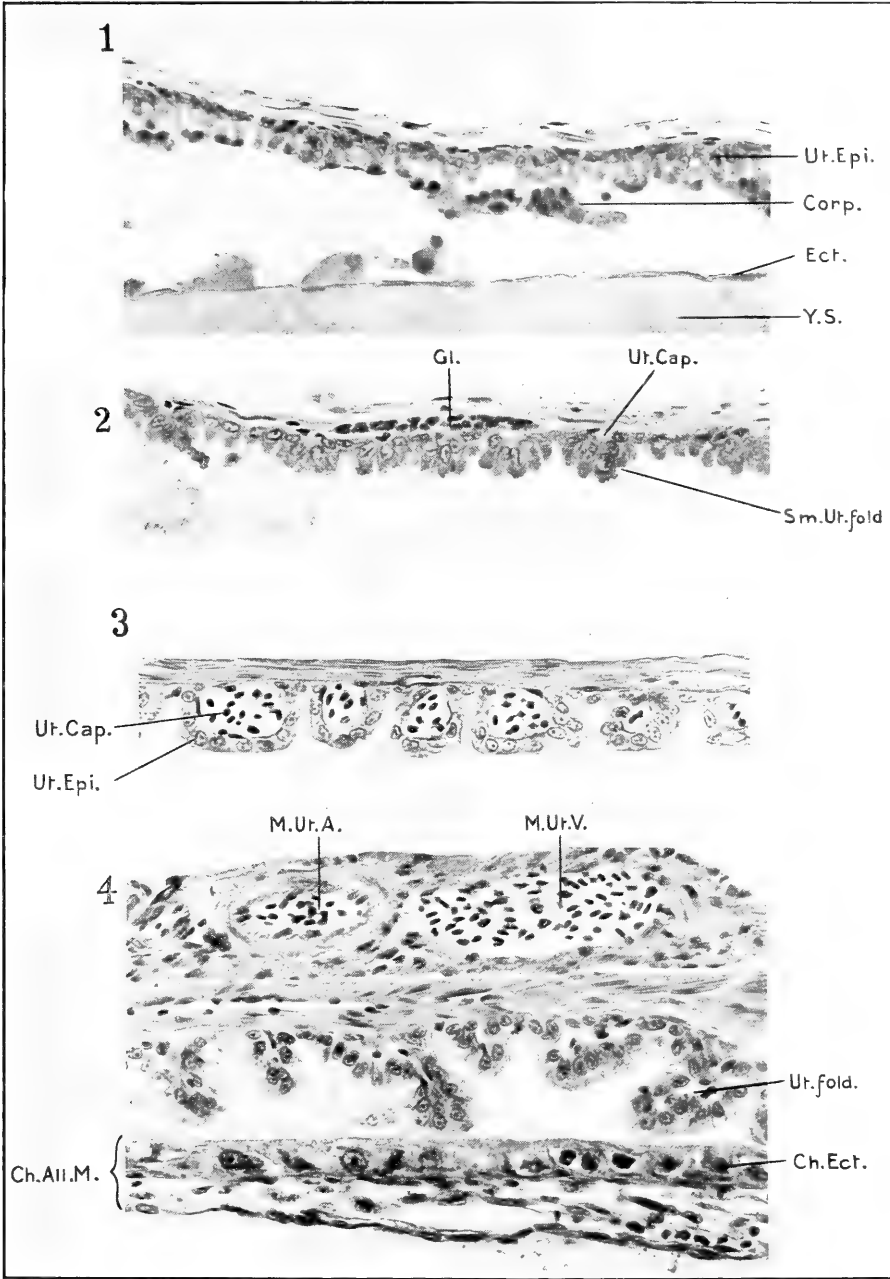
- 1.—Photomicrograph of section of uterine wall of *L. (L.) entrecasteauxi* showing beginnings of flattening and degeneration of folds in the neighbourhood of elliptical placental region. $\times 350$.
- 2.—Photomicrograph of section of uterine wall of *L. (L.) entrecasteauxi* in same region as Figure 1, but at a later stage. $\times 350$.
- 3.—Photomicrograph of section of uterine wall of *L. (L.) entrecasteauxi* in same region as Figure 1 showing complete degeneration of folds and establishment of smooth region of allantoplacentation. $\times 350$.
- 4.—Photomicrograph of section through mature allantoplacenta of *L. (L.) weekesae*. $\times 50$.
- 5.—Photomicrograph of section through mature allantoplacenta of *L. (L.) entrecasteauxi*. $\times 50$.

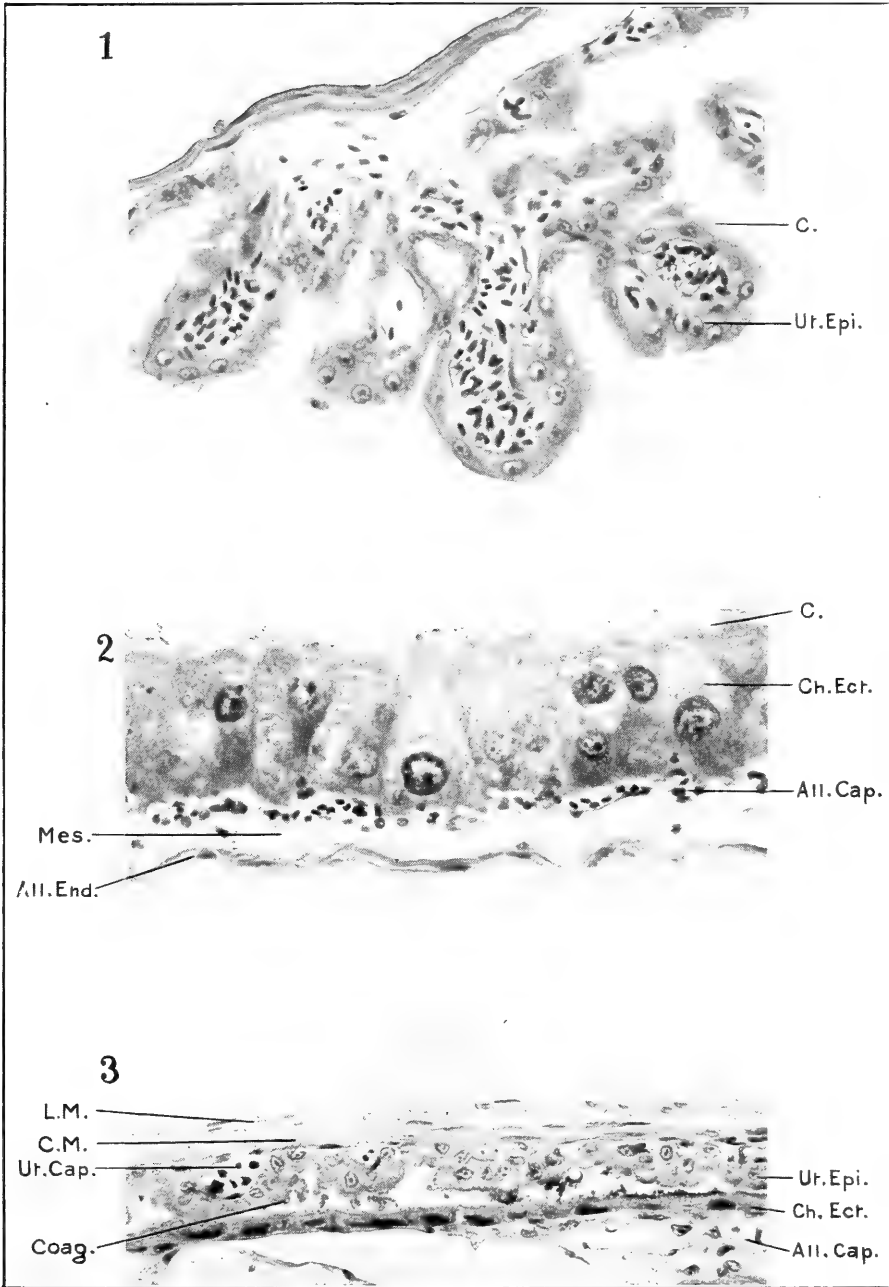
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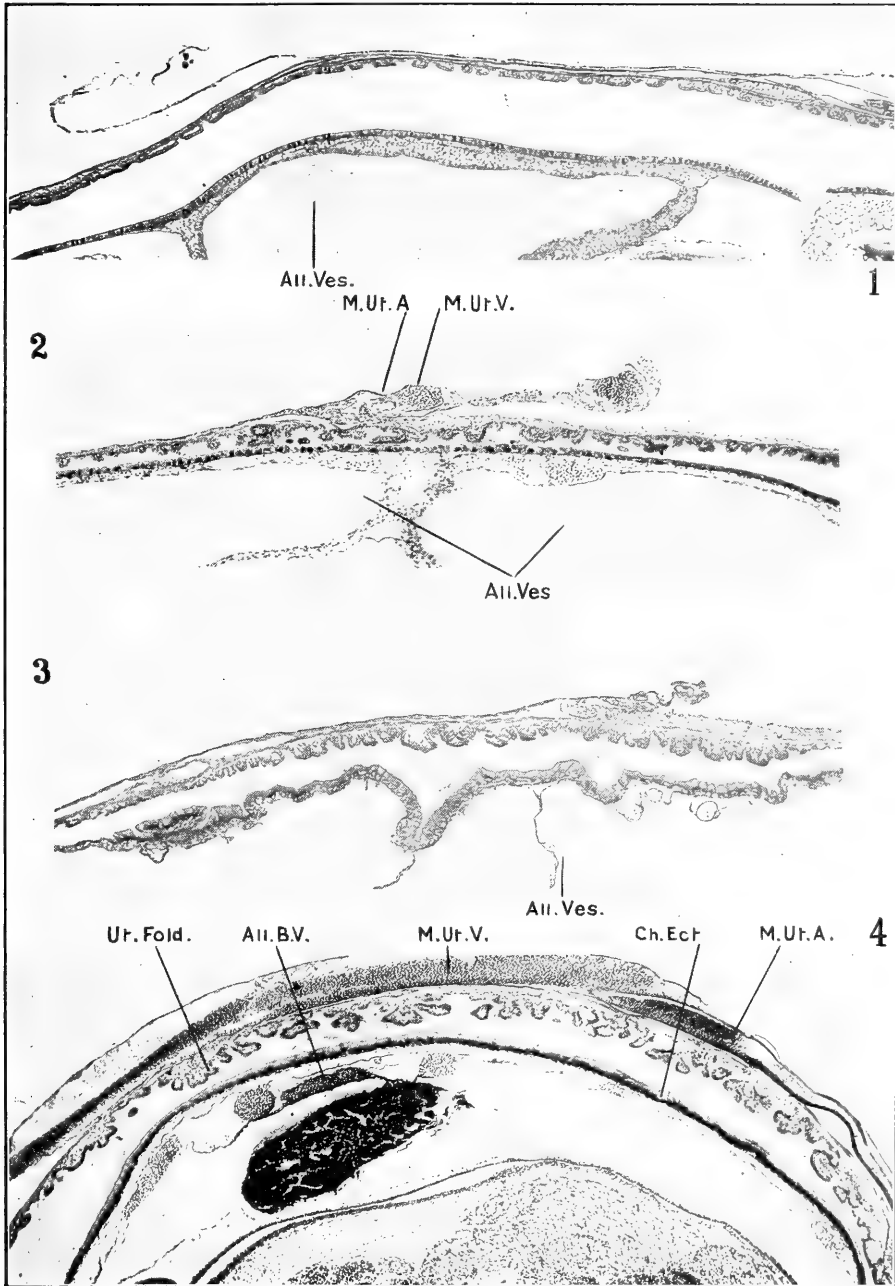
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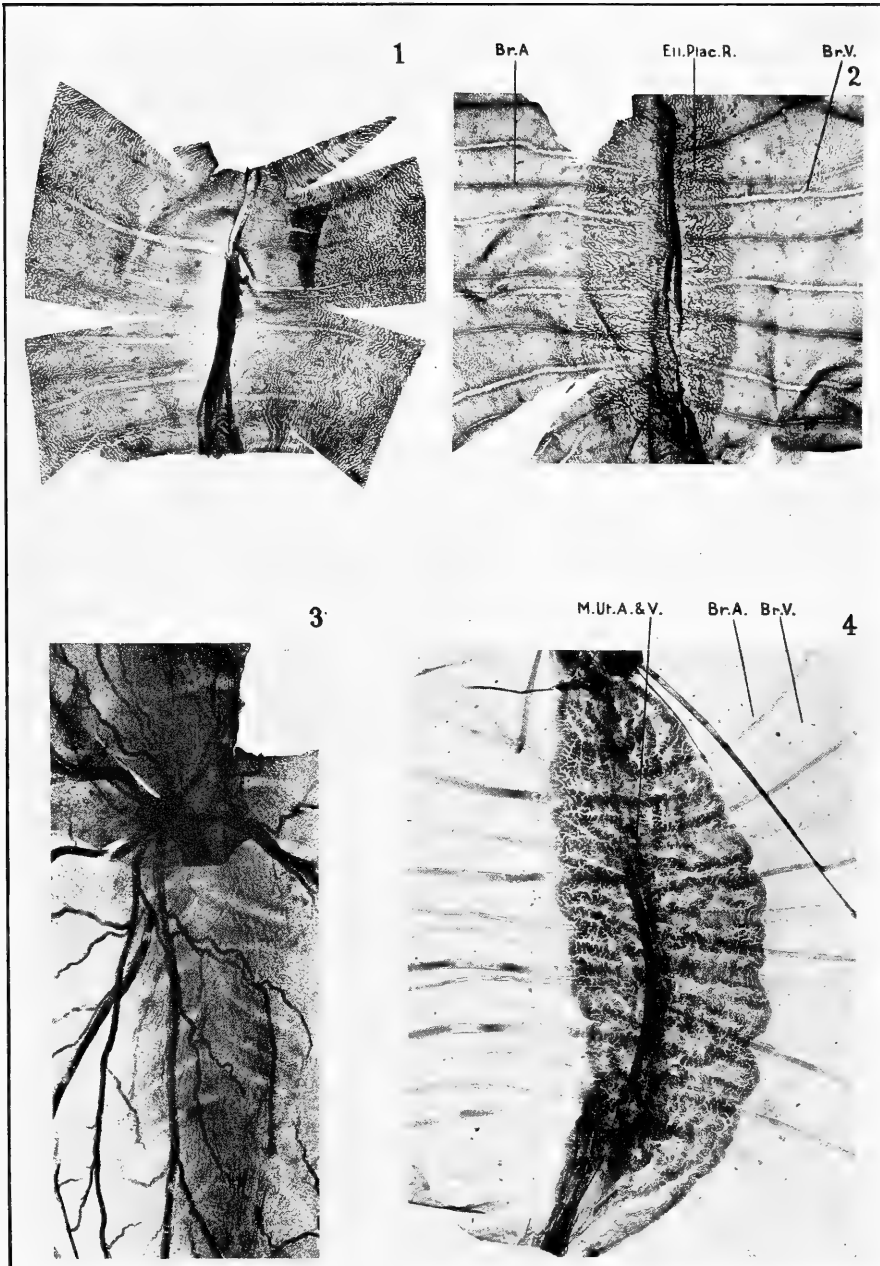


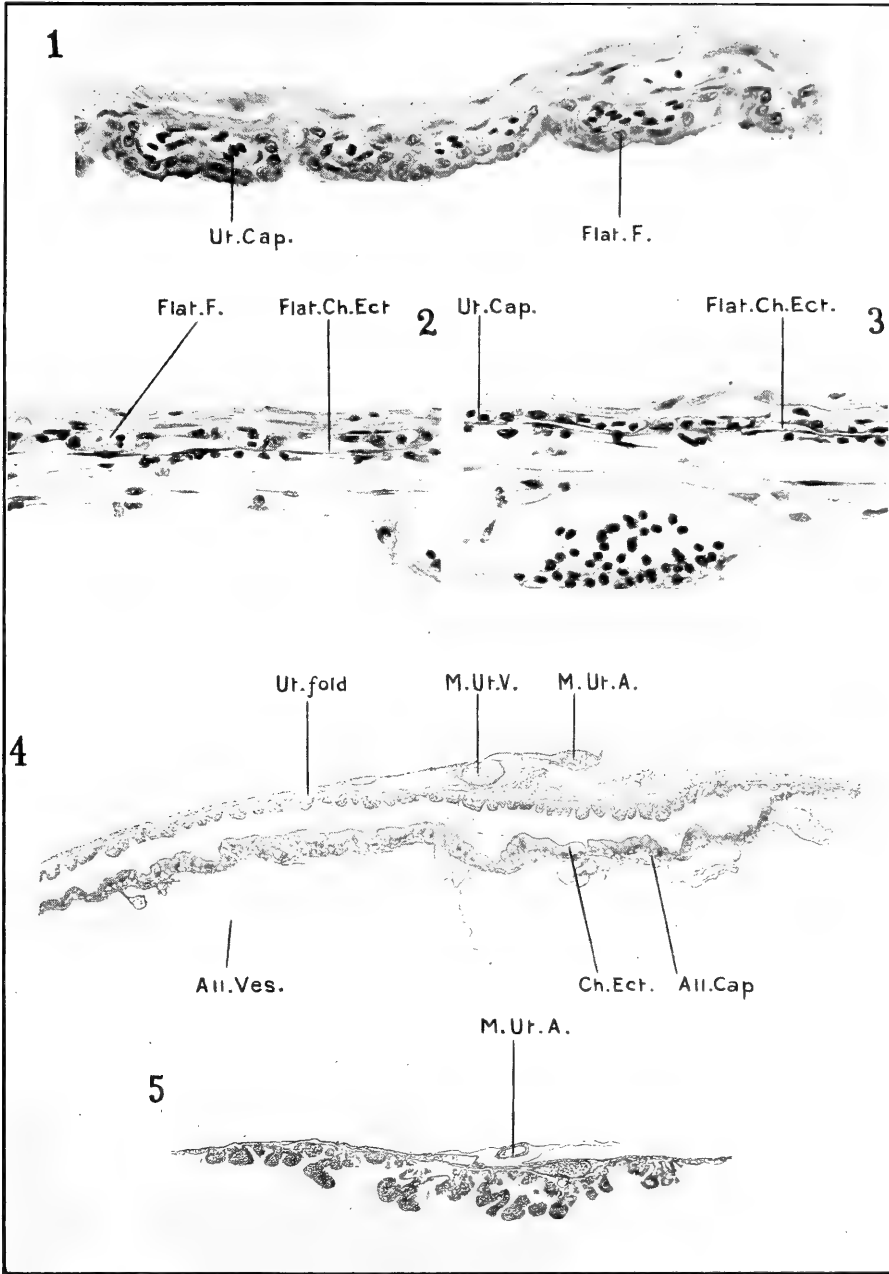












XEROPHYTES AND XEROPHILY.

WITH SPECIAL REFERENCE TO PROTEAD DISTRIBUTION.

By OSWALD H. SARGENT.

(Communicated by A. G. Hamilton.)

[Read 26th November, 1930.]

The inspiration of this paper is to be found in one by A. G. Hamilton (These PROCEEDINGS, lii, 1927, 258), where it is stated (p. 260): "Notwithstanding their very perfect adaptation it is very noteworthy that the Proteaceae are very sparsely distributed in the arid and semi-arid regions of Australia. . . The stronghold of the family is the belt of well-watered country bordering the Continent, and possessing a sandy soil. It therefore seems to be the edaphic factor which governs the distribution of the Proteaceae—they require a highly siliceous soil." Invited by its author to comment on his suggestion, that soil governs the distribution of Proteads, the present writer was incited to search diligently through his note books and available literature, make many fresh field observations, and experiment as far as limited means and circumstances would permit.

Authors consulted are unanimous as to the general distribution of the family. Spencer Moore (*Journ. Linn. Soc. Lond.*, xxxiv, 1899) writes: "Bearing in mind the richness of this order in the south-west corner of the Continent, it is very poorly represented in the desert." He states that only 47 of the 397 then known species are found in the drier areas, 12 of them being endemic there. Writing of the Sandhills flora of the Ooldea district, Nullarbor Plain, E. H. Ising (*Trans. Roy. Soc. S. Aust.*, xlv, 1922) says: "Two Grevilleas were usually seen growing on the flat ground, but of infrequent occurrence." Not only are species and individuals more numerous near the coast; but in the case of most, if not all, those which have a wide range, the coastal examples are larger and more vigorously healthy than those of inland districts. In the moister regions tree forms are more numerous and distinctly larger. According to J. H. Maiden (*B.A.A.S.*, Federal Handbook, Australia, 1914), proteads only attain the dignity and magnitude of first class trees in the brushes of New South Wales and Queensland; and "the brush corresponds to what in India is called jungle and consists of well-watered, rich soil areas chiefly in the coast belt and coast tablelands of Eastern Australia".

It seems, therefore, quite beyond dispute that this family, whose members are generally regarded as "typical xerophytes"—drought-resisting plants, often, indeed, drought-loving plants—as a family has a strong preference for the moister regions of our Island Continent. Perhaps no other family is quite so inconsistent, so very unfaithful to appearances; but such behaviour characterizes more than a few genera and species of other families. Xerophytes in aspect—they are leafless, and only a few have leaf-like phylloclades, rigid or coriaceous in texture—species of *Jacksonia* (Leguminosae) seem admirably adapted to inhabit the driest regions; yet they are more abundant and more luxuriant in the moister coastal parts.

Viminaria denudata Sm., though its leaf is reduced to a slender bladeless petiole, is to be found only in boggy places. *Casuarina glauca* Sieb., leafless switch-plant as it is, rarely, if ever, wanders far from the banks of permanent pools. *Melaleuca raphiophylla* Schau. has short terete leaves, and its trunk and branches are wrapped in many layers of papery cork; but it is not found away from places that are permanently moist. The "Black Boy", *Xanthorrhoea Preissii* Endl., though its trunk is encased in a resinous shell and its leaves are harsh, dry, and rush-like, does not wander far from the coast, and seems to prefer the wettest parts of its habitat. Species of *Lachnostachys* (Verbenaceae) are provided with so dense a coat of woolly indumentum that they well deserve the name of "Blanket Plants". The aspect of a flowering branch suggests an arid desert or parched tableland as its habitat. It was, therefore, strange to find *L. cordifolia* Moore and another (undetermined) species at home in the wettest parts—damp valley bottoms—of the wettest portion of the York district. *Physopsis spicata* Turcz., a somewhat less woolly ally, was equally at home on higher, rather less moist ground near by. The incident was very impressive, and consideration on the spot led to the making of the following note: "whilst among these plants to-day it struck me that their wool is related to the extremes endured: over wet in winter, over dry in summer". In the light of subsequent experience with Proteads, it seems not unlikely that these plants, and innumerable others that might be cited as examples of paradoxical behaviour, really require abundance of water; and that their wool (or other protection) saves them from over desiccation in the driest periods. It is not necessarily too great a hindrance to transpiration in wettest times, because then the plants are dormant or sub-dormant.

This question of apparently paradoxical distribution arose in connection with the Proteaceae, and it seemed that so natural a family should offer special opportunities for the elucidation of the problem. It was therefore decided to concentrate on the Proteads. Western Australia offers unique opportunities for the study of the Proteaceae, seeing that it possesses nearly twice as many species as all the other States of the Commonwealth together, and six of the family's seven tribes are represented here. Even a superficial study of the whole 400 (or thereabouts) species was quite out of the question. In his all too limited time the writer has given so much attention as circumstances permitted to a few representative species and the results seem worthy of record.

While authorities consulted are unanimous in regard to distribution of the family in reference to rainfall, in regard to the influence of soil few references have come under the notice of the author. Valuable evidence is contained in a paper by Cecil R. P. Andrews (*Journ. Mueller Bot. Soc., W.A.*, i (10), 1902). He writes: "I have tried to ascertain the relation of our Proteaceae to the geological conditions. For this purpose I have taken the 61 species I know to occur in the neighbourhood of Perth. I have divided our district into—(1) The Darling Range with its granite, ironstone and red clay, extending to Guildford; (2) the intermediate belt of sand, roughly from Guildford to Subiaco; (3) the limestone belt of the coast; (4) swamps. The only species confined to swampy ground are *Hakea varia* and *Banksia littoralis*. Of the other 59, 6 are found on all three belts, 2 on the hills and sand, 4 on sand and on limestone, 2 on the hills and the limestone. Of the remaining 45, 33 seem to belong to the hills alone, 10 to the sand, and 2 to the limestone." Thus it seems, in a district of approximately equal rainfall, the majority of species prefer the less siliceous soils. Recently the opportunity occurred for the writer to make counts of the species growing on two types of

soil, loam and sand, in a still more restricted district, Mt. Clarence, at Albany. Twelve species were found exclusively on loam, seven on sand, and nine were common to both. An attempt was then made to estimate the relative abundance of individuals, irrespective of species, on the two soils. In places offering as uninterrupted a view as possible, where the protead population appeared to be of average density for the soil concerned, while standing at the centre the proteads visible within a circle of about 20 yards radius (about one-quarter of an acre) were counted, with these results: sand, 14; loam bordering sand, 22; loam, more than 100 (owing to the size of some examples many of the smaller plants could not be seen on the loam). On another occasion a patch of apparently firmer slightly damp sand was found and 100 proteads were counted in the circle, with the probability of a few misses. No other sand patch so densely populated was discovered; but in many places the count for such an area would be nil. Not a single protead could be found on a hill apparently of drift sand at the head of Princess Royal Harbour, where *Agonis flexuosa* was growing as a fair sized tree, and *Hibbertia*, *Pimelea* and other shrubs were plentiful and healthy enough. Proteads seem to be entirely absent from Garden Island (W.A.), though its sandy soil does not seem to differ from that of the neighbouring mainland coast, where proteads are not uncommon. So far, therefore, as Western Australia is concerned the Protead family shows no preference for a sandy or highly siliceous soil. Even if they did, are there no highly siliceous soils in the interior? No opportunity has presented itself for the present writer to make a detailed examination of the distant interior of the State; but he has given some attention to the relation of Proteads to soils in the wheat belt, about 160 miles from the coast. Here, on sandy loam, the estimate was 350 shrubs (5 species) per acre; on heavy clayey soil, 20 shrubs (3 species) per acre. These soils are scarcely comparable with those of the coast. While in this district (Bruce Rock), an observation was made which suggested the making of an attempt to estimate the water needs of a few species. On a broad elevation where the soil was firm, dry, and barren-looking loam mixed with ironstone gravel two species of *Acacia* with rather broad (about one-quarter of an inch) phyllodes almost monopolized the ground. Scattered amongst them were a few rather impoverished examples of *Grevillea paradoxo*, with leaves bipinnately divided into narrow terete segments. The *Grevilleas* increased in numbers and luxuriance as one gradually descended into looser and less parched-looking ground. Twigs of one of the *Acacias*, and of the *Grevillea* were taken and placed with cut ends in narrow-necked vials filled with water. At varying periods the quantity of water used up was determined by measuring the quantity necessary to refill the vials, a vial without a specimen being used as a check. Whenever hereinafter mentioned this is designated the "wet" method.

Seeing that some species might be much more dependent than others upon root-pressure, the cut ends of their stems less efficient as absorption organs, this method seemed of doubtful value for comparative purposes. A "dry" method was tried as a check and alternative: the cut end of the twig was sealed with soft paraffin or anhydrous wool fat, weighed, and water loss determined by periodical weighings. Often, but not always, the two methods gave closely concordant results. Rigid accuracy could not be expected; but the figures obtained do at least give some idea of minimum water needs, which is all that is needed for present purposes. There was no perceptible loss of turgidity by tender developing parts, nor any visible evidence, such as change of colour in mature parts, suggestive of serious water shortage till long after the conclusion of any experi-

ment recorded. Transpiration seemed to be proceeding in a perfectly normal way. Absence of injury was demonstrated in some instances by changing over from "dry" to "wet" method, when water absorption proceeded quite normally. In one experiment both *Acacia* and *Grevillea* lost 10% of their original weight in 24 hours. In each of the 11 others made, *Grevillea* lost far more heavily than *Acacia*. The average for the 12 experiments (7 wet, 5 dry) was: *Grevillea* 33% and *Acacia* 12% of original weight in 24 hours. Some experiments were made in July; others in October. It seems certain that the water needs of the *Grevillea* far exceed those of the *Acacia* as their relative abundance and luxuriance in the locality mentioned suggest. Taking into consideration the size of the shrub and the area it occupies, the minimum transpiration rate found for the *Grevillea* suggests a water requirement for the four almost-rainless summer months roughly equivalent to 0.15 inch of rain; the maximum is equivalent to quite 12 times as much. As the experiments had to be conducted indoors, it is certain the figures do not overstate the case. Similar experiments on twigs of *Hakea trifurcata*, R. Br., at Albany and at Claremont in the open air suggested water-needs for that species equivalent to 5 inches and 3 inches of rainfall respectively. The shade temperature at the time of both these experiments varied between 60° F. and 70° F., and a gentle breeze was blowing. These conditions are far too mild for average summer weather, so that the estimates may well be regarded as representing something like minimal requirements.

In order to link up, so far as practicable, with the more precise and more extensive work of other investigators on transpiration, the total area of the leaf surface of the Claremont specimen was calculated, and the transpiration rate worked out at 18 grammes per square metre per hour. For the first 20 minutes of this experiment, the rate was 35. These rates are considerably below rates found by H. W. Wilson (*Proc. Roy. Soc. Vict.*, n.s. xxxvi, 1924) for *Grevillea robusta*, *Hakea gibbosa*, and *Banksia serrata* in Victoria. Now *Hakea trifurcata* covers a wide range of territory from the coast to some considerable distance inland. It may probably be fairly taken as representative of the family in regard to water requirements. Only one author, E. H. Ising (*l.c.*), mentions it; but it is a point of considerable importance that their water supply is rapidly decreasing to its minimum just at the time when Proteads stand in much need of water. It is with the advent of warmer (and drier) weather that most of them wake into activity, putting forth fresh young growth and flowers. No opportunity has presented itself for the estimation of the relative water needs of young and mature leaves; but experiments with a species of *Grevillea* at Cunderdin showed that a flowering branchlet required about twice as much water as a flowerless one of the same size. During this period of activity (the warmer summer months) over a large portion of South-western Australia only about 10% of the annual rainfall occurs. For the whole continent, according to meteorological maps, evaporation increases as rainfall decreases. This must needs accentuate the adversity of the summer months where winter rains exceed summer rains, and everywhere when evaporation exceeds rainfall. Ignoring evaporation for the moment, assuming rainfall to be regular, and granting that the average Protead requires during summer 3 inches of rain, that being 10% of the annual fall, we ought to find the majority of Proteads grouped about or within the 30-inch isohyet. Stated still more broadly, in view of their heavy water requirement Proteads ought to be most numerous and most luxuriant in the wetter regions of Australia, as in fact they are: the distribution of the Proteads as a family is ruled by rainfall!

Admitting their need of abundant water we can well understand that Proteads reach their noblest development "only in the brushes of New South Wales and Queensland". We can understand, also, why they are so heavily waterproofed. For practically all there must be times of dangerous dryness. In spite of their armour they transpire very heavily: what would happen without it?

The fact that many Proteads wander far beyond the 30-inch isohyet—some species, indeed, being actually endemic in the dry area beyond the 10-inch rainfall belt—does not in the least invalidate the hypothesis of "rainfall rule" for the family. Moreover, the term "rainfall rule" must be accepted in a rather broad sense: it is not, indeed, a stated amount of rain that our plants need, so much as a sufficiency of water within reach of their roots in the soil. There are oases in every desert; and in every belt of country there are favoured spots where the water available to roots is actually in excess of the rainfall. Therefore, we must not expect the isohyet indicated by the ascertained water needs of any species to be the actual limit of its range. *Hakea suberea* S. Moore is a tree with thick corky bark and slender terete leaves, endemic in distinctly dry country, beyond the 10-inch isohyet; nevertheless, "wherever it occurs, subterranean water is supposed to be somewhere in the vicinity, and experience has, so far I believe, justified the supposition" (Moore, *l.c.*). The author well remembers an abandoned plantation of fig trees and a few grape vines, which for many years continued to bear moderate crops of passable fruit each year; and more recently he has seen abandoned plums and peaches doing reasonably well. These are scarcely to be called xerophytes: they would need many times the rain that falls during their active lives each year. They were in spots where there is reason to think a good supply of subterranean water would be within reach of their roots. During a recent visit to Merredin a healthy looking colony of *Casuarina Huegeliana* (?) trees was observed growing on the top of a large granite outcrop. Investigation revealed a large soil-filled basin, whose broad rim, sloping inwards, formed an excellent water-shed for the soil-filled centre. "This seems probably a miniature of what must be existent, invisibly, on a larger scale in many places. Depressions or basins in the underlying rock would perhaps secure for plants, trees particularly, a more regular water supply in regions of less rainfall, than others obtain in heavier rainfall belts" runs a note made at the time. Three weeks had elapsed since rain had fallen, but on a patch of coarse sandy loam between granite outcrops the vegetation was distinctly fresh and green; small annuals, including a species of *Drosera* (in bloom) had sprung up and were growing vigorously: only an inch below the surface the soil was still quite moist. Not very far away ploughs and scarifiers in action were accompanied by clouds of dust! Later still, nearly five weeks after rain, in soil capping a mound showing granite outcrops, *Cheilanthes tenuifolia* Swartz., the "Rock Fern", was in vigorous healthy growth. These observations are important, because it is highly probable that the question, whether a Protead shall occur in a given locality or not, is largely dependent upon whether the advancing root-tips of the young plants can or cannot keep pace with the receding water level. Mature plants with water-absorbing root-tips buried deeply in the soil, or perhaps with their own storage reservoirs well filled, would doubtless withstand a period of dryness fatal to the young ones. At Albany, many hundreds of young *Hakea trifurcata* were seen. Those on the rapidly drying sand were showing signs of distress and seemed likely to die, while those on the heavier and moister soils were still healthy and vigorous. The close proximity of rocks at times presents special problems in superabundance and

deficiency of water; and only specially adapted plants can inhabit outcrops and their near neighbourhood. An interesting example of this is presented by the small terrestrial orchid, *Spiculaea ciliata* Lind. This species is found in the Darling Range, scarcely 20 miles from the coast and extends eastwards at least 150 miles (Merredin), and probably much further. It grows in the shallow soil close to the lower edges of granite outcrops, or in shallow soil-filled basins on the sloping face of the rock. In these places the soil is supersaturated during the wet season. At this time a small fleshy dark-green leaf, the only sub-aerial portion of the orchid, exposes its broad surface to the winter sun. With the advent of warmer weather a small fleshy spike appears in the axil of the leaf. Though the humous nature of the soil retards desiccation to some extent, the cessation of rain is soon followed by the withering and gradual conduplication of the leaf, while the flower spike rapidly elongates and enlarges. When the first flower opens late in October the soil of the plant's habitat is "dust dry". The peduncle is now a fleshy fulvous elongated club, its base at the soil surface dead or nearly so. As flowering proceeds, mortification of the stem progresses steadily upwards. Severing the scape from the parent plant makes no difference to open flowers or unopened buds, unless indeed to prolong the period of inflorescence. It may be stood in a dry vase—water is undesirable—or even placed under pressure between drying sheets. Bud after bud to the topmost and last will expand as normally as circumstances permit. To make a satisfactory herbarium specimen the scape must first be dipped in boiling water, or its vital activity otherwise be brought to an abrupt end, when drying will be rapid. A microscopic examination was disappointing: the cuticle was not thick, and stomata were numerous. These results, considered in conjunction with the striking effect of boiling water, point to the conclusion that the nature of the plasma, rather than the structure of the epidermis, is the real regulator of transpiration. Is there not some evidence that this is the case with Proteads and other plants too? Moore (*Journ. Linn. Soc. Lond.*, xxxiv, 1899) remarks upon the paucity of plants in the near neighbourhood of outcropping granite, and decides upon soil constitution rather than water supply as the principal reason. It may be so; but often in such places there is a very long range between wettest and driest conditions, and sometimes the extremes must be suddenly experienced. *Spiculaea ciliata* is specially adapted to meet both extremes; and some Proteads seem to be unharmed thereby; but many plants are not so constituted. Moisture and the duration of the desirably moist state undoubtedly exercise a very powerful influence upon the distribution of all plants. On the one hand, *Spiculaea ciliata* makes special provision for excessive dryness; *Leschenaultia biloba* Lindl., conversely, must needs provide defence against excessive wet. Seven years ago, while rambling through the bush, a white-flowered example of this species attracted attention; and as the other two branches of the shrublet bore normal blue flowers, the specimen was taken for further study. Interest in floral coloration was soon overshadowed by an utterly unexpected discovery. On the following day, while examining the specimen which had been standing in a vase of water over night, glistening droplets were noticed on the tips of the sepals and some of the upper leaves. Investigation into their nature and the reason for their presence was immediately commenced. The results are briefly recorded hereunder. The apex of the subterete or triquetrous leaf (or sepal) is reminiscent of the prow of a boat, even to two depressions, one on either side, suggestive of hawse holes. Usually in each depression there is a small dark globular body, though recently specimens have been seen in which this

is replaced by a group of minute papillae. Observations in the field and upon cultivated plants (in pots) leave no doubt that the globules or papillae are hydathodes, active during times of hyperturgidity and retarded transpiration. They are not found on leaves developed early or late in the season, when water supplies are not excessive. They are very rare on plants from the drier areas (the species extends more than 100 miles eastwards from the coast) and are not invariably present even on wet-country plants; indeed, field observations suggest that the number of leaves so provided is closely related to the actual moisture conditions of the spot where the plant grows. The leaves of coastal plants are patent; those from the drier areas are shorter, relatively broader, and closely appressed. Last year a dry-area plant was successfully transferred to Claremont. Its leaves spread to normal patency, and tiny hydathodes developed on some of the young leaves formed after the transfer. This plant was from a locality where no trace of hydathodes could be found when the plants were examined during the previous flowering season. However, on examining again the following season (after transferring the experimental plant) a plant with a few small hydathodes (active) was found. The transferred plant has died; and the question whether the hydathodes are only formed as a direct response to the stimulus of environment remains so far unanswered. Similar structures occur upon *L. taricina* Lindl., but the author has examined the following without finding any trace: *L. formosa* R. Br., *L. linarioides* DC., *L. tubiflora* R. Br., and *L. floribunda* Benth. The matter is still receiving attention.

This experience recalls the experience of many years ago with *Acacia celastri-
folia*, var. *myrtifolia* Benth. (Sargent, *Journ. W.A. Nat. Hist. Soc.*, vi, 1909). The upper (adaxial) edge of the phyllode of this species bears a small saucer-shaped gland, active at flowering time, when it secretes a slightly sweet fluid attractive to honey-eating birds, which pollinate the blossoms while sipping the fluid. In the course of attempts to discover the mechanism of secretion, some young plants (in pots) intended for later experimental work, happened to be submitted to conditions favouring vigorous absorption by the roots, while retarding transpiration. The glands on the phyllodes were roused into activity, suggesting hydathode nature for themselves. Many other species possess phyllode glands, more or less developed; but the author has not yet seen any other species with glands in a state of activity. In the light of experience with *Leschenaultia*, it seems not unlikely that these glands serve (or have served) to extend the range of some species into moister regions. Seeing that in some cases they are obsolete or obsolescent, they also suggest that once upon a time the habitat of the plants was moister than now. So far no special defence against excess of water has been recorded for any Protead. It seems these thirsty plants are capable of dealing with all they can get, though upon occasion they can withstand a remarkably high degree of desiccation unharmed. A goodly company of species and genera, representative of many other families, also gravitates to wetter regions, notwithstanding the pronounced xerophytic appearance of the plants. On the other hand, examples are not lacking of plants, not always of specially xerophytic aspect, which gravitate to the drier parts. Of these the Myoporaceae are specially noteworthy, so high a proportion (50% or thereabouts) of its species being dry-area endemics. Thus it seems we have two distinct classes of xerophytes: the moisture-seeking or hygrophilous; and the true dry-country or xerophilous. Xerophyte and xerophil are both useful, but not synonymous terms.

Hakea trifurcata R. Br. is a strange shrub: almost always, scattered among the forked needle leaves (assumed normal), there are to be found broad, more or less flat, lanceolate or elliptical simple blades. Though the former are usually far in excess, the proportion of both types varies from zero to 100%; but the writer has seen only one example with 100% broad leaves, a small shrub on Mt. Clarence, Albany. While endeavouring to glean an idea of the water needs of this species, it was decided to test how much more was transpired by the broad leaves than by the needles. The astonishing result in eight experiments out of ten was that the broads transpire less than the needles! The other two are rather mixed results. The experiments were made under varying circumstances and conditions, so that it was impossible to observe uniformity in the duration of the whole experiment, or in intervals between weighings. The following are some of the results obtained:

Four pairs of specimens from four localities were carefully measured and the surface areas of the leaves estimated: needle leaves were 300, 360, 400 and 510 sq. millimetres; broad leaves, 360, 400, 500 and 600 sq. mm., *i.e.*, on the average the broad leaves present to the air a surface 20% greater than the needle leaves.

At Merredin, two specimens were compared for loss by the "dry" method. One bore 57 broad leaves of total area 22,800 sq. mm.; the other, 32 needles, 11,520 sq. mm. Losses in weight were: for the first hour, 2 grains and $1\frac{1}{2}$ grains; second hour, $1\frac{1}{2}$ gr. and 2 gr.; third hour, 1 gr. and $1\frac{1}{2}$ gr. During the experiment the temperature rose from 67° F. to 75° F.

At Albany a pair of specimens was exposed to sunshine and breeze in the open air for an hour. One bore 142 broad leaves, 64 mature and 50 immature needles, the other 100 needle leaves. The former lost 18 grains and the latter 10 grains, though the calculated areas were 125,200 and 50,000 sq. mm. respectively. Presuming that the needle leaves lost at the same rate in both cases, the smaller size of immature leaves making the area of needles in both specimens approximately equal, the broad leaves should have lost (at the needles' rate) 50% more than they did.

The discovery of the shrub, bearing broad leaves only, induced another trial. A branchlet from it bearing leaves, many of them immature, having a total surface area of 12,000 sq. mm., was exposed in the open air for 20 minutes side by side with a branchlet, from a neighbouring shrub, bearing nearly all mature needle leaves, 5,600 sq. mm. in area. The actual loss was exactly the same for both—one grain.

An experiment at Claremont in May last yielded interesting results. An hour's exposure to sun and breeze was divided into three periods of 20 minutes. Taking as standard the weight lost by the needle-leaf specimen, the broad-leaf twig should have lost 3.04 grains during the full hour; it did actually lose 3.5 grains. However, during the first and last 20 minute sections its loss was 33% above standard; but during the middle section 33% below. At the conclusion of this experiment the sealing grease was removed from the twig ends and the specimens were put in water. In 39 hours (indoors) the needles had regained their original weight utilizing 17 minims of water to recover the 2 grains lost. The broad leaves during the same period used only 10 minims of water and regained only $1\frac{1}{2}$ of the $3\frac{1}{2}$ grains lost. There is some doubt about the accuracy of the only other experiment which showed a higher rate of water loss by the broad leaves, so it is not detailed here.

The weight of experimental evidence strongly suggests that the furcate needle leaves are the more active transpirers as a rule. Field observations lend

support to this suggestion. Nowhere has the author seen broad leaves so plentiful as at Albany, where the vegetation has a very pronounced xerophytic facies, and severe variations in soil moisture certainly occur, often with some suddenness. Inland, shrubs with a high proportion of broad leaves seem much more plentiful than in the moister coastal belt. Recently in Perth, four shrubs in cultivation were examined. These of course have their water supply artificially augmented during the rainless periods. Only on one could any broad leaves at all be found and on it there were only two, both small. Examination of many hundreds of young plants at Albany revealed that broad leaves are not developed till the second year of life, perhaps not till the third—during this period death seems to be the result of failing water supply. For the older plant the broad leaf certainly possesses the advantage of presenting a wider area to direct light, thereby presumably speeding up photosynthesis during periods of water sufficiency; if it actually as a rule requires less water than the needle leaves, it must also prolong the period of food-forming activity. A few plants are now being raised from seed with a view to more exact experimentation. The tiny plumules just appearing are clothed with appressed silky hairs, though the plantlets have been kept in a moist atmosphere under glass. At Merredin some young plants of *Grevillea excelsior* (?) were found. The lowermost leaves were broad, lance-ovate, entire. Successive later leaves were more and more divided. Several experiments pointed to the conclusion that the broad leaf did not lose water more rapidly than the divided leaves. The adult leaf of this species consists of a short rachis bearing long narrow virgate pinnae, carried so as to expose but little surface at a time to direct light. Round Albany *Petrophila diversifolia* R. Br. is common. The juvenile foliage of this shrub is very graceful, the much-divided feathery leaves having an aspect suggestive of fern fronds. Gradually, as the plant ages, the foliage coarsens till the leaf is a rigid structure of few broadly cuneate segments. The young plants are of value for table decoration; so it may be of some economic importance that a damaged shrub was seen reproducing the foliage appropriate to the stem level, that is, juvenile foliage near the base. No reason for the diversity of foliage can be offered, because the author has not been able to experiment with this species.

From the observations and experiments recorded above it may be judged that it is necessary to be very cautious about divining habitat from aspect, or from minute anatomy. To know the plant's needs, however, is to know something of the place in which it grows.

In conclusion, the author desires to express his special indebtedness to Mr. A. G. Hamilton, who inspired the paper, and the work involved in its preparation.

Addendum.—Since the above was completed, a copy of J. C. Philip's "Physical Chemistry: Its Bearing on Biology and Medicine" (E. Arnold, 1910) has come under notice. The chapter therein on gases has an important bearing on the subject of this present essay. Quoting the researches of Brown and Escombe, it is shown that the hindrance offered to the diffusive flow of a gas (in this case carbon dioxide) by a multi-perforate diaphragm (such as the cuticle of a leaf) "may be nil and is certainly surprisingly small". The significance of this in reference to carbon dioxide intake had been noted by the present writer years ago; but it was only on the occasion of this recent re-reading that the importance of the following almost casual statement was suddenly realized: "A similar 'diameter law' has been established for the diffusion of water vapour . . . and

for the evaporation of water through narrow apertures into desiccated air." Its density being lower, the diffusion rate of water vapour must be higher than that of carbon dioxide. Presumably, therefore, epidermal obstructions will hinder egress of water less than ingress of CO₂. Biological observations and experiments, notably the high transpiration rates found for Proteads, certainly support this conclusion. Wilson (*l.c.*) quotes Brown and Escombe as stating that the diffusion capacity of the epidermis of *Helianthus* leaf is six times greater than its transpiration rate! Now if we regard the epidermis as practically non-existent as a primary factor in the regulation of transpiration (as indeed, it seems we must), we can well understand why Hamilton (*l.c.*) could "detect no modification or diminution of xerophytic characters" in specimens sent from wet places in Tasmania, and why the addition of "another xerophytic character" (thickened succulent leaves) was the only response he found in *Hakea pugioniformis* growing on a sand dune almost on the edge of the sea. When water supply approaches a minimum and the stomata gradually close, the protective power of the epidermal structure doubtless comes fully into play. The heavy cuticle, and the wonderful internal stereome system of the protead leaf maintain its shape and orientation, preserving the organ in fit condition to make full use of any chance accession of moisture during times of stress. But the dominant vegetation of Australia is not protead. Wilson's conclusion is extremely pertinent: "It is certain that in plants there must be some important factor, other than the opening and closing of the stomata, regulating the supply of water to the foliage, and so regulating, to a great extent, the transpiration rate."

It is the inner nature, and not the outer structure that decides whether any species shall inhabit a given locality or not.

ADDITIONS TO THE FLORA OF NEW ENGLAND, N.S.W.

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(Plates xxix-xxx.)

[Read 29th October, 1930.]

In this paper the following five species and two varieties are described as new:

Proteaceae: *Grevillea sarmentosa*.

Leguminosae: *Aotus subglauca*, *A. subglauca*, var. *filiformis*.

Epacridaceae: *Brachyloma daphnoides*, var. *latiusculum*.

Myrtaceae: *Eucalyptus codonocarpa*, *E. Youmani*, *E. tinghaensis*.

Family PROTEACEAE.

GREVILLEA SARMENTOSA, n. sp. Plate xxix, fig. 1.

Frutex procumbens, ramis gracilibus sericeo-tomentosis, 2-3 m. longis. Folia oblongo-pinnatifida, breviter petiolata, basi congruentia vel obliqua, 5-8 cm. longa, 4-5 cm. lata, lobis 4-5 latis, pungentibus, lévibus, supra nitidis venulosis, subtus albidis sericeo-pubescentibus. Racemi solitarii, axillares vel terminales, pruinoso-purpurei, subsecundi, 2-3 cm. longi. Flores breviter pedicellati, pedicellis robustis sericeo-pubescentibus. Corolla pruinoso-purpurea, 8 mm. longa, glabra intus, stylo glabro atropurpureo 15-20 mm. longo; disco stigmatico ovato rugoso, ovario stipitato sericeo-hirsuto. Folliculus non visus.

A strictly prostrate shrub with long slender, silky-tomentose branches extending along the ground for several feet, the young shoots silky-silvery to purple-ferruginous. Leaves alternate, oblong, coarsely pinnatifid, petiolate, regular or oblique at the base, 5-8 × 4-5 cm., 4-5-lobed, the main lobes divided to about the centre of the lamina, and again divided into one or three short broad pungent-pointed lobes, smooth, shining and venulose above, silvery or closely silky-hairy beneath, the midrib and primary veins very conspicuous on the lower surface. Racemes solitary, axillary and terminal, hoary-purple, subsecund, 2-3 cm. long. Flowers shortly pedicellate, the pedicel robust and, like the rhachis, silky-hairy. Corolla hoary to pale-purple, 8 mm. long; style glabrous, dark purple, 15-20 mm. long; stigmatic disc ovate-rugose; ovary stipitate, silky-hairy, stipes elongated. Fruit not seen.

Loc.—Pheasant Mountain, 2 miles NE. of Backwater, Guyra district, New South Wales (Rev. E. N. McKie, T. Youman and W. F. Blakely, 30th Oct., 1929).

Its position is near *G. aquifolium*, from which it differs in the larger and broader-lobed leaves, the finer and more silvery tomentum on the under surface, and in the different vestiture of the inflorescence, smaller and narrower flowers, differently shaped stigmatic disc, and in its strictly prostrate habit.

Family LEGUMINOSAE.

AOTUS SUBGLAUCA, n. sp.

Suffrutex humilis, erectus, ramosissimus, subglaucus, pedalis vel bipedalis, ramulis virgatis modice hirsutis, subglabris. Folia lineari-oblonga vel lineari-lanceolata, 10–20 mm. longa, 1–3 mm. lata, glabra, subglaucous subtus, folia juvenilia etiam minute hirsuta. Flores in fasciculis 2–3-floris axillaribus aggregati, breviter petiolati cum bracteis carnosis, deciduis, late obovato-emarginatis, subscabris, circa 2 mm. longis. Calyx villosus, subatropurpureus, 4 mm. longus, hujus lobi lati, acuti, fere aequales. Vexillum orbiculare, emarginatum, flavidum macula purpurea media notatum, 5–6 mm. longum, 5–6 mm. latum. Carina oblonga, obtusa, atropurpurea, 5 mm. longa. Alae flavae, obtusae, longitudine carinam aequantes. Ovarium breviter stipitatum, dense villosum. Legumen stipitatum obtuse ovoideum, subhirsutum, apiculatum, 5 mm. longum, 4 mm. latum. Semina subreniformia, modice muricata, strophiolata, 2 mm. longa.

A small, erect, densely branched, subglaucous, virgate undershrub, 1–2 feet high. Branches slender, closely hirsute, with very short appressed hairs or nearly glabrous. Leaves linear-lanceolate, acute or linear-oblong, obtuse, 10–20 × 1–3 mm., the margins revolute, glabrous, scabrous and shining above, or when young minutely hirsute, the lamina glabrous and subglaucous beneath, the midrib smooth or minutely hairy. Flowers clustered in the axils, shortly pedicellate. Bracts carnosae, deciduosa, broadly obovate, emarginate, slightly scabrous, about 2 mm. long. Calyx villose with long white hairs, green at the base, the upper half dark purple or nearly black, 4 mm. long, the lobes broad, acute, almost equal, purple inside and minutely fringed. Standard orbicular, emarginate, yellow, with a large purple blotch in the centre, 5–6 × 5–6 mm., the filiform claw 2–3 mm. long. Keel oblong, obtuse, slightly incurved, dark purple, about 5 mm. long. Wings yellow, obtuse, as long as the keel. Ovary shortly stipitate, densely villose with white silky hairs. Pod 5 × 4 mm., stipitate, obliquely ovoid, hirsute to almost glabrous, subglandular, terminating in a short, strong hooked point, not seen in a fully developed state. Seeds subreniform, slightly muricate, strophiolate, 2 mm. long.

Affinities.—Near *A. mollis*, from which it differs in the almost glabrous branches and lanceolate scabrous leaves with their subglaucous under surface, different vestiture, shorter, scabrous, and emarginate bracts, and slightly smaller flowers with straighter and more oblong keels.

Loc.—"The Parlor", Boorolong Run, 18 miles SW. of Guyra, New England, N.S.W. (Rev. E. N. McKie, T. Youman and W. F. Blakely, the type, 28th Oct., 1929); Pheasant Mountain, Backwater; Wandsworth; Bismuth, via Deepwater; Torrington; Jennings; Boonoo Boonoo, N.S.W.; Stanthorpe, Q.; Wallangarra, Q.

AOTUS SUBGLAUCA, var. FILIFORMIS, n. var.

Leaves very slender, almost subulate, 8–18 × 1 mm.

Loc.—Tingha (R. H. Cambage); Warialda; Timor Rock, Coonabarabran, N.S.W.

Family EPACRIDACEAE.

BRACHYLOMA DAPHNOIDES Benth., var. LATIUSCULUM, n. var.

An evergreen shrub, three to five feet high, with oblong or oblong-cuneate leaves, 7–16 × 3–5 mm. Flowers axillary, the outer floral bracts measuring 7 × 4 mm. Sepals scarcely acute, 3–4 mm. long; corolla 6 mm. long, with acuminate lobes.

This variety differs from the typical form in its taller habit, broader leaves, larger flowers, and in its outer floral bracts being much longer and broader.

Loc.—Pheasant Mountain, two miles NE. of Backwater, Parish of Coventry, County Clarke, Guyra district, N.S.W. (Rev. E. N. McKie, Thos. Youman and W. F. Blakely, 30th Oct., 1929, the type); Torrington (J. L. Boorman, Oct., 1911).

Family MYRTACEAE.

EUCALYPTUS CODONOCARPA, n. sp. Plate xxix, fig. 2.

“Mallee” erecta, multicaulis, 6–25 pedes alta, cortice levi, glauco, deciduo. Folia alterna, petiolata, lanceolata vel obliquo-falcata lanceolata, acuminata, uncinata, 10–17 cm. longa, 1.5–2.3 cm. lata, pallido-viridia, tenui-coriacea et propter glandulas oleosas multas semi-pellucida. Costae penninervosae; venae laterales tenuissimae, subobscurae, a costa media divergentes angulo 20 graduum, vena peripherica juxta marginem laminae. Inflorescentia in umbellis axillaribus plerumque 3-floris. Gemmae sessiles, conicae, 5–6 mm. longae. Operculum fere hemisphaericum, subverrucosum, tubo calycis multo brevius. Antherae subadnatae, reniformes. Capsulae sessiles, campanulatae, truncatae, 8–10 mm. longae, 7–8 mm. latae. Discus latus, tenuis, fere planus. Valvae tres, inermes, maxime fragiles.

An erect, many-stemmed, smooth-barked Mallee, 6–25 feet high, 1–4 inches in diameter, with rather short branches and almost equal-sided, narrow, glossy leaves. Bark subglaucous, perfectly smooth and of a uniform colour throughout, deciduous. Timber white or a very pale brown at heart, moderately tough and strong. Juvenile leaves not seen in the earliest stage, opposite for 2–3 pairs, shortly petiolate, narrow lanceolate, thin and flat, 2–4 × 0.5–1 cm., dark-green on both sides, copiously dotted with minute oil glands. Internodes elongated, markedly glandular-hispid with raised reddish glands. Intermediate leaves alternate, petiolate, lanceolate to somewhat obliquely lanceolate, 6–9 × 1.5–2.5 cm., dark glossy-green on both sides, slightly hispid with numerous oil glands, venation obscure, lateral veins spreading at an angle of 15–20° to the midrib, intramarginal vein distant from the edge. Adult leaves alternate, petiolate, obliquely falcate-lanceolate to acuminate, uncinata, 10–17 × 1.5–2.3 cm., flat, glossy on both surfaces, coriaceous, semi-pellucid with copious oil dots, almost inodorous, the midrib canaliculate on the upper surface, slightly raised on the lower; lateral veins very fine and almost obscure, making an angle of about 20° to the midrib; intramarginal vein somewhat close to the edge. Petioles usually erect, yellowish to purple-brown, semi-canaliculate above.

Umbels axillary, 3–5-flowered, usually three; peduncles slightly compressed, dilated upwards, 5–7 mm. long. Buds sessile, the central one shortly pedicellate, conical to umbonate, nearly as long as the peduncles. Operculum almost hemispherical, slightly warty, obtuse or minutely apiculate, much shorter than the calyx-tube. Anthers adnate, reniform, opening in divergent slits. Fruit sessile to shortly pedicellate, campanulate, truncate, with a slightly expanded, rather thin rim and a broad countersunk brownish disc, which occupies two-thirds of the capsule, 8–10 × 7–8 mm., valves usually three, very thin and pointless, or so frail that they roll up, leaving a rather small roundish orifice.

Loc.—Pheasant Mountain, 2 miles NE. of Backwater, Guyra district, New South Wales (Rev. E. N. McKie, T. Youman and W. F. Blakely, 30/10/1929).

Affinities.—It differs from *E. stricta* Sieber in the three-flowered umbels and in the campanulate fruit, with its broad, almost flat, disc and very frail valves.

The leaves are also slightly broader than those of *E. stricta* and are more copiously dotted with oil glands.

It has the habit of *E. approximans* Maiden and resembles it somewhat in the leaves being densely covered with oil dots, but on the other hand they are longer, broader, and more falcate. The fruit, however, is distinct from that of *E. approximans*; it is larger and uniformly more bell-shaped.

EUCALYPTUS YOUMANI, n. sp. Plate xxx, fig. 1.

Arbor robusta, "Stringybark", 25-50 pedes alta, dense vestita cortice rufo-fusca trunco ramisque persistenti. Folia juvenilia opposita bina ad nodum tertium vel quartum, deinde alterna, paulo stellato-pilosa petiolata obtuso-lanceolata vel lanceolata, 3-6 cm. longa, 2-5 cm. lata. Folia matura alterna, petiolata, levia, obliquo-lanceolata, breviter acuminata, crassa, coriacea, atroviridia, nitida, 8-14 cm. longa, 2-3 cm. lata, venis lateralibus tenuibus, subobscuris, a costa media angulo 30-40 graduum egredientibus, vena peripherica prope marginem. Inflorescentia in umbellis axillaribus, 3-7-floris, pedunculis compressis, 7-15 mm. longis. Gemmae plerumque sessiles, ovoideae vel clavatae angulares, 8-10 mm. longae, 5-6 mm. latae. Operculum obtuso-triangulari vel acute conicum, aequilongum nunc longius tubo calycis. Antherae adnatae, reniformes. Capsulae sessiles, subsphaericae vel turbinatae, 10-12 mm. longae, 12-15 mm. latae, disco prominenti convexo, lato, crasso, parte obscuranti tres inclusas vel minime exsertas valvas. Lignum fuscum vel rufo-fuscum, fissile, permanens.

A sturdy Stringybark, 25-50 feet high, invariably spreading in habit when mature, the large branches usually crooked, forming a somewhat open but heavy canopy. Young trees are more symmetrical and furnished with a dense crown of coriaceous, rather broad, dark-green leaves. Branchlets compressed to sub-quadrangular. Bark thick, markedly furrowed, reddish-brown, strongly fibrous and persistent to secondary branches, the latter covered with a smooth or thinner and less fibrous bark. Timber brown to reddish-brown, fissile, durable and largely used for fencing and building purposes.

Juvenile leaves opposite for 3-4 pairs, slightly stellate-hairy, shortly petiolate, thick, subcoriaceous, oblong-ovate, to somewhat obtusely lanceolate, 3-6 × 2-5 cm. Intermediate leaves alternate, petiolate, dark-green, ovate to obliquely lanceolate, abruptly apiculate, thick, coriaceous, 7-10 × 4-7 cm. or larger, lateral veins obscure, making an angle of 40° to 50° with the strong midrib; petioles rather broad, compressed, channelled above, 10-15 mm. long. Adult leaves alternate, petiolate, broadly and obliquely lanceolate, shortly acuminate, moderately thick, dark green and shining on both sides, 8-14 × 2-3 cm., venation fine and subobscure, the lateral veins making an angle of 30-40° with the midrib; the intramarginal vein close to the edge; petioles thick, usually reddish.

Umbels axillary, 3-7-flowered; peduncles angular or compressed, robust, expanded at the top, 7-15 mm. long. Buds sessile, or the inner ones on very short compressed or quadrangular pedicels, somewhat ovoid to angular clavate, 8-10 × 5-6 mm. Operculum obtusely triangular to acutely conical, thick, shining, as long as, or longer than, the calyx-tube. Anthers reniform, the broad cells opening in front, sometimes crowned with a minute terminal gland. Fruit sessile, subspherical to turbinate, 10-12 × 12-15 mm.; disc convex, broad and thick, extending half-way over the thick capsule and sometimes leaving a well-defined furrow between the base and the calycine ring; valves usually three, enclosed or slightly exsert.

Named in honour of Mr. Thomas Youman, Rosehill, Guyra, who assisted the authors in many ways to work out the New England Stringybarks.

The late Mr. Maiden regarded this species as an extreme form of *E. macrorrhyncha*, and illustrated it in his "Critical Revision of the Genus *Eucalyptus*", Part viii, Pl. 39, figs. 12a, 12b, 12c, 12d, 13a, 13b, 18a, 18b. Plate 37, figures 7a, 7b, under *E. capitellata* (page 214) from Guy Fawkes, are also *E. Youmani*. It is also recorded as *E. capitellata* Sm. by Deane and Maiden (These PROCEEDINGS, xxi, 1896, 800).

Loc.—It is very plentiful on the New England Tableland, and around Stanthorpe, Q., and particularly in the Guyra district, principally on slate and trap-rock formations, where it forms moderately thick forests, mainly in shallow or moist depressions, but it is by no means uncommon on dry stony ridges; on the latter, however, its growth is more retarded.

Specimens from Rosehill, 6½ miles SW. of Guyra (T. Youman, Rev. E. N. McKie, and W. F. Blakely, October, 1929) constitute the type. Some of the fruits from Stanthorpe are much smaller than those on the type.

Affinities.—The sessile buds and fruits of *E. Youmani* readily separate it from *E. Cannoni* R. T. Baker, which is regarded as a large-fruited form of *E. macrorrhyncha*, and a close study of the floral and carpological characters of both species will show that the former is much closer to the type of *E. macrorrhyncha* than the latter.

Both *E. Youmani* and *E. macrorrhyncha* F.v.M. are typical Stringybarks; but on the whole *E. Youmani* is a shorter-barrelled and more spreading tree, with shorter and broader coriaceous leaves than *E. macrorrhyncha*. It also differs from it in having the buds sessile and angular, in the more pyriform sessile fruit and in the darker timber.

Maiden (*Crit. Rev.*, Part viii, p. 229) discussed this species under *E. macrorrhyncha* as follows: "On New England the tendency of the leaves is to become smaller and more coriaceous, and the buds to become less to more angular than the type,* the operculum shorter and the fruit more pear-shaped. The rim is not so sharp and the domed portion is narrow. At the same time there are considerable differences in the shapes and sizes of the fruits in these Northern forms as the figures will show."

E. Youmani is somewhat similar to *E. capitellata* Sm. in the sapling and adult stages, but the buds of *E. Youmani* are shorter than those of its ally, the fruits are also thicker, less compressed, and more turbinate, while the timber is much darker and far more brittle.

EUCALYPTUS TINGHAENSIS, n. sp. Plate xxx, fig. 2.

Arbor "Stringybark" 40–80 pedes alta, cortice maxime fibroso longitudinaliter sulcato persistente. Folia juvenilia angusto-lanceolata, acuminata, molliter stellato-hirsuta, 3–6 cm. longa, 0.7–1.5 cm. lata. Folia matura angusto-lanceolata vel obliquo-lanceolata, levia, nitida, in longum petiolum sensim angustata, 8–13 cm. longa, 1.5–2 cm. lata. Inflorescentia in umbellis axillaribus 5–10-floris, gemmae pedicellatae, clavatae, acutae, 6–7 mm. longae, 3–4 mm. latae, operculis acute conicis vel rostratis calycis tubo longioribus. Antherae subadnatae, reniformes. Capsulae brevi-pedicellatae, ovoideae, truncatae, subpyriformes, supra cum orificio paulo

* "In the more exposed situations the mutual compression causes the buds to be bluntly angular and compressed just like *E. capitellata* of the coast."

contracto, 8-10 mm. longae, 7-9 mm. latae. Discus angustus, planus vel subconvexus. Valvae parvae, deltoideae, inclusae.

A typical Stringybark, 40-80 feet high and 1-4 feet in diameter, with a long straight barrel, and a very broad canopy of rather dark-green glossy leaves. Bark longitudinally furrowed, red-brown, somewhat soft, very fibrous and persistent to secondary branches. Timber pale-pink shading to very light-brown, straight-grained, very fissile, strong and durable, one of the best of the Stringybarks in the Guyra-Tingha districts. Juvenile leaves opposite for 3-5 pairs, very shortly petiolate, narrow lanceolate, acuminate, pale-green, very fragrant when fresh, softly stellate-hairy, much paler on the lower surface than on the upper, 3-6 × 0.7-1.5 cm.; internodes terete, minutely stellate-hairy. Intermediate leaves occasionally opposite, but usually alternate, narrow lanceolate, subacuminate, thin, pale-green, much paler beneath, 8-10 × 1.5-2.5 cm., lateral veins very thin, diverging at an angle of 30-40° from the prominent midrib. Adult leaves alternate, petiolate, narrow lanceolate-acuminate to obliquely lanceolate, gradually tapering into the rather long petiole, 8-13 × 1.5-2 cm., pale-green when dry. Venation somewhat distinct, lateral veins spreading at an angle of 25-35° from the midrib, intramarginal vein rather distant from the thin margin. Some of the leaves are denticulate like those of *E. quadrangulata* and *E. nitens*.

Umbels axillary, 5-10-flowered, peduncles compressed and somewhat sharply angled, up to 10 mm. long. Buds pedicellate, clavate, acute, 6-7 × 3-4 mm., pale-green, smooth and shining. Operculum sharply conical to rostrate, usually longer than the calyx-tube. Anthers sub-adenate, reniform. Fruit shortly pedicellate, ovoid to subpyriform, truncate or slightly contracted at the top, 8-10 × 7-9 mm., sometimes smaller. Disc flat or slightly thickened into a narrow convex ring over the top of the capsule and exceeding the calycine ring, or sometimes a little oblique, the orifice rather broad; valves 3-4, small, deltoid, usually enclosed.

Loc.—Forest Reserve 43110, Inverell district, near Gilgai, and 7 miles on the Inverell-Guyra Road (L. B. Peacock); 6 miles from Tingha, on G. W. Browning's property (Rev. E. N. McKie, Thos. Youman and W. F. Blakely, 1st Nov., 1929, the type); Kangaroo Camp, about one mile south of 30 mile post, Guyra-Tingha Road, and also about one mile further south on the fall to Cope's Creek; junction Limestone and Moredun Creeks on the track from Barn Gully to Tingha (Rev. E. N. McKie).

Affinities.—Closely allied to *E. nigra* in the buds and fruits, but the latter are thicker than those of *E. nigra*, while the juvenile leaves are much narrower, the timber is also paler in colour and superior in every way.

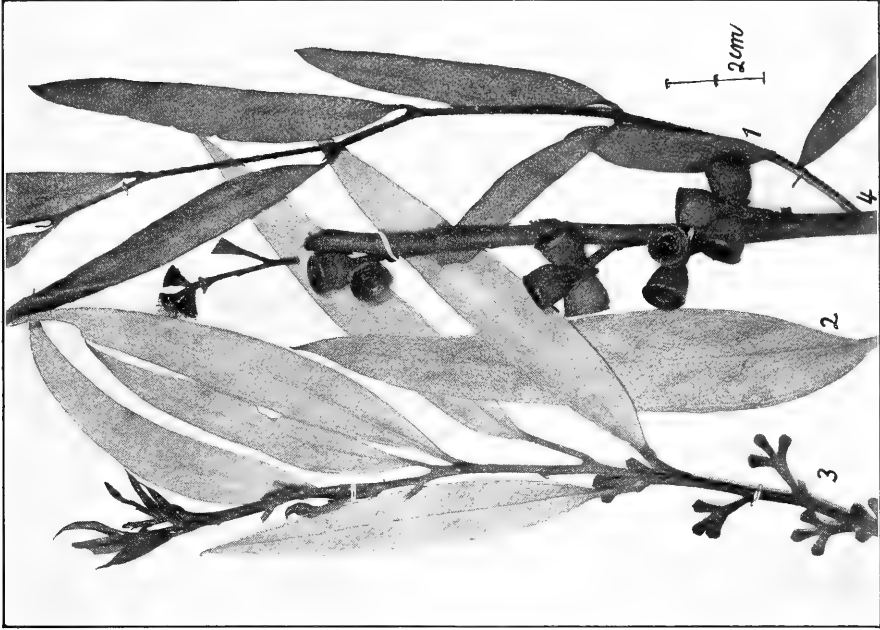
It differs from the species described as *E. McKieana* (see *post.*) in its broader, softer and more aromatic juvenile leaves, its larger and differently shaped fruits and its paler timber which is longer in the grain.

EXPLANATION OF PLATES XXIX-XXX.

Plate xxix.

1.—*Grevillea sarmentosa* Blakely and McKie.—1. Portion of flowering branch showing the upper surface of the leaves, and the short tomentose raceme. 2. A leaf showing the pale-silvery under-surface.

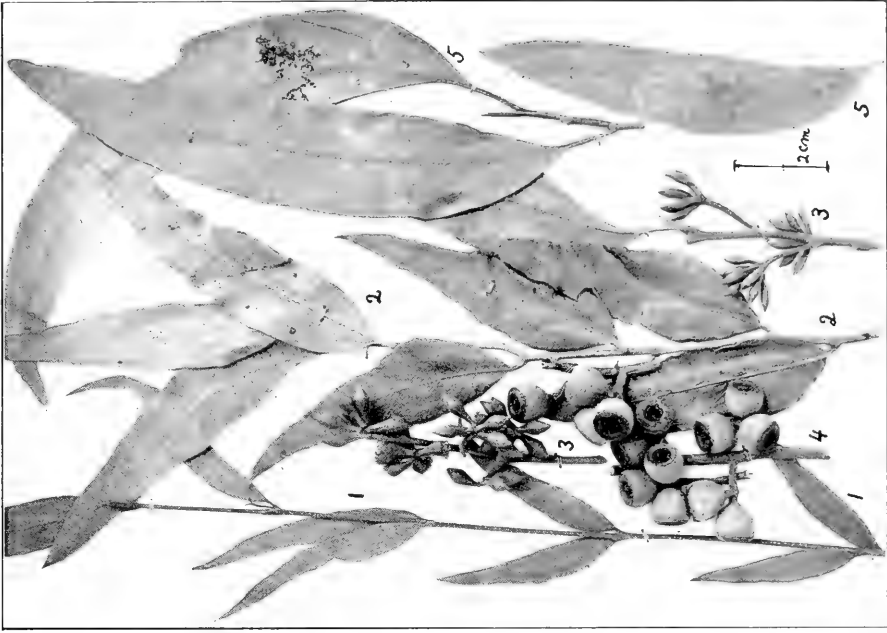
2.—*Eucalyptus codonocarpa* Blakely and McKie.—1. Juvenile leaves, of which one pair is opposite. Note the minute oil dots and the prominent oil glands on the internodes. 2. Intermediate leaf. 3. Upper portion of a branch with immature buds, and mature leaves. 4. Fruiting branch showing the sessile, bell-shaped fruits.



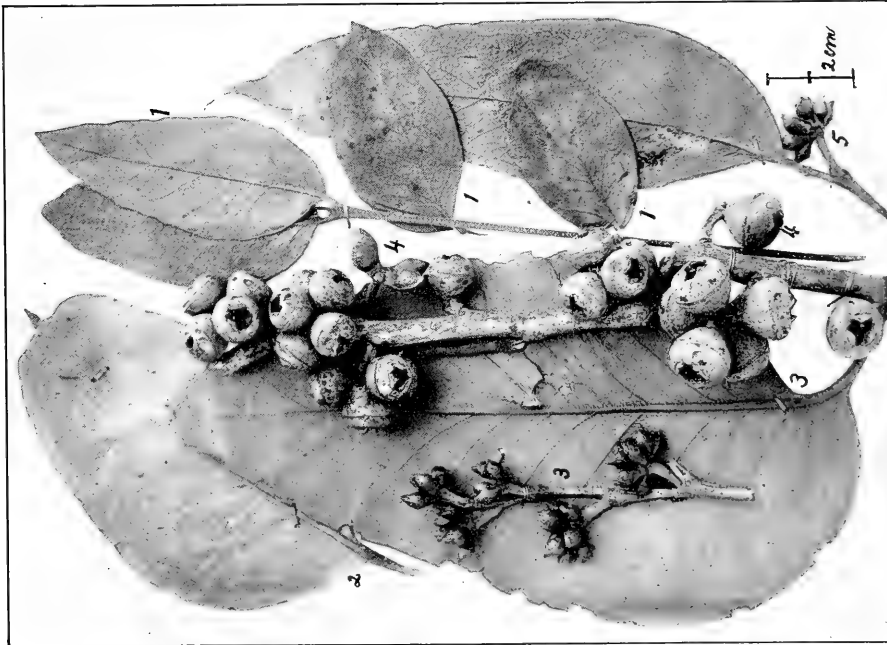
2. *Eucalyptus codonocarpa*, n. sp.



1. *Grevillea sarmenifosa*, n. sp.



2. *Eucalyptus tinghaensis*, n. sp.



1. *Eucalyptus Youmani*, n. sp.

Plate xxx.

1.—*Eucalyptus Youmani* Blakely and McKie.—1. Juvenile leaves. 2. An oblong, apiculate intermediate leaf. 3. A large obliquely lanceolate intermediate leaf, with the long acuminate point broken off, and a spray of immature buds. 4. Four almost mature buds, and two clusters of fruits. 5. Mature leaf with buds *in situ*.

2.—*Eucalyptus tinghaensis* Blakely and McKie.—1. Juvenile leaves, of which three pairs are opposite. 2. Types of intermediate leaves, the four lower ones are acuminate-lanceolate and slightly hispid, the upper ones are narrow lanceolate, very shortly petiolate and almost smooth. 3. Two clusters of buds. 4. Fruits. 5. Types of mature leaves (All figures about three-fourths natural size.)

ANOTHER NEW SPECIES OF *EUCALYPTUS* FROM NEW ENGLAND.

By W. F. BLAKELY, Assistant Botanist, National Herbarium, Sydney.

(Plate xxxi.)

[Read 29th October, 1930.]

EUCALYPTUS *McKIEANA*, n. sp. Plate xxxi.

Arbor "Stringybark", ampla, formosa, 50-100 pedes alta, diametro 1-3 pedes, cortice rufo-brunneo, parum sulcato, maxime fibroso, persistente ad ramulos parvos. Lignum pallido-brunneum, leve, firmum. Folia juvenilia creberrima, opposita ad 4-6 paria, sessilia vel brevi-petiolata, lineari-oblonga, acuminata vel angustolanceolata, dilute viridia, microscopice stellata vel subglabra, 1.5-4.5 cm. longa, 0.3-0.5 cm. lata. Folia intermedia, opposita et alternata, nec numerosa, sessilia vel brevissime petiolata, levia, parum undulata, angusto- usque lato-lanceolata, 4-7 cm. longa, 1.3-2.3 cm. lata, venis lateralibus tenuissimis, a costa media angulo 20-30 graduum divergentibus. Folia matura alternata, petiolata, angustolanceolata vel falcato-lanceolata, dilute viridia, tenuia, coriacea, nitida, 5-9 cm. longa, 0.8-1.4 cm. lata, venis lateralibus subobscuris, angulo 20-25 graduum a costa media orientibus. Inflorescentia axillaris, umbellata vel breviter paniculata, umbellis 5-10-floris, pedunculis gracilibus subteretibus, 7-10 mm. longis. Gemmae flavidae, cylindroideae, acutae, breviter pedicellatae, 5-6 mm. longae, 3-4 mm. latae. Operculum acute conicum, calycis tubo aequilongum. Capsulae ovoideae usque ad formam sphaeroideo-urceolatam, truncatae, breviter pedicellatae, coronatae disco annulari parvo angusto-convexo in quo valvae tres aut quattuor inclusae. Valvae raro subexsertae.

A symmetrical Stringybark, 50-100 feet high, 1-3 or more feet in diameter, of a good shape and with a rather dense canopy of narrow glossy leaves. Bark red-brown, slightly furrowed, very fibrous and persistent to the small branches. Timber pale-pink when fresh, drying a pale brownish-pink, rather light, with a moderately long, free grain and, when well worked, displays a slightly mottled and wavy figure with faint transverse markings. It is also tough and flexible, and capable of withstanding a good strain, and is mainly used for poles, mining purposes, fences and building construction.

Juvenile leaves opposite for 4-6 pairs, then alternate and growing up with the plant to a height of 6-12 feet, sessile to very shortly petiolate, linear-oblong to linear and narrow lanceolate or acuminate, minutely stellate-hairy, but not hispid, dull and pale on the lower surface, dark green on the upper, 1.5-4.5 × 0.3-0.5 cm., obscurely veined, the margins subcrenulate and somewhat thickened. Internodes covered with a minute greyish stellate tomentum. Intermediate leaves opposite and alternate on the same branch but not numerous, sessile to very shortly petiolate, narrow to broad lanceolate, dark green above, pale beneath, smooth and slightly undulate, 4-7 × 1.3-2.3 cm. Venation penninerved, the lateral veins very fine and somewhat obscure, diverging at an angle of 20-30° from the



Eucalyptus McKieana, n. sp.

more prominent median nerve. Adult leaves alternate, petiolate, narrow lanceolate to falcate-lanceolate, rather thin, light-green and shining on both surfaces, 5-9 × 0.8-1.4 cm. Lateral veins moderately distinct, radiating at an angle of 20-25° from the midrib; intramarginal vein very close to the edge. Inflorescence usually umbellate, but sometimes forming short axillary panicles which are shorter than the leaves. Umbels 5-10-flowered; peduncles slender, subterete, 7-10 mm. long. Buds cylindroid, acute, yellowish-brown, radiating in stellate clusters, subsessile, 5-6 × 3-4 mm. Operculum conical, shining, as long as or longer than the calyx-tube. Anthers subadnate, reniform, the cells distinct and opening in divergent slits.

Fruit ovoid to sphaeroid-urceolate, truncate, shortly pedicellate, 4-5 × 4-5 mm. Disc small, slightly convex or forming a narrow raised band over the top of the capsule, leaving a moderately large orifice in which are usually enclosed 3-4 small broad acute valves.

This species is remarkable for its very narrow and numerous sucker leaves, the narrowest of all the Stringybarks, and which persist to a height of 6-12 feet.

Loc.—From Limestone Creek to Moredun Creek, Guyra-Tingha districts, N.S.W., 24 to 27 miles NW. of Guyra, where it forms in places a moderately dense forest, partly in association with *E. Andrewsii*, *E. macrorrhyncha* and *E. Nicholii* (Rev. E. N. McKie, Thos. Youman, and W. F. Blakely, 30th Oct., 1929).

At Moredun Creek, on the upper part of the Gwydir watershed, this new species is found growing on quartz-porphry formation on the edge of the Tingha tin-granite, at an elevation of 3,000 feet or more above sea-level.

The Moredun Creek specimens constitute the type.

Its nearest affinity is *E. conglomerata*, from which it differs in size and habit, in the narrower and more numerous juvenile leaves, differently shaped intermediate leaves, shorter and narrower adult leaves, in the sparsely-flowered umbels and subpaniculate inflorescence, pedicellate, nonconglomerate fruits, and in the quality of the timber.

Named in honour of the Rev. Ernest Norman McKie, B.A., Presbyterian Minister at Guyra, N.S.W., who, by his intimate field and botanical knowledge of the New England Eucalypts, has helped in the elucidation of this and other species of this most economic genus.

EXPLANATION OF PLATE XXXI.

1.—*Eucalyptus McKieana* Blakely.—1. Juvenile leaves (note their grass-like appearance). 2. Intermediate leaves (note the change from sessile to shortly petiolate). 3. Buds and fruits. The upper buds are mature, some have lost their opercula and display the white filaments, and reniform anthers. 4. Types of mature leaves showing the filiform petioles. (Approximately three-fourths natural size.)

2.—A photograph of *Eucalyptus McKieana*, about 100 feet high, near Moredun Dam, Guyra-Tingha districts.

AUSTRALIAN RUST STUDIES. III.

INITIAL RESULTS OF BREEDING FOR RUST RESISTANCE.

By W. L. WATERHOUSE, D.Sc. (Agr.), The University of Sydney.

(Plates xxxii-xxxiv.)

[Read 26th November, 1930.]

CONTENTS.

Introduction.

Crossing technique.

Germination as affected by developmental stage of grain.

Breeding results.

Wide crosses.—Wheat × barley; wheat × rye; interspecific wheat crosses: "Khapli" crosses, Durum crosses.

Vulgare crosses.—"Canberra" × "Thew": Inheritance of resistance to stem rust, inheritance of resistance to leaf rust, inheritance of morphological characters; "Federation" × "Canberra"; "Federation" × "Thew"; "Riverina" × "Thew"; "Gluyas" × "Thew"; "Federation" × "Japanese Bearded".

Further crossing work.

Occurrence of grass clumps in wheat crosses.

Inheritance of resistance to *Puccinia graminis avenae*.

Summary and conclusions.

Bibliography.

Introduction.

In this paper it is proposed to record some of the initial results obtained in breeding varieties for rust resistance. The first paper of the series (Waterhouse, 1929) set out the general results of the specialization studies, and the second (Waterhouse, 1930) referred to biometrical studies of the spore forms. All three papers deal with results obtained in work ending early in 1929. Help has been given throughout by numerous workers as gratefully acknowledged in the first paper of this series.

In the control of plant diseases many methods are used. Of these it is generally conceded that the practice known as "immunization" offers the greatest promise. When dealing with an annual crop plant cultivated as wheat is, other methods are difficult of application. Breeding for disease resistance is the main hope for the control of rust, as well as the other diseases of wheat. Considerable success has attended work of this nature in many places, and a voluminous literature has accumulated. References to some of the important contributions are included in the bibliography. The phenomenon of specialization offers one of the greatest complications, but controlled genetical studies help largely in overcoming this obstacle.

Naturally, success in breeding work is not likely to be met with except as a result of many years of work. Any addition to the physiologic forms of the pathogen present in a country must seriously prolong the operation. This is well illustrated in the results of the work now to be recorded. These have not involved

the production of a rust epidemic in the field. The danger of having valuable F_1 and other wheats killed or seriously affected by such an occurrence has made it unwise to produce an epidemic. With a "rust nursery" available, this would be done. Nevertheless, spontaneous rust attacks in the field have been made use of wherever possible.

Crossing Technique.

The methods adopted in the work may be briefly described.

Heads of the maternal variety were selected just as the anthers about one-third the length of the head below the tip were turning yellow and ripening. The flowers were emasculated in the usual way. But instead of leaving only about three spikelets on each side of the rachis of the spike, it has been the practice to leave double that number, and frequently many more. The emasculated heads were covered with glassine bags and allowed to mature for pollination.

TABLE 1.

The result of pollinating stigmas of "Federation" of different ages with pollen of "Indian 12".

Cross No.	Date of Emasculatation.	Date of Pollination.	Age of Stigmas in days.	Number of Flowers Pollinated.	Number of Grains produced.	Percentage of Grain set.
II 23.31	13.10.23	13.10.23	0	24	11	45.8
32	13.10.23	14.10.23	1	28	21	75
33	13.10.23	15.10.23	2	28	22	78.6
43	13.10.23	17.10.23	4	26	16	61.5
54	13.10.23	22.10.23	9	28	3	10.7
69	13.10.23	24.10.23	11	24	1	4.2
72	13.10.23	26.10.23	13	28	0	0
74	13.10.23	27.10.23	14	20	0	0
76	13.10.23	30.10.23	17	32	0	0
83	13.10.23	31.10.23	18	26	0	0
92	13.10.23	1.11.23	19	28	0	0
96	13.10.23	2.11.23	20	24	0	0
100	13.10.23	5.11.23	23	24	0	0
103	13.10.23	6.11.23	24	28	0	0
106	13.10.23	7.11.23	25	26	0	0
109	13.10.23	8.11.23	26	26	0	0

A test was made to determine how long such heads ought to be left before being pollinated. The variety "Federation", which is botanically *Triticum vulgare alborubrum* Körn., was selected as the ovule parent, and "Indian 12", which is *T. vulgare pseudo-hostianum* Flaksb., as the pollen parent. The former has opaque grain and the latter corneous grain. Grain produced as the result of crossing the two is corneous, so it was possible to be assured that grain set on "Federation" was the result of crossing. Furthermore, the F_1 plants are markedly different from each of the parents, so that any plants not true crosses can be readily detected.

In the test that was made, fifteen heads were selected at the same stage of development, viz., with the ripest anthers just turning yellow. These were emasculated and bagged, and successively pollinated with "Indian 12" on different days, the operation being carried out in the early afternoon. For purposes of

pollination, from the selected male parent an anther which at a touch was ready to dehisce was inserted in each emasculated flower. The pollinated heads were then covered again with the glassine bags and allowed to mature grain. The result of the test is shown in Table 1.

Each of the grains was corneous. Confirmation of the fact that they were the result of the pollination specified was obtained by sowing them and noting their growth. All had tip-beards, velvet chaff which was bronze, and coloured grain. These characters are of course quite different from those of "Federation", the ovule parent.

TABLE 2.

Results obtained in crosses between varieties of the same species groups of wheat in 1925, showing the number of grains set.

Cross No.	Parents.	Grains set.	Pollinations made.
II 25.13	Bunyip × Early Bird	20	24
16	Gullen × Firkbank	18	24
18	Bunyip × Gullen	14	26
19	Florence × Gullen	11	22
21	Riverina × Firkbank	19	22
22	Gullen × Florence	17	24
24	Clarendon × Bunyip	12	24
27	Thew × Riverina	16	18
30	Indian F × Canberra	16	26
31	Cedar × Indian F	20	26
33	Canberra × Gullen	20	24
34	Canberra × Bunyip	18	24
35	Canberra × Bunge	18	26
37	Indian F × Cedar	14	28
38	Gullen × Federation	11	18
40	Bunyip × Federation	15	24
43	Federation × Gullen	27	30
46	Waratah × Clarendon	23	24
47	Bena × Clarendon	28	30
48	Clarendon × Bena	21	26
49	Clarendon × Waratah	18	24
52	Federation × B 33/4	23	26
54	Federation × Canaan	27	30
55	Federation × College Eclipse	26	28
56	Federation × Aussie	16	26
57	Federation × White Federation	15	22
58	Indian F × Jonathan	22	26
59	Canaan × Waratah	19	20
60	Canaan × Federation	30	32
65	Bobs × Federation	23	26
69	Canberra × Bobs	21	22
70	Jonathan × Bobs	24	26
71	Bathurst 7 × Bathurst 8	29	30
72	Indian F × Bobs	17	22
75	Khapli × Glossy Huguenot	26	30
80	Federation × Jonathan	29	34
86	Khapli × Kahla	21	28
88	Federation × Barletta	21	22
100	Federation × Japanese Bearded	19	22
	Percentage of grain set, 79%	784	986

Clearly then, under the conditions prevailing at Sydney University, the best result was obtained by pollinating flowers about 2 days after emasculation. After about 10 days, a setting of grain can hardly be expected.

It was of interest to note that the one grain produced in cross No. II 23.69 was present in the lowest flower on the spike; this is, of course, the latest flower in the head to mature.

At Chico, California, Florell reports that a 26% successful pollination was obtained in 1920 in a case involving about 240 pollinations of emasculated flowers which had been left for 16 days. The different climatic conditions doubtless explain the divergent results.

To indicate the efficiency of the method, results which have been obtained are quoted in Tables 2-4.

TABLE 3.

Results obtained in crosses between varieties of the same species groups of wheat in 1926, showing the number of grains set.

Cross No.	Parents.	Grains set.	Pollinations made.
II 26.6	Florence × Gullen	18	22
9	Firbank × Florence	15	24
10	Gullen × Federation	13	24
14	Federation × Firbank	10	24
15	Federation × Florence	15	24
21	Federation × Thew	18	24
22	Bunyip × Gullen	16	22
26	White Federation × Federation	15	24
29	Hard Federation × White Federation	12	24
30	White Federation × Hard Federation	13	22
31	Federation × White Federation	11	32
38	Marshall's No. 3 × Thew	13	30
39	Federation × Roseworthy	24	26
40	Thew × Roseworthy	11	14
43	Exquisite × Thew	9	28
44	Wandilla × Federation	21	28
47	Bobs × Roseworthy	23	26
48	Roseworthy × Bobs	24	30
49	Thew × Marshall's No. 3	14	16
53	Glossy Huguenot × Kubanka 2094	25	32
56	Yandilla King × Gullen	17	22
57	II 23.97.2 × II 23.97.4	10	22
58	Federation × Webster	20	22
65	Webster × Federation	12	24
66	Federation × Webster	15	18
71	Thew × Japanese Bearded	11	20
78	Hope × Federation	8	24
	Percentage of grain set, 64%	413	648

In many species crosses made between varieties of groups like *T. vulgare* and *T. durum*, where the chromosome numbers are different, poor setting of grain was of course obtained. Low results were also obtained, as was expected, in certain crosses in which it was known that the emasculated heads had been left longer than they should have been, or that the pollen used was unavoidably

TABLE 4.

Results obtained in crosses between varieties of the same species groups of wheat in 1927, showing the number of grains set.

Cross No.	Parents.	Grains set.	Pollinations made.
II 27.12	Firbank × Florence	22	26
13	Florence × Firbank	17	26
14	Gullen × Florence	20	24
15	Florence × Gullen	17	26
16	Bunyip × Gullen	19	22
17	Gullen × Federation	20	28
19	Federation × Florence	21	30
20	Florence × Federation	21	26
21	Hard Federation × Florence	19	30
25	Thew × Canberra	23	24
28	Yandilla King × Thew	28	34
34	Hard Federation × White Federation	16	28
36	Yandilla King × Gullen	16	28
37	Federation × Yandilla King	20	26
43	Federation × Roseworthy	19	26
48	Federation × Marshall's No. 3	22	26
53	Federation × Rieti	14	22
80	Federation × Euston (Sel.)	21	24
81	Federation × Euston (Sel.)	25	26
82	Federation × Euston (Sel.)	20	24
87	Waratah × Webster	18	26
89	Clarendon × Webster	16	24
91	Marshall's No. 3 × Webster	12	14
93	Warren × Webster	16	26
94	I 17/4 × Webster	18	20
98	J 37/1 × Webster	14	18
102	H 27/2 × Webster	23	26
103	G 1/1 × Webster	14	20
110	Webster × Euston (Sel.)	13	16
111	Euston × Webster	14	18
117	Euston × Webster	20	26
123	Euston × Webster	17	22
127	Euston × Webster	19	22
128	Euston × Webster	15	18
	Percentage of grain set, 76%	629	822

in a poor condition. These results have not been included in the tables. There was a noticeable falling off in the efficiency of the crossing in 1926 and in 1928 when abnormally dry spring and early summer conditions were experienced. But the results show that under ordinary conditions an efficiency of 75% may be looked for.

Pollination of Flowers on severed Stems.

An unusual method of effecting the cross was tested. A head of "Waratah" was emasculated in the usual way in the field. The stalk was then cut off at ground level and inserted in a conical flask of water, where the end of the stem was severed under water. After removal of this severed portion from the flask, the stigmas were pollinated in the plant house with pollen of a selection from

the cross "Federation" × "Webster". The flask and stem were kept in a sunny position in the plant house, where each day a stream of water was allowed to flow gently through the flask for two minutes and thus completely change the water in which the stem was immersed. Under these conditions the uppermost of the three leaves on the stalk remained green for three weeks. The water was then removed from the flask and the stem allowed to dry out.

Later the grain was rubbed out. From 28 flowers pollinated, 16 grains were obtained. They were somewhat shrivelled, but gave normal germinations and healthy F_1 plants.

This method may be valuable in special cases. Repeatedly it has been necessary to obtain pollen from heads of particular plants forwarded from country centres. No difficulty has been met in obtaining a normal setting of grain by this method. But the test just recorded shows that maternal as well as paternal material severed from the plant may be used in cases of necessity.

Germination as affected by the Age of Grain.

It was decided to see how soon after pollination, under the prevailing conditions, viable grain was set. In a uniform plot of "Federation" wheat growing at Sydney University, a number of plants were selected on the same day when the first flowers of the most forward ear of each plant were just about to push up the anthers. All these ears at the same stage of maturity were tagged, and all but the two lowest flowers in each spikelet removed. Commencing on the third day from the first appearance of the anthers, i.e., the 16th of October, the stalk bearing the tagged head was cut off at ground level. This was done at daily intervals as far as possible. The harvested heads were suspended in a dry room for a little more than four months, when the grain was rubbed out and tested for germination by sowing in separate pots of garden soil. Pots of normal graded "Federation" grain were sown at the same time for comparative purposes. The results are shown in Table 5.

It was surprising to find that after only six days from pollination, 28 very shrivelled grains in an ear produced 11 very spindly seedlings. The seven-day-old ear gave 12 very spindly seedlings from the 26 very shrivelled grains formed, and the nine-day ear, 17 from 26 grains. Thereafter, although the grain was shrivelled, it was fully viable, but gave spindly seedlings. An ear 17 days old gave practically normal seedlings. These results are illustrated in Plate xxxii.

The result showed that it was perfectly safe to use this method of harvesting crossed heads of wheat and obtain a normal germination of the crossed grain. On account of the danger from sparrow attack and from damage by trespassers, the method of harvesting the stalks carrying the crossed ears after lapse of a period of three to four weeks from pollination has been adopted, and has proved fully satisfactory.

BREEDING RESULTS.

WIDE CROSSES.

The possibility of obtaining resistant types of wheat from wide crosses has not been neglected. This was additional to considerations concerning the genetics of such crosses.

TABLE 5.

Stage of development of wheat grain after pollination in relation to germination capacity.
Anthers first showing in each case on 13th October.

No.	Date Harvested.	Age of Grain in days.	Character of Grain.	Character of Resultant Seedlings.
1	16 October	3	Nil.	Nil.
2	17 "	4	Nil.	Nil.
3	19 "	6	Very shrivelled.	$\frac{11}{28}$ Very spindly
4	20 "	7	do.	$\frac{12}{26}$ do.
5	22 "	9	do.	$\frac{17}{26}$ do.
6	23 "	10	Shrivelled.	$\frac{24}{24}$ Spindly.
7	24 "	11	do.	do.
8	25 "	12	do.	do.
9	26 "	13	do.	do.
10	27 "	14	do.	do.
11	29 "	16	do.	do.
12	30 "	17	Somewhat pinched.	Almost normal.
13	31 "	18	do.	do.
14	1 November	19	do.	do.
15	2 "	20	do.	Normal.
16	3 "	21	do.	do.
17	5 "	23	do.	do.
18	6 "	24	do.	do.
19	7 "	25	do.	do.
20	8 "	26	Normal.	do.
21	9 "	27	do.	do.
22	10 "	28	do.	do.
23	12 "	30	do.	do.
24	13 "	31	do.	do.
25	14 "	32	do.	do.

Wheat × Barley.

The commercial variety of wheat named "Bobs" is reputed to have been derived from a cross of this nature. It was produced by the late William Farrer in 1896 and is stated to have originated from a cross between "Nepaul" Barley and a wheat named "Early Lambrigg". Starting with one shrivelled grain obtained from the cross, the variety was fixed in four years.

A second Australian variety known as "Canberra" is also stated to have originated in a cross of this nature. The parents in this instance are reputed to be "Federation" crossed with "Volga" Barley.

In the work that is in progress, both these varieties of barleys were used as the pollen parents, the main work being done with "Volga". Farrer's "Early Lambrigg" was not available as an ovule parent. A number of varieties of *T. vulgare* which flowered at the same time as the two barleys were used as the ovule parents. The work reported covered tests made in 1924, 1925, 1926, and 1927. This gave a range of seasons in case some special seasonal influence might contribute to successful crossing. The practice was to emasculate the flowers at the stage already described under the technique of crossing, and to leave them

until the next day for pollination. On the following day the pollinations of the same flowers were repeated. In a number of cases when it was practicable, yet another pollination was made on the next day. In the results given hereunder, this third pollination is not counted. Nor is any note taken of numerous further attempts made by senior students of various classes. The phrase "pollinations made",—totalling 1,932,—means that 961 wheat flowers were actually used, being pollinated at least twice. The results are as follows:

TABLE 6.
Results of attempts to cross varieties of *T. vulgare* with 2 varieties of barley.

Parents of Cross.	Number of Grains set.	Number of Pollinations made.
Clarendon × Volga Barley	2	336
Hard Federation × Volga Barley	0	80
Federation × Volga Barley	0	104
Hurst's 11 × Volga Barley	0	328
Bunyip × Volga Barley	0	332
Early Bird × Volga Barley	0	92
Sunset × Volga Barley	0	48
Plowman's No. 3 × Volga Barley	0	52
Canberra × Volga Barley	0	144
Firbank × Volga Barley	0	52
Federation × Nepal Barley	1	164
Canberra × Nepal Barley	2	144
Bobs × Nepal Barley	0	56
	5	1,932

It will be seen that in all, five grains were obtained. In each case they were sown the next season and grown to maturity. All proved to be normal wheat plants of the variety used as the pollen parent, viz., "Federation", "Canberra", and "Clarendon". In the succeeding generation no segregation occurred. Each was clearly the result of accidental self-pollination.

There would therefore seem to be doubt whether the claims that barley and wheat were successfully crossed to give "Bobs" and "Canberra" can be substantiated.

Wheat × Rye.

It has long been known that crosses between these two cereals can be made. Reference has elsewhere been made to the fact that even in seasons when wheat was heavily attacked by *P. graminis tritici* 34, adjacent crops of rye showed but rare infections. For a long time it has been hoped that cross-bred material might be available for studies in rust resistance.

In the years 1921, 1922, 1924, 1925, 1926, 1927 and 1928 crosses have been attempted. The ovule parent in each case has been wheat. "Federation" has been mainly used, but in some cases "Hard Federation" has been substituted, and in fewer instances, "Thew". The pollen parent has in the main been "Rosen" rye, but "Black Winter" has also been used. As in the case of the wheat × barley

crosses, pollinations of the same flowers were made on the second and on the third days after emasculation. In these instances also, yet a third pollination was many times made, so the results given are again conservative. Actually 1,010 wheat flowers were used. Senior students made additional attempts which are not here included.

During the six years, 13 grains have been obtained from more than 2,020 pollinations: five of the grains failed to germinate, seven yielded "Federation" or "Hard Federation" plants which showed no departure from the normal behaviour of these varieties and were therefore the result of accidental self-pollination. In only one case to date has a true cross been obtained. This was in 1925 from a cross between "Federation" and "Rosen" rye. The F_1 plant tested with Forms 43 and 46 gave "flecks", whereas the ovule parent "Federation" at the same time gave "f" reactions. The seedling after test was transplanted and grown to maturity. A notable feature was its abundant stooling. This was welcomed as giving the possibility of making back crosses.

The hybrid plant proved to be completely sterile, though pistils and stamens were seemingly normal. A large number of attempts were made to effect crosses with each of the parents, and also to pollinate stigmas of the hybrid plant with pollen from the wheat and from the rye parents. In no case was the attempt successful. The hybrid was sterile and the attempt to obtain resistance accordingly failed.

From crosses made in 1928, two plants are available from the cross "Canberra" \times "Rosen" rye. In the seedling tests, these gave flecks with *P. graminis tritici* 46 which normally produces a fully susceptible reaction on "Canberra". They are therefore hybrids and are being grown to maturity under carefully controlled conditions.

It will therefore be seen that so far no success has attended the efforts to secure fertile progeny as a result of crossing wheat and rye.

Interspecific Wheat Crosses.

"Khapli" Crosses.

Of the wheat varieties tested by different workers for resistance to stem rust, the variety of *T. dicoccum* Ajar Perc., known as "Khapli", is, perhaps, the most resistant. Of the physiologic forms recorded to date by Stakman and Levine, only one attacks "Khapli". It is, therefore, not surprising that many efforts have been made to cross this resistant emmer with the commercial types of vulgare wheat which are susceptible.

Hayes and Stakman (1922) report disappointing results from the attempts to cross "Khapli" with "Marquis" wheat. Hynes (1926) reports a successful cross between "Federation" and "Khapli".

Commencing in 1921 attempts have been made each year to obtain successful crosses between commercial vulgare wheats and "Khapli". In the main, "Federation" has been the variety used. Extending the work over a number of seasons has made it possible for various seasonal influences to operate. It was thought that perhaps some special influences might contribute to successful crossing.

In the work it has been the practice to pollinate the vulgare wheat with "Khapli" pollen on the second day following the emasculation, and to repeat this the next day. In very many cases a third pollination was also effected. In tabulating the results only the two pollinations are taken into account. Actually

930 flowers were used for the pollinations. Senior students have also made a number of unsuccessful attempts to secure results, but these are not taken into account. The figure 1,860 is therefore a very conservative estimate of the pollinations made.

The results are summarized in Tables 7 and 8.

TABLE 7.

Results obtained in seven of the years in attempts to cross certain vulgare wheats with "Khapli" emmer.

Year.	Vulgare Parent.	Number of Grains set.	Number of Pollinations made.
1921	Federation	0	32
1922	Federation	1	40
	Hard Federation	5	34
1923	Hard Federation	9	96
1924	Federation	17	262
1925	Federation	13	96
	Canberra	7	52
1926	Federation	25	304
	Gluyas	6	48
	Gurkha (Gullen)	9	44
1927	Federation	106	380
	Gluyas	52	240
	Gurkha (Gullen)	7	64
	Bunyip	15	60
	Hurst's 11	9	56
	Early Bird	5	52
Totals ..	.. .. .	286	1,860

TABLE 8.

Summary of the results of attempts to cross certain varieties of vulgare wheat with "Khapli" emmer.

Variety.	Number of Grains set.	Number of Pollinations made.
Federation	162	1,114
Hard Federation	14	130
Gluyas	58	288
Gullen	16	108
Bunyip	15	60
Hurst's 11	9	56
Early Bird	5	52
Canberra	7	52
Totals ..	286	1,860

Out of the 286 grains obtained, two germinated, with the production of pure "Federation" plants. These two grains were plump and well filled. Clearly they were the result of accidental self-pollinations. The 284 F₁ plants which were

crossed thus show approximately a 15% setting of grain. In all instances the grain was much shrivelled. Much of it was very tiny. Typical results are illustrated in Plate xxxiii.

The crossed grain was sown in pots or boxes under the best conditions for germination.

Prior to 1927, the F_1 seedlings were in part inoculated in the "first leaf" stage with Form 43, and in a later leaf stage with Form 46. In other cases this order was reversed, Form 46 being used first and Form 43 second. The mean of the reactions shown with Form 43 was "1", and with Form 46 "2+". Simultaneous tests on "Federation" and "Khapli" gave respectively "4" and "0;" with Form 43, and "4" and "1" with Form 46. There is, therefore, dominance of resistance in the F_1 , although the dominance is not quite complete. In 1927 and 1928 the F_2 seedlings were inoculated with Form 34. Whilst the parental reactions were again as just stated, the F_1 reactions were of the "X" type. They are illustrated in Plate xxxiii.

After the seedling tests, the F_1 plants were transplanted to open beds and given the best possible conditions for growth. In no case did any one of them attain to maturity. The plants were stunted and died before producing ears—with two exceptions—usually when about 10 inches high. It was observed that there was a difference in development depending upon the vulgare parent used. When "Gluyas" and "Hurst's 11" were the parents, the smallest growth took place, the plants reaching only 6 inches in height. With "Federation" as the parent, the F_1 plants grew slightly larger, reaching 8 inches. The plants derived from the crosses using "Bunyip" and "Early Bird", grew to 10 inches, being exceeded slightly by those derived from the "Gullen" crosses, which grew to 12 inches. Illustrations of these are given in Plates xxxiii and xxxiv.

The two exceptions above referred to occurred in the crosses of "Khapli" with "Bunyip" and "Gullen". In each case one tiny ear resembling an emmer with a tip beard was produced. Each ear comprised two lateral spikelets on each side of the spike. In one of the spikelets of one ear, three small stamens were produced, and in one spikelet of the other ear a small pistil was found. In each instance an effort was made to cross back on to the "Bunyip", "Gullen" and "Khapli" parents. The pistil of the F_1 in addition to receiving pollen from "Bunyip", "Gullen", and "Khapli", was also pollinated with one of the three small anthers produced by the other F_1 plant. No setting of grain occurred in any case.

In 1924 Mr. J. T. Pridham forwarded a quantity of grain stated to be an F_2 generation obtained from a cross between "Canberra" and "Khapli". The grain was white and opaque and perfectly plump and well-filled. No shrivelled grains at all were present. A series of more than 900 seedlings was tested with Forms 43 and 46. To these "Canberra" shows respectively resistance and susceptibility, whilst "Khapli" is strongly resistant to both. In all cases the seedlings showed resistance to Form 43 and susceptibility to Form 46. Nevertheless they were transplanted to open beds and grown to maturity because of the potential value of such cross-breeds. All plants showed the typical characteristics of "Canberra", proving clearly that the F_1 plant or plants had resulted from accidental self-pollination of the female parent.

It is therefore believed that little is to be gained from attempts to cross vulgare wheats directly with "Khapli". The fact that the F_1 plants of some

vulgare parents showed greater vigour than others may perhaps make it worth while to persevere with tests of other vulgare varieties as parents.

Attempts to incorporate the "Khapli" resistance in vulgare wheat are being made in other ways. "Khapli" has been crossed with certain durum wheats which readily give fertile progeny as a result. Some of these F_1 plants have been used for crossing with commercial vulgare wheats. In other cases, series of F_3 families of such crosses have been tested in the seedling stage for resistance, and families homozygous for resistance of the "Khapli" type noted. These will be used for crossing with commercial vulgare wheats. These studies are still in their early stages, but the general results may be indicated.

One of the crosses involves the durum wheat known as "Kahla". This is resistant to all the Australian forms except the second group, viz., 45, 46, and 55. "Khapli" is strongly resistant to all.

In the F_1 , six seedlings tested with Form 43, as representing the first group, gave flecks. Tested with Form 46 they gave "1" reactions. There was dominance of resistance. At that time the troublesome Form 34 had not yet made its appearance.

A group of 190 F_2 seedlings was tested with Form 43. They showed strong resistance throughout. Another batch of 184 was tested with Form 46. There were 170 resistant : 14 susceptible plants. This approximates to a 15 : 1 ratio. On a two factor basis the expectancy for 184 individuals would be 172 resistant : 12 susceptible plants. This result is now being confirmed by F_3 tests.

A series of F_3 tests involving the use of Form 34 is in progress and points clearly to the operation of two factors.

Further crosses between "Khapli" and "Abyssinian", and between "Khapli" and "Glossy Huguenot" are giving essentially similar results.

Vulgare and Durum Crosses.

The durum wheats are reputedly rust-resistant in Australia. Tests of seedlings have shown that some varieties are quite susceptible. Others are strongly resistant to some of the physiologic forms, e.g., "Arnautka", "Mindum", and "Spelmars" of the differential set. It was decided to see the mode of inheritance of this sharp resistance in crosses with vulgare wheats.

Crosses were made in 1922 between "Federation" and each of these three durums. From 176 "Federation" flowers pollinated, 98 grains were secured. The grains were somewhat shrivelled, and in some cases produced very weakly F_1 plants which failed in the seedling stage. The F_1 plants were tested in the seedling stage with Forms 43 and 46, to which the durum parents are respectively strongly resistant and strongly susceptible. The reactions are "flecks" in the first case and "4" in the second. "Federation" is completely susceptible to both.

The F_1 plants gave "1" reactions to Form 43, and "4" to 46, indicating dominance of resistance. The F_1 plants at maturity were intermediate in characters between the two parents. Many flowers in each spike failed to produce any grain, and where grain was set, much of it was very shrivelled.

F_2 tests were made with seedlings sown in boxes and inoculated with Form 43 in the usual way. The results are as follows:

TABLE 9.

Results in the F₂ generation of crosses between "Federation" and certain durum varieties tested with Form 43 of *P. graminis tritici*.

Cross.	Reactions and Frequency.	
	"0," to "X".	"3" & "4".
Federation × Arnautka	98	33
Federation × Spelmars	211	54
Federation × Mindum	25	11
Mindum × Federation	84	24
Totals	418	122

Thus the ratio is 418 resistant : 122 susceptible plants. The expectancy on a single factor hypothesis is 405 resistant : 135 susceptible plants.

$$\frac{D.}{P.E.} = \frac{13}{6.79} = 1.91.$$

After completing the tests on the first leaf, the seedlings were carefully pruned and new leaves of each plant inoculated with Form 46. In 10 plants out of the 540, the reaction, instead of being "4", was "1". Cultures from these tiny reactions were made and proved to be Form 46. Transgressive segregation had occurred. This series of tests was carried out in the late spring, and although the transgressive segregates were transplanted, they failed to mature.

In regard to Form 43, there would seem to be a single dominant factor determining the resistance of these durum wheats when they are crossed with "Federation". Complications from sterility in the progeny may, however, upset this assumption.

A second cross made in the same year was between "Marquis" and "Mindum", and reciprocally. Form 43 gives completely susceptible and resistant reactions respectively on these parents. The grain setting was 29 grains from 46 pollinations.

The F₁ plants gave flecks with Form 43. There was a considerable degree of sterility in the F₁ plants.

The F₂ results were as shown in Table 10.

TABLE 10.

Results of testing F₂ generation seedlings of crosses between "Marquis" and "Mindum" with Form 43.

Cross.	Reactions and Frequency.	
	"0," to "X".	"3" & "4".
Marquis × Mindum	101	32
Mindum × Marquis	76	23
Totals	177	55

Thus the ratio is 177 resistant to 55 susceptible plants. On a single factor hypothesis the expectancy would be 174 resistant : 58 susceptible plants.

$$\frac{D.}{P.E.} = \frac{3}{4.45} = 0.68.$$

Here again there are clear indications that a single dominant factor for resistance is present in the durum parent.

This work with the durums has not so far been carried beyond the F_2 generation. As pointed out later, from certain vulgare wheats the desired resistance should be obtainable, and will not involve the very wide segregation and sterility involved in the vulgare and durum crosses. But the work points to the resistance of the durums being due to one main dominant factor.

VULGARE CROSSES.

"Canberra" × "Thew".

It has been pointed out that specialization studies revealed that prior to 1926 there were six physiologic forms of wheat stem-rust in Australia. These six forms belonged to two divergent groups, each group comprising three forms. Tests with commercial varieties of wheat showed that, amongst others, "Canberra" was strongly resistant to Forms 43, 44, and 54 which comprise the first group, but was completely susceptible to the second group comprising Forms 45, 46, and 55. The variety "Thew" showed reciprocal reactions. Crosses were therefore made with a view to selecting commercial types which would embody the complete resistance to all six forms. The discovery that "Thew" was also resistant to one of the two known Australian forms of *P. triticina* and to at least one form of *Erysiphe graminis* was not made until the work was well in progress. The initial aim was simply to obtain stem-rust resistance from this cross.

Inheritance of Resistance to Stem-Rust.

F₁ Results.—A number of seedling tests of the F_1 plants has been made, using inoculations with Form 43 as representing the first group of forms, and with Form 46 as representing the second group. In some tests the first leaf was inoculated with Form 43, and a later leaf with Form 46; in others Form 46 was used for the first leaf and Form 43 for a later leaf. When tested with Form 43 the reaction was "0," and with Form 46 it was "2+." Simultaneous tests with the parental varieties were made. "Canberra" with Form 43 gave "0;" and "Thew" with 46 gave "2+." These tests were carried out in the late autumn (May). Dominance of resistance is shown in the F_1 .

Certain of the F_1 grains were not tested, but were kindly grown at the Cowra Experiment Farm by Mr. J. T. Pridham in order that a good yield of grain might be obtained. The F_1 seedlings which had been subjected to test were afterwards transplanted to open beds and grown to maturity. After harvest, a comparison of the heads of the individual plant progenies was made in order to be certain that each plant was truly an F_1 plant, and not the result of accidental self-pollination. That this was really so was further proved by the segregation which occurred in the progeny. In all cases the F_2 progenies of individual F_1 plants were kept separate.

F₂ Results.—Grain from single F_1 plants was sown in boxes and tested in the seedling stage. In some instances the first inoculation was made with Form 43, and after notes had been taken on this first leaf reaction, these leaves were

carefully removed, the plants thoroughly sprayed with distilled water, and the emerging leaf then inoculated with Form 46. In other instances the order of inoculation was reversed. Pots of each parent were similarly treated and used for comparison.

The results were as follows:

TABLE 11.

Results of testing F_2 seedlings of "Canberra" \times "Thew" with two forms of *P. graminis tritici*.

Form of Stem-Rust Used.	Reactions and Frequency.		Totals.				D. P.F.
			Observed.		Expected.		
	"0;" to "X".	"3" & "4".	Resistant.	Susceptible.	Resistant.	Susceptible.	
Form 43	509	135	509	135	483	161	$\frac{26}{7.41} = 3.5$
Form 46	493	151	493	151	483	161	$\frac{10}{7.41} = 1.3$

From these results it will be seen that the F_2 analysis is explainable on a single factor hypothesis. There is a somewhat wide divergence in the case of Form 43, but it appears that one main factor determines the resistance to each of the forms.

F_3 Results.—During the late autumn, winter, and spring of 1924 and of 1926, two series of F_3 tests were carried out. Single F_2 plants grown at Hawkesbury Agricultural College were harvested separately, at least three good ears of each being taken. In promising agronomic plants more were harvested. Two pots containing about 20 grains of each family were sown and tested in the ordinary way with Forms 43 and 46.

TABLE 12.

Results of testing seedlings of F_3 families of a cross between "Canberra" and "Thew".

Form of Stem-Rust Used.	Number of families present in each of the three classes.					
	Homozygous Resistant.		Heterozygous.		Homozygous Susceptible.	
	Observed.	Expected.	Observed.	Expected.	Observed.	Expected.
Form 43	90	83	170	166	72	83
Form 46	74	76.25	148	153.5	83	76.25

In the pots tested with Form 43, there were, on an average, 24 plants per pot in the homozygous resistant class, and 23 per pot in the homozygous susceptible class. In the pots tested with Form 46, the numbers were 23 and 25 respectively. Taking the heterozygous classes, in the tests with Form 43 it was found that there were 3,058 resistant and 993 susceptible plants. The expectancy on a single factor difference is 3,038 : 1,013, and $\frac{D}{P.E.} = 0.87$. The average number of plants tested in each family was 23. In the tests with Form 46, the heterozygous class comprised 3,565 plants, of which 2,638 were resistant and 927 were susceptible. The expectancy here on a single factor hypothesis is 2,674 resistant : 891 susceptible, and $\frac{D}{P.E.} = 2.1$.

It would seem, therefore, that a single factor underlies resistance to each of these two forms.

Assuming "A" to represent the dominant factor for resistance to Form 43 and "a" its allelomorph for susceptibility, and "B" to represent the dominant factor for resistance to Form 46, and "b" its allelomorph, then "Canberra" can be represented as having the genotype AAbb, and "Thew" as having aaBB. The F₁ would be AaBb, and in the F₂ there would be the usual nine classes. On the basis of the F₃ reactions shown, the genotypes of the F₂ families were allocated and the results are summarized in Tables 13 and 14.

TABLE 13.
F₂ genotypic results as determined by the F₃ tests.

F ₂ genotypes.									
AABB	AABb	AaBB	AaBb	AAbb	Aabb	aaBB	aaBb	aabb	
30	30	27	83	18	38	15	30	22	Observed.
18.3	36.6	36.6	73.2	18.3	36.6	18.3	36.6	18.3	Expected.

TABLE 14.
F₂ Phenotypic results.

AB	Ab	aB	ab	
170	56	45	22	Observed.
165	55	55	18	Expected.

It will be seen that there is a fairly close agreement between the observed and the expected results, the main departure being in the double dominant genotype.

Inheritance of Resistance to Leaf Rust.

The fact that "Thew" shows marked resistance to one form of leaf rust designated "Aust. 1", whilst "Canberra" is fully susceptible, was also taken into account in this work.

F₁ tests with six seedlings showed that they gave flecks at a time when the resistant parent "Thew" was also showing flecks. Dominance of resistance occurs.

One series of 110 F₃ families, after being tested with Form 46, was pruned and tested with this form of *P. triticina*. It was found that there were 26 homozygous resistant families, 55 heterozygous families and 29 homozygous susceptible families. This is a close approximation to the expectancy on a single factor hypothesis.

Work was done to determine whether the same factor determined resistance to Form 46 and the form "Aust. 1" of *P. triticina*. In one instance a series of 12 pots of families heterozygous for resistance to Form 46 was taken and the resistant and susceptible plants separately tagged prior to inoculation with the leaf rust. There was no connection between the resistance to the two rusts.

This was further borne out by an examination of the results for all the families.

Calling the dominant factor for resistance to this form of *P. triticina* "C" and its allelomorph "c", "Thew" may now be represented as having the genotype "aaBBCC", whilst "Canberra" is AAbbcc.

On the basis of the F₃ results, the genotype was allotted to each of the 107 families fully tested. In dealing with this small number of families on a three factor basis it is to be expected that a divergence from the genotypic expectancy should occur. On a phenotypic basis the approximation is close. The results were as shown in Table 15.

It is clear, then, that with this independent assortment of the factors for resistance, homozygous types combining the complete resistance should be obtainable.

Results of Back Crosses.

Heads of "Canberra" after emasculation were pollinated with pollen from F₁ plants of the "Canberra" × "Thew" cross. Seventy-one grains were obtained and without testing were sown and the plants grown to maturity. The grain produced by 70 of these plants was harvested separately and tested in the seedling stage with Forms 43 and 46 of *P. graminis tritici* and with Aust. Form 1 of *P. triticina*.

In the tests with *P. graminis tritici* 43, it was found that there were 35 families homozygous for resistance. These comprised 780 plants, or an average of more than 22 plants per family. There were also 35 families heterozygous for resistance. They comprised 810 plants or more than 23 per family. Of them, 614 were resistant and 196 susceptible. On a single factor basis the expectancy is

a ratio of 607.5 : 202.5 plants. $\frac{D.}{P.E.} = \frac{6.5}{8.31} = 0.78.$

Hence there is a close approach to the expectancy on a single factor hypothesis.

In the tests with *P. graminis tritici* 46, it was found that there were 33 families homozygous for susceptibility. These comprised 748 plants, or an average of more than 22 plants per family. The remaining 37 families were heterozygous. They comprised 739 individuals, or an average of 20 plants per family. Of them,

TABLE 15.
Results of F₂ tests of seedlings of "Canberra" × "Thew".

Genotype.	Observed.	Expected.	Phenotype.	Observed.	Expected.
AABBCC	3	1.7	} ABC	45	45
AABBcc	6	3.3			
AABbCC	3	3.3			
AaBBCC	1	3.3			
AABbCc	5	6.7			
AaBBcC	1	6.7			
AaBbCC	9	6.7			
AaBbCc	17	13.3			
AABBcc	2	1.7	} ABc	14	15
AaBBcc	4	3.3			
AABbcc	4	3.3			
AaBbcc	4	6.7			
AAbbCC	0	1.7	} AbC	16	15
AabbCC	5	3.3			
AAbbCc	7	3.3			
AabbCc	4	6.7			
aaBBCC	1	1.7	} aBC	13	15
aaBbCC	1	3.3			
aaBBcC	4	3.3			
aaBbCc	7	6.7			
AAbbcc	2	1.7	} Abc	5	5
Aabbcc	3	3.3			
aaBBcc	0	1.7	} aBc	4	5
aaBbcc	4	3.3			
aabbCC	2	1.7	} abC	7	5
aabbCc	5	3.3			
aabbcc	3	1.7	abc	3	2
Totals	107	106.7		107	107

573 were resistant and 166 susceptible. On a single factor basis the expectancy is

$$\text{a ratio of } 554 : 185 \text{ plants. } \frac{D. \quad 19}{P.E. \quad 7.94} = \frac{19}{7.94} = 2.4$$

Here again the assumption that a single factor determines resistance is borne out, although the approach to the expectancy is not as close as in the tests with Form 43.

For the tests with Aust. Form 1 of *P. triticina*, more plants were available. Seedlings that had already been used in the stem-rust tests were pruned and inoculated in later stages of growth for purposes of these leaf-rust tests, with quite satisfactory results.

The tests revealed that there were 37 families homozygous for susceptibility. They comprised 1,427 plants, or an average of more than 38 plants per family. The remaining 33 families were heterozygous. They comprised 1,373 individuals, or more than 41 plants per family. Of them, 1,042 were resistant and 331 susceptible. The expectancy on a single factor basis is a ratio of 1,030 : 343 plants.

$$\frac{D. \quad 12}{P.E. \quad 10.8} = \frac{12}{10.8} = 1.1$$

The approach to the expectancy in this instance is very close.

Using now the same factorial symbols for the resistance to each rust, viz., "A" for resistance and "a" for susceptibility to *P. graminis tritici* 43, "B" for resistance and "b" for susceptibility to *P. graminis tritici* 46, and "C" for resistance and "c" for susceptibility to *P. triticina* Aust. Form 1, the genotypes of each may be written. "Canberra" becomes AABbcc and the F₁ plant AaBbCc. Summating the genotypes obtained, the results were as follows:

TABLE 16.
Results of testing 70 families of a back cross between "Canberra" and the F₁ of the cross "Canberra" × "Thew".

Genotype.	Number of Families.	
	Observed.	Expected.
AABbCc	9	8.75
AABbcc	7	8.75
AAbbCc	10	8.75
AAbbcc	8	8.75
AaBbCc	9	8.75
AaBbcc	12	8.75
AabbCc	5	8.75
Aabbcc	10	8.75

It is seen that there is confirmation of the assumption that a single dominant factor underlies resistance to each of the three rusts used. These factors are independent in their inheritance.

F₃ Field Results.—Of the same F₃ families which were tested in the plant house, seed residues of 132 taken at random were sown in row tests at Hawkesbury

Agricultural College in 1924. Observations were made on stem-rust attack naturally occurring. Forms 43 and 46 were known to be present in the area. The plant-house tests of seedlings inoculated with the two forms had shown that 14 of these families were homozygous for resistance. The field observations indicated that in all but two cases, these families showed no infection. In the remaining two where rust was present, the attack was light and occurred on only a few of the plants in the rows. There were six additional field rows in which no rust was noted. These families were all early maturing types and they had apparently escaped attack. The seedling tests in the plant house had shown heterozygosity for resistance in these families.

F₄ Results.—Of the F_3 families, 11 were carried into the F_4 . They comprised five of the first series tested in 1924 which were shown to be homozygous for resistance to Forms 43 and 46, together with six other families which were heterozygous for resistance but were particularly promising agronomically in the row tests. Two of the five homozygous families were the most promising of all. They were heterozygous in the F_3 for chaff colour and tip beard, and one of the two was heterozygous for grain colour as well. The selections used in these F_4 tests totalled 44; they came from 11 of the F_3 families, varying from 1 to 7 per family.

Two pots, each of 20 grains, were used for plant-house tests with Forms 43 and 46. The five families which had shown homozygosity for the double resistance in the F_3 tests were again homozygous for resistance. Further sowings of the grain of these F_4 selections were made in the open at Sydney University and at Hawkesbury Agricultural College, and Mr. J. T. Pridham kindly made yet another sowing of them at Cowra Experiment Farm. He made selections for agronomic characters from these families, and these selections formed the basis of the subsequent work.

F₅ Results.—These tests dealt with 14 selections tracing back to the two homozygous resistant F_3 families which were so promising. Each one showed homozygosity for resistance to Forms 43 and 46. Four were also homozygous for resistance to the form of *P. triticina* designated "Aust. 1", one was homozygous for susceptibility, and the remaining nine were heterozygous to this leaf-rust.

Sowings of all families were made at the Sydney University and Hawkesbury Agricultural College for field observations. At Cowra Mr. Pridham again grew them and made further selections.

At Hawkesbury Agricultural College, Forms 43 and 46 were found to be present in the area this year. "Thew" and "Canberra" were each infected. Plant-house tests showed the rusts to be Forms 43 and 46 respectively. Both Australian forms of leaf-rust were also abundant in the crop. On the flag of "Thew" were pustules of leaf-rust intermingled with sharp flecks and tiny "1" reactions. Cultures from the pustules tested in the plant-house showed that the rust was the "Aust. 2". The flag of "Canberra" gave cultures of Aust. 1 and Aust. 2. A scrutiny of the "Canberra" × "Thew" selections revealed no stem-rust attack. On the flag, leaf-rust was present. The family which was homozygous for susceptibility gave cultures of both forms. The homozygous resistant families showed flecks and pustules on the leaves, and from these latter the form Aust. 2 was determined.

There was, then, complete agreement between the plant-house and field results at Hawkesbury Agricultural College.

At the same time that these results were obtained, further samples were grown by Mr. J. R. A. McMillan at the Gatton Agricultural College in Queensland,

and by Mr. W. H. Darragh at Grafton, N.S.W. Mr. McMillan reported that at Gatton the wheats were sown on black soil and were irrigated during growth. As was to be expected, a very severe rust attack developed in the early summer as the wheats approached maturity. Samples of susceptible varieties submitted showed some of the heaviest infections ever seen. Tests showed that Forms 43 and 44 were present.

Under these identical conditions the "Canberra" \times "Thew" selections were reported to be "perfectly clean and free of rust."

At Grafton Mr. Darragh reported that rust was present in abundance on susceptible varieties of wheat. Tests showed that it consisted of Forms 43 and 44. The "Canberra" \times "Thew" selections were rust-free as had been the case at Gatton.

F₂ Results.—The tests made in 1927 dealt with 41 selections. Homozygosity for resistance to Forms 43 and 46 was shown, but in some cases there was heterozygosity for resistance to the Form Aust. 1 of *P. triticina*.

The 1927 field results with the F_2 material proved to be very interesting. An extensive series of selections which plant-house tests showed to be homozygous for resistance to Forms 43 and 46 was sown at Sydney University, Hawkesbury Agricultural College, Cowra, Gatton, and Grafton. It will be remembered that the specialization studies had shown that prior to 1926, only the two groups of forms represented by 43 and 46 respectively were present in New South Wales, and that in the summer of 1926, a few scattered isolations from western areas of New South Wales revealed the advent of Form 34.

In July and September of 1927, rust samples sent by Mr. T. H. Harrison showed that Form 43 was present in the crops at Hawkesbury Agricultural College. On 31st October a scrutiny of the plots showed that the "Canberra" \times "Thew" cross-breeds were perfectly clean, but rust was found on "Little Club", "Thew", and a number of other varieties. The collection made was a representative one of wheats and barleys. The rust proved in each case to be Form 43. "Canberra" was free. On 4th November, Mr. Harrison forwarded a sample of rust on "Japanese Bearded" growing in the plot: it proved to be Form 43. A further visit to Hawkesbury Agricultural College was made on 11th November. Collections of rust on "Thew", a representative group of wheats, and a group of barleys were made. The "Canberra" \times "Thew" wheats were still free of stem-rust. Tests made with the three collections showed in each case a mixture of Forms 43 and 34. On 18th November another visit revealed a tremendous development of stem-rust throughout the plot. Samples were collected from "Thew", "Canberra", numerous other wheats and groups of barleys. Stem-rust was now present on the "Canberra" \times "Thew" selections and was also sampled extensively. In every instance Form 34, and only this form, was present. Since that date very numerous isolations of rust from Hawkesbury Agricultural College have been made. Excepting an occurrence in December, 1927, of Form 43 on *Agropyron scabrum* and one on "Glossy Huguenot" wheat when Forms 43 and 34 were together present, Form 34 alone has been present at the College. This applies to wheat, barley, rye and grasses. The change in the rust flora has been as complete as it is remarkable.

The leaf-rust tests during this period at Hawkesbury Agricultural College revealed that forms Aust. 1 and 2 were present on susceptible varieties in the plot. On "Thew", "Japanese Bearded", and the "Canberra" \times "Thew" selections, flecks and pustules occurred. In each case the pustules were those of Aust. 2.

From Gatton, Q., Mr. McMillan forwarded representative rust samples of the commercial varieties twice in October, 1927. In each instance a mixture of Forms 44 and 34 occurred. A fortnight later another representative sample was sent, together with a series of rusted specimens of the "Canberra" × "Thew" selections which were stated now to be showing rust. In each instance the only form present was Form 34.

The Grafton results were of the same nature. In October, 1927, samples of wheat and barley showed that Forms 43 and 34 were present. Three weeks later similar samples showed that only Form 34 occurred in both the wheats and barley, and that the "Canberra" × "Thew" selections were now attacked by this form. Leaf rust isolations from this locality again showed only Aust. 2 on the "Canberra" × "Thew" selections.

At Cowra the same general result was obtained.

At Bathurst there was also a development of Form 34.

In this year Mr. R. E. Dwyer was given a number of F_6 selections of "Canberra" × "Thew", many of them different from those tested at Cowra and Gatton. The only rust determined on the samples of these which were submitted was Form 34.

Thus it became abundantly clear that the "Euston" types needed resistance to more than Forms 43 and 46 and their cotypes. Further crossing of the "Euston" types became necessary in order to obtain resistance to Form 34. It was a fortunate circumstance that Dr. Levine of Minnesota at this time forwarded samples of his "Webster" and "Hope" varieties, both of which show resistance to Form 34. Crosses with them have been made, and some of the material is now in the F_3 generation. Various strains of "Euston" and of other commercial varieties have been used in this work.

F₇ Results.—In 1928 a further series of plant-house tests of the selected material was made, and homozygosity for resistance to Forms 43 and 46 determined. Now known as the variety "Euston", tests were made at Cowra on a field scale for the first time. In its trial as a late-sown grain variety, Euston headed the list with a computed yield of 23 bushels 15 lbs. per acre (Medley, 1929). At Bathurst, yield tests carried out by Mr. Dwyer with his types showed that one of the "Canberra" × "Thew" selections headed the list. Taking the yield given by the standard variety "Waratah" as 100, the best of these "Canberra" × "Thew" selections yielded 115.6%. In all, five families were included in this test and all except one exceeded 100%.

Conclusion.—The results of this work show that plant-house work in conjunction with field tests can lead to the development of useful varieties of wheat which are rust-resistant.

Inheritance of Morphological Characters.

When practicable, the inheritance of certain obvious morphological characters has been traced. "Canberra" has tip beard, bronze chaff, and white grain. "Thew" is beardless, has white (golden) chaff and reddish grain.

In the F_1 , intermediacy was found in the characters.

A group of F_2 plants was analysed, with the following results:

Tip Beard.—By direct comparison with the parent types, the generation was sorted into a group with tip beards similar to "Canberra", a group that was beardless similar to "Thew", and a third group that was intermediate in character. The ratio was—90 tip bearded : 191 intermediate : 106 beardless. This approximates

to a 1:2:1 ratio, the expectancy being 97 : 193 : 97. Seemingly a single genetic factor determines the production of the tip beard in "Canberra".

Chaff Colour.—The same F_2 generation was sorted into groups on the basis of the presence or absence of colour in the chaff. The ratio obtained was 298 coloured : 89 white-chaffed plants. The expectancy on a single factor basis is

290 : 97. $\frac{D.}{P.E.} = \frac{8}{5.75} = 1.4$. That is, a single factor also underlies the production

of bronze chaff.

Grain Colour.—The same F_2 generation was sorted, by direct comparison with grain of the parental types into the three groups, one coloured corresponding to "Thew", one white corresponding to "Canberra", and a third group comprising individuals intermediate in colour. There were 107 coloured : 195 intermediate : 85 white-grained, the expectancy being 97 : 193 : 97. A single factor determines the production of grain colour in this cross.

Grass Clump Habit.—In the F_2 generation it was early noticed that a number of the segregates were dwarfed, resembling clumps of grass. These are illustrated in Plate xxxii. Counts of these have been made in all available F_2 generations of this cross. The results to date show a total ratio of 1,220 normal : 281 grass clump plants, a very close approach to the 1,219 normals : 282 grass clumps which would be expected on a 13 : 3 basis. A series of F_3 counts further confirmed this result. Clearly then, an inhibiting factor operates. Further evidence will be presented to show that it is carried by "Thew".

These four characters were found to be inherited independently of each other, and also independently of the rust resistance or susceptibility.

Further Work Bearing upon the "Canberra" × "Thew" Cross.

Further work was carried out to test the hypothesis that the resistance of "Canberra" and "Thew" to Forms 43 and 46 respectively was due in each case to one dominant factor. Each of these wheats was crossed with "Federation", a variety very susceptible to all known rust forms, and the resultant material studied in the F_1 , F_2 and F_3 generations.

"Federation" × "Canberra".

The F_1 grain was in part sown in pots, tested in the seedling stage, and afterwards transplanted to open ground where it was grown to maturity. Other grains were sown at Cowra by Mr. J. T. Pridham to provide a large yield. In the seedling tests with Form 43, the F_1 plants gave a "1" reaction, whilst "Federation" and "Canberra" seedlings under the same conditions gave respectively "4" and "1" reactions. Clearly resistance was dominant.

F_2 tests were made by sowing grain in boxes and inoculating with Form 43. After note-taking, one series of more than 200 seedlings was sorted into groups on the basis of the reaction shown, and grown to maturity in open beds in order that F_3 material of known phenotype might be available. In other cases F_2 grain was sown without any tests, and at maturity, complete single plants were harvested separately.

The results of testing the F_2 seedlings showed that 477 gave reactions varying from "0;" to "X", and 158 gave "3" and "4" reactions.

"Federation" and "Canberra" seedlings tested at the same time gave respectively reactions varying from "3+" to "4-", and from "0;" to "2". Summarizing the F_2 results, it will be seen that there were 477 resistant and 158 susceptible

plants, which is a close approximation to the expectancy of 476 resistant : 159 susceptible plants on a single factor hypothesis. $\frac{D.}{P.E.} = \frac{1}{7.36} = 0.14$

F₂ tests were made with a small series of families taken at random from F₂ material which had been grown without test. Of 64 families tested, 11 were homozygous for resistance. They comprised 199 individuals, thus averaging 18 plants per pot. There were 32 families heterozygous for resistance. These comprised 625 individuals, an average of 19 per pot. Of them, 446 were resistant and 179 susceptible. On a single factor hypothesis the expectancy would be

469 : 156. $\frac{D.}{P.E.} = \frac{23}{7.3} = 3.15$. The remaining 21 families were homozygous for

susceptibility. They comprised 342 plants, an average of 16 plants per pot.

The results of these tests can be taken as pointing to a single dominant factor determining resistance to Form 43 in this cross.

Inheritance of Morphological Characters.

"Federation" and "Canberra" differ mainly in respect of the tip beard which is present in the latter variety. In chaff colour and grain colour, differences are not apparent.

Tip Beard.—In the F₁ an intermediate condition occurs.

An F₂ generation was analysed, being sorted into classes similar to the two parents and to the intermediate hybrid. There were 44 beardless : 90 intermediate : 59 tip bearded. The expectancy is 48 : 97 : 48. Although the numbers are small, the result clearly indicates that a single factor determines the production of the tip beard in this cross.

The inheritance of tip beard was found to be independent of inheritance of resistance to Form 43.

Grass Clumps.—In no case did examination of an F₂ generation reveal the presence of any but normal plants.

"Federation" × "Thew".

An examination of this cross was also made for confirmatory evidence regarding the factorial basis for resistance in the "Canberra" × "Thew" cross.

F₁ seedlings were tested with Form 46 and afterwards grown to maturity, and in other cases the grain was grown at Cowra. The reaction to Form 46 was "2+", and under the same conditions "Federation" and "Thew" gave respectively "4" and "2". Resistance is dominant in the F₁.

A series of F₂ seedling tests showed that there were 468 giving reactions varying from "0;" to "X", and 186 giving "3" and "4" reactions.

Simultaneously pots of "Federation" and "Thew" were tested. "Federation" gave "3" and "Thew" gave "1", "2", and "X" reactions. It has already been pointed out that a number of varieties of wheat have shown that, whereas inoculations under winter conditions gave strongly resistant reactions, a repetition of the experiment in the summer gave susceptible reactions. In this instance the test was made in August under rather warm conditions.

Summarizing the result, it is seen that regarding the "X" reaction as indicating resistance, there were 468 resistant and 186 susceptible plants. The expectancy

on a single factor hypothesis is 490 resistant : 164 susceptible plants.

$$\frac{D.}{P.E.} = \frac{22}{7.47} = 2.9.$$

A series of F_2 families was tested. These were obtained from the plants which had been tested as F_2 seedlings, sorted on the basis of their F_2 reaction, and planted out into open beds. The occurrence of "grass clumps" accounted for the loss of some plants, and in other cases the yield of grain was so low (fewer than 20 grains) that the results were rejected.

In all, 101 F_2 families were tested with Form 46. There were 22 which were homozygous for resistance; they averaged 31 plants per pot in the test. Of families homozygous for susceptibility, there were 30, averaging 29 plants per pot. There were 50 families heterozygous for resistance, and they averaged 24 plants per pot. Summarizing the results in the heterozygous families, there were 925 resistant : 304 susceptible plants. This gives a very close approach to a 3 : 1 ratio and confirms the opinion that the resistance of "Thew" is due to a single dominant factor.

Resistance to *P. triticina*.

It has already been pointed out that "Thew" is resistant to one Australian form of *P. triticina*. An examination of the mode of inheritance of this character was made in this cross.

In the F_1 , a group of six seedlings was tested and found to give flecks, whilst at the same time "Federation" and "Thew" respectively gave "4" and "0;" reactions.

In the F_2 , the same series of seedlings which had been tested with Form 46 was pruned, and later tested with the form of *P. triticina* designated Aust. 1. The result was as follows:

Reactions	"0;"	"1" & "2"	"4"
Frequency	166	239	154

That is to say there were 405 resistant : 154 susceptible plants. On the basis of a single factor difference the expectancy is 419 resistant : 140 susceptible plants.

$$\frac{D.}{P.E.} = \frac{14}{6.91} = 2.0.$$

The relation between the resistance to *P. graminis tritici* 46 and to the form Aust. 1 of *P. triticina* on a phenotypic basis was examined. If "B" represents a factor for resistance to Form 46, and "b" its allelomorph which determines susceptibility, and "C" and "c" respectively the factors for resistance and susceptibility to the Form Aust. 1 of *P. triticina*, the results were as follows:

	BC	Bc	bC	bc
Observed	249	81	94	21
Expected	245	82	82	27

It will be seen that there is a fairly close agreement between the frequency and the expectancy if free assortment took place. The two factors for resistance are inherited independently.

In the F_3 tests, the same series of 101 families used in the Form 46 tests was pruned, and later tested with the leaf-rust. The number of seedlings used has already been set out. Owing to damage by *Helminthosporium* sp. and accident, ten of the families were lost. Of the remaining 91, it was found that 23 were homozygous resistant, 17 homozygous susceptible, and 51 heterozygous. Of the latter, 1,350 were resistant and 474 susceptible. The expectancy on a single

factor hypothesis is 1,368 resistant : 456 susceptible, and $\frac{D.}{P.E.} = 1.44$.

Here again the question of correlation between resistance to Form 46 and Aust. 1 of *P. triticina* was considered. The genotypes of the 91 families were summarized with the following result:

	BBCC	BbCC	BBCc	BbCc	BBcc	Bbcc	bbCC	bbCc	bbcc
Observed	4	13	15	23	3	7	6	13	7
Expected	5.7	11.4	11.4	22.6	5.7	11.4	5.7	11.4	5.7

There is a fairly close agreement with the expectancy, confirming the result that the resistance to Form 46 is independent of resistance to *P. triticina*.

Results of Back-Crosses.

Emasculated heads of "Federation" were pollinated with pollen from F_1 plants of the cross "Federation" \times "Thew". Thirty-eight grains were produced. The seedlings were tested with Aust. Form 1 of *P. triticina*, with the result that of the 32 obtained, 17 were susceptible and 15 resistant. The plants were grown to maturity and harvested separately. Each family was tested with *P. graminis tritici* 46 and with the Aust. Form 1 of *P. triticina*.

In the tests with *P. graminis tritici* 46, there were 14 families homozygous for susceptibility. They comprised 328 plants, or an average of more than 23 per family. The remaining 18 families were heterozygous, comprising 385 plants or an average of more than 21 per family. Of them, 283 were resistant and 102 susceptible. On a single factor basis the expectancy is a ratio of 289 : 96 plants.

$$\frac{D.}{P.E.} = \frac{6}{5.73} = 1.05.$$

This is a close approximation to the expected result.

In the tests with the Aust. Form 1 of *P. triticina*, there were 17 families homozygous for susceptibility, comprising 363 plants or an average of more than 21 per family. The remaining 15 families were heterozygous. They comprised 359 plants or an average of 24 per family. Of them, 277 were resistant and 82

susceptible. The expectancy on a single factor basis is a ratio of 269 : 90 plants.

$$\frac{D.}{P.E.} = \frac{8}{5.53} = 1.4.$$

Here again there is a close approximation to the expected result.

Using now the factorial symbols already suggested, viz., "B" representing resistance and "b" susceptibility to *P. graminis tritici* 46, and "C" representing resistance and "c" susceptibility to Aust. Form 1 of *P. triticina*, "Federation" becomes bbcc and the F₁ parent is BbCc. Summating the genotypes obtained, the result was as follows:

TABLE 17.
Results of testing 32 families of a back-cross between "Federation" and the F₁ of "Federation" × "Thew".

Genotype.	Number of Families.	
	Observed.	Expected.
BbCc	8	8
Bbcc	10	8
bbCc	7	8
bbcc	7	8

It is seen that there is further confirmation of the assumption that a single dominant factor underlies resistance to each of the rusts used. These factors are independent in their inheritance.

Resistance to *Erysiphe graminis*.

It has been found in the plant-house work that at least two forms of the powdery mildew occur. Inoculation tests have shown that "Thew" is resistant to one form and susceptible to another. "Federation" is completely susceptible to both.

Using the first form, inoculations of six F₁ seedlings showed that they were resistant. In the F₂, a series of 212 seedlings gave 161 resistant : 51 susceptible, a near approach to a 3 : 1 ratio. These F₁ and F₂ tests were made simultaneously with tests of "Federation" and "Thew" as controls.

A series of F₃ tests was made, using the same seedlings which had been tested first with Form 46 and later with *P. triticina*. After taking notes on the latter results, the plants were pruned, and then atomized with an abundant suspension of conidia in water. Notes were taken on homozygosity for resistance and susceptibility and on heterozygosity. It was found that the results agreed with those for leaf-rust. In the series tested, there was linkage between resistance to leaf-rust and resistance to powdery mildew. Further extensive tests are needed for a determination of crossing-over if this occurs. It may be mentioned that nine other varieties of wheat have been found which behave in this same way, showing resistance to *P. triticina* 1 and to the form of *E. graminis* made use of in this work.

Inheritance of Morphological Characters.

"Federation" differs from "Thew" in having bronze chaff and white grain, whilst "Thew" has white (golden) chaff and somewhat reddish grain.

The F₁ is intermediate in character.

A small F₂ generation was analysed.

Chaff Colour.—The material was sorted by direct comparison with the parental types, no attempt being made to sort the coloured types further. There were 72 coloured : 23 white chaffed plants, indicating a single factor difference.

Grain Colour.—In this case again the F₂ grain was compared directly with the parental types and sorted into three classes. The result was 26 coloured : 47 intermediate : 22 white grained plants. This again points to a single factor difference.

Grass Clumps.—Counts in F₂ generations showed a total ratio of 468 normals : 119 grass clumps. The expectancy on a 13 : 3 basis is 477 normals : 110 grass clumps, showing the presence of an inhibiting factor. That this is present in "Thew" is now evident.

These characters were inherited independently of each other and apparently were also inherited independently of resistance to Form 46 and the form of *P. triticina* called Aust. 1.

"Riverina" × "Thew".

An examination of the inheritance of resistance to Form 1 of *P. triticina* was carried out in this cross, which was made in the first instance because of the reciprocal reactions of the parents to Forms 43 and 46 of *P. graminis tritici*.

In the F₁, six seedlings were tested and gave "0;", when "Riverina" and "Thew" gave respectively "4" and "0;".

In the F₂ the results were as follows:

Reactions	"0;"	"1" & "2"	"4"
Observed	108	247	99
Expected	113.5	227	113.5

That is, there were 355 resistant : 99 susceptible plants. $\frac{D.}{P.E.} = \frac{14.5}{6.22} = 2.33$

The F₃ families were tested in the usual way, with the result that there were 34 homozygous resistant, comprising an average of more than 21 plants each, 37 homozygous susceptible families each comprising more than 23 plants, and 91 heterozygous families which comprised 1,756 resistant : 547 susceptible plants. This is in close agreement with the expectancy on a single factor hypothesis,

which is 1,727 resistant : 576 susceptible plants, and $\frac{D.}{P.E.} = 2.06$.

In 1925 a back-cross was made. Pollen from an F₁ plant was used to pollinate emasculated "Riverina" flowers. A poor setting of grain occurred, only 13 grains being obtained. These were sown and tested in the seedling stage prior to being

planted out. Eight gave "4" reactions, the remaining five gave flecks. The progeny of each plant was saved separately and tested. The eight susceptible plants yielded a progeny of 433 plants, all of which gave "4" reactions. The five resistant were each heterozygous, producing a total of 183 resistant to 74 susceptible plants. The expectancy on a single factor hypothesis is 193 : 64.

$$\frac{D.}{P.E.} = \frac{10}{4.68} = 2.13$$

Here again is good evidence of a single factor determining the resistance of "Thew" to the Aust. 1 form of *P. triticina*.

"Gluyas" × "Thew".

This cross was primarily made for resistance to Forms 43 and 46 of *P. graminis tritici*. Resistance to *P. triticina* also received some attention.

In the F₁, four seedlings tested each gave "0;" reactions, whilst the parents gave respectively "4" and "0;".

An F₂ test gave 165 resistant : 60 susceptible plants. The expectancy on the basis of a single factor difference is 169 : 56.

A small number of F₃ families taken at random was tested. They gave 19 families which were homozygous resistant, 12 families homozygous susceptible, and 27 families heterozygous. The latter comprised 292 resistant : 87 susceptible. The expectancy on a single factor basis is 284 : 95.

In this cross also the evidence points to the resistance of "Thew" to leaf-rust being dependent upon a single dominant factor.

"Federation" × "Japanese Bearded".

The variety known as "Japanese Bearded", received from Mr. F. T. Brooks of Cambridge, was found to show strong resistance to *P. triticina*, Aust. Form 1. In 1924 it was crossed with "Federation" for study of the inheritance of this character.

Inheritance of Resistance to Leaf-Rust.

In the F₁, ten seedlings showed a "2" reaction under conditions such that "Federation" and "Japanese Bearded" gave respectively "4" and "2=" reactions.

In the F₂ a series of tests was made with the following result, at a time when control tests gave "4" and "0;" reactions with "Federation" and "Japanese Bearded" respectively.

Reactions	"0;"	"1" & "2"	"4"
Observed	169	281	156
Expected	151.5	303	151.5

Summating the resistant types, it is seen that there were 450 resistant and 156 susceptible plants. $\frac{D. \quad 5.5}{P.E. \quad 7.19} = 0.77$

In the F₃ tests, there were 45 families which were homozygous for resistance. These comprised 1,249 individuals, or an average of more than 27 plants per pot. Fifty-two families were homozygous for susceptibility, comprising 1,627 plants or an average of more than 31 plants per pot. There were 98 heterozygous families comprising 2,809 plants, an average of more than 28 plants per pot. Taking the number of families occurring in these three classes, the ratio is 45 homozygous resistant : 98 heterozygous resistant : 52 homozygous susceptible families, which is a close approximation to a 1 : 2 : 1 ratio. In the heterozygous families there were 2,138 resistant : 671 susceptible plants. The expectancy on a 3 : 1 basis is 2,107 : 702, and $\frac{D.}{P.E.} = 2.0$.

Further confirmation of this analysis was forthcoming. After taking notes on one of the batches of F₂ seedlings, these were sorted into the "0;", "2", and "4" classes, and transplanted into an open bed under this classification. The plants were harvested separately and kept in these groups to provide the grain actually used in the F₃ tests recorded above. The homozygous susceptible F₃ families came in all cases from plants which were susceptible in the F₂. The homozygous resistant F₃ families did not show the same accurate result. Of the F₂ plants classified as "0;", all proved to be homozygous for resistance in the F₃, with the exception of five which produced heterozygous families. Similarly those classed as "2" in the F₂ gave heterozygous F₃ families, with the exception of ten which proved to be homozygous resistants. An error of this magnitude could easily be induced by improved and by worse environmental conditions for the rust development during the F₂ analysis.

It is clear that, as in "Thew", there is a single dominant factor in "Japanese Bearded" for resistance to the form Aust. 1 of *P. triticea*.

Inheritance of Morphological Characters.

An attempt was made to determine association of resistance to leaf-rust with certain morphological characters.

Beard.—"Federation" is a bald wheat and "Japanese Bearded" fully bearded. The F₁ plants were intermediate in character. In the F₂ 450 plants were examined. Of them, 29 were fully bearded. This indicates a two-factor difference, since the expectancy on this basis is 28 plants. Several attempts were made to devise a scheme for classifying the other groups. A satisfactory fit was not obtained, the nearest result being

	Bald.	Awnletted.	Tip bearded.	Half bearded.	Full bearded.
Observed.. ..	66	161	146	48	29
Expected.. ..	28	112	168	112	28

Grain Colour.—"Federation" has white grain, "Japanese Bearded" has red. The F₁ plants produced an intermediate red grain. In the F₂, 450 plants were

sorted into two classes, one containing coloured grain and one containing white grain. In the former class, marked differences were noted in the degree of colour, but they were not finally classified. The total was 442 coloured : 8 white grained, indicating a three-factor difference for this character, since the expectancy on this basis is 7 white-grained individuals.

Coleoptile Colour.—In very young seedlings there are marked differences between the colour of the coleoptile in "Federation" and "Japanese Bearded." In the former, the colour is white, in the latter, brown. The F_1 showed an intermediate amount of colour. In the F_2 , 212 individuals were examined, giving a ratio of 50 white : 96 intermediate : 66 dark. This is an approximation to a 1 : 2 : 1 ratio. In the F_3 , a group of 132 families was examined. There were 34 families homozygous for light coleoptile. They comprised 865 individuals, or an average of 25 plants in each family. Also there were 34 families homozygous for dark coleoptile. These comprised 921 individuals, or an average of 27 plants per family. The heterozygous families numbered 64, comprising 1,855 individuals or 29 per family. Totalling the classes in these heterozygous families, it was found that there were 450 dark : 971 intermediate : 434 light, which again approximates to a 1 : 2 : 1 ratio. Assuming dominance of colour, the ratio becomes 1,421 : 434,

as compared with an expectancy of 1,391 : 464, and $\frac{D.}{P.E.} = 2.38.$

Rust Resistance and Coleoptile Colour.

It was considered that there might perhaps be some correlation between the pigmentation and resistance. The F_2 families which were classified according to colour production were allocated their genotype on a resistance basis.

Assuming that "A" represents the factor for resistance to Aust. Form 1, and "a" its allelomorph for susceptibility, whilst "B" represents the factor for coloured coleoptile and "b" the allelomorph for white coleoptile, then the constitution of "Federation" would be aabb, and of "Japanese Bearded" AABB. In the F_2 the following are the results:—

Genotypes	AABB	AABb	AaBB	AaBb	AAbb	Aabb	aaBB	aaBb	aabb
Observed	6	15	18	34	5	18	9	19	8
Expected	8	16.5	16.5	33	8	16.5	8	16.5	8

Although the number of families examined was small, it is clear that the two characters are inherited independently.

Grain Colour.—Of the families examined, only three had white grain colour. On the genotypic basis just postulated, these three families had respectively the genotypes Aabb, AaBB and AaBb. This indicates the probability of no association between these three characters.

Further Crossing Work.

It is not intended at this juncture to describe in detail other breeding results, but simply to indicate in general terms what has been found. A number of crosses have been examined, following the same general procedure outlined in connection with the "Canberra" × "Thew" cross. As in that case, the crosses

before 1926 were made for resistance to the two groups of forms which were then present in Australia. Many of the crosses were made between varieties which showed reciprocal reactions to these two groups of forms with a view to combining this double resistance. Others had as one parent a wheat like "Kanred" or "Kota" which showed the double resistance, the other parents being commercial wheats like "Federation", "Hard Federation", "Canberra", etc. In yet other cases the crosses involved "Federation" and one other of the varieties showing the single resistance, as had been done in the "Canberra" \times "Thew" cross. A number of the actual parents are set out in Tables 2, 3, and 4 and will not be repeated here.

Since 1926, the crosses made have involved resistance to Form 34. "Webster" and "Hope" have been mainly used to contribute this.

F₁ Results.—In the stem-rust work, to date F_1 plants from 286 wheat crosses have been tested with Form 43 to represent the first group of forms, and with Form 46 to represent the second group. In all cases there has been dominance of resistance. The tests have been made in the autumn in order that the seedlings, after being tested, might be transplanted to open beds and grown to maturity. Pots of the parental varieties have been tested under the same conditions for comparative purposes. Almost complete dominance of resistance to Forms 43 and 46 has been shown. A number of barley crosses have shown similar results.

When the first of the F_1 tests was made with Form 34 in 1927, it was very surprising to find almost complete dominance of susceptibility to this form. To date F_1 seedlings from 76 wheat crosses have given this result. There has been no departure from it. In a number of cases, as, for example, the cross "Federation" \times "Webster", the F_1 grain of a cross has been divided into three groups. One batch has been inoculated with Forms 34, 43, and 46 in that order, Form 43 being used for inoculation after note taking and removal of the leaves which gave the Form 34 reaction, and Form 46 being used after removal of the leaves giving the Form 43 reaction. The other two groups of seedlings have been inoculated with these same cultures used in different chronological order. The result has been the same. There is dominance of resistance to Forms 43 and 46, and dominance of susceptibility to Form 34. Similar dominance of susceptibility has been shown in a number of barley crosses.

In the leaf-rust tests of F_1 seedlings from 17 crosses, there has been dominance of resistance similar to that described in the crosses of "Thew" with "Canberra" and other susceptible wheats.

F₂ Results.—In the stem-rust work, a number of the crosses have been tested in the seedling stage with Forms 43 and 46, or with one or other of these two, depending upon the parents. The rule has been to find segregation on a single factor basis. One of the interesting cases was in crosses of "Kota" with "Federation", "Hard Federation", and "Canberra", where there were, on an average, 3 resistant : 1 susceptible plant. Clark (1925) made an extensive study of a "Kota" \times "Hard Federation" cross and found segregation on the basis of 15 susceptible : 1 resistant. The form or forms of stem-rust present are not indicated. An exception to the general happening has been in a "Federation" \times "Webster" cross. In some of the tests, Form 43 has been used to inoculate the first seedling leaf, and Form 46 to inoculate a later leaf after note-taking and removal of the leaf infected with Form 43. In other tests the order in which the forms have been used has been reversed. The result has been the same. There has been a ratio

of 15 resistant : 1 susceptible plant. Furthermore, the plants susceptible to Form 43 are also susceptible to Form 46. This indicates that in "Webster" there are two dominant factors for resistance to Form 43 and 46 which are cumulative in their effects. The same cross tested with Form 34 gives a result in which the dominance of susceptibility is outstanding, with an approximation to a ratio of 3 susceptible : 1 resistant. This is merely a tentative suggestion, since a series of F_2 tests that are in progress seems to point to a 13 : 3 ratio. A comprehensive series of crosses and back-crosses under study will give further light on the point. In the F_2 work it was found that the segregates which were susceptible to Forms 43 and 46 were not necessarily susceptible to Form 34. The inheritance of resistance to Form 34 is independent of resistance to Forms 43 and 46. The same F_2 plants used in these tests were also inoculated with the form of *P. triticina* known as Aust. 1. Segregation on the basis of 3 resistant : 1 susceptible plant occurred.

"This again was independent of the inheritance of resistance to the three forms of stem-rust.

Some of the morphological characters which are exhibited have been studied in certain of the crosses, with the following general results:

TABLE 18.

Summary of results of counts in F_2 generations of certain wheat crosses, showing ratios found in the inheritance of some morphological characters.

Parents of Cross.	Chaff Colour.	Full Beard.	Grain Colour.
Canberra × Kanred	3 : 1	3 : 1	15 : 1
Federation × Kanred	3 : 1	15 : 1	63 : 1
Canberra × Kota	3 : 1	3 : 1	63 : 1
Hard Federation × Kota	3 : 1	3 : 1	15 : 1
Federation × Kota	3 : 1	15 : 1	15 : 1
Federation × Webster	—	15 : 1	15 : 1
		Tip Beard.	
Gullen × Thew	3 : 1	15 : 1	3 : 1
Gluhas × Thew	3 : 1	15 : 1	3 : 1

F₂ Results.—Tests of F_2 families of several crosses for resistance to Forms 43 and 46 have been made. These include "Canberra" × "Kanred", "Canberra" × "Kota", "Hard Federation" × "Kota", "Federation" × "Kota", "Gullen" × "Thew", "Canberra" × "Bobs", "Firbank" × "Wandilla", "Canberra" × "Clarendon", and "Bena" × "Clarendon". The results confirm the F_2 hypothesis that one main dominant factor for resistance operates in these crosses. Evidence was obtained of modifying factors operating in some cases.

It has already been stated that a series of F_2 families of the "Federation" × "Webster" cross are under study, mainly in regard to the inheritance of resistance to Form 34. It is early to attempt to draw final conclusions from this work. The dominance of susceptibility has been very clear. It has meant that an abundance of inoculum of this form has been available in the plant house in which the tests have been made. In all other cross-bred tests, a sufficiency of

the inoculum has only been ensured by frequent inoculations of an appropriate susceptible host variety. Several families have been found which are homozygous in the seedling stage for resistance to Form 34, in addition to having shown satisfactory agronomic characteristics as F_2 individuals. A result in the flag-smut work which is in progress promises to have an important bearing on these F_3 family tests. In pot tests carried out in 1928 and 1929, the strain of "Webster" used in the crosses for rust resistance has remained quite free of flag-smut, alongside fully susceptible plants of "Federation" and "Waratah" derived from grain which was heavily smutted with flag-smut spores as was the "Webster" grain.

Results in Later Generations.—In some of the crosses, notably those enumerated under the heading " F_3 Results", selections have been made in each generation up to F_7 , helped largely by Mr. J. T. Pridham at Cowra. Plant-house tests have been made before deciding upon the progeny for the next sowing. Certain of these types give considerable promise agronomically. The occurrence of Form 34 has greatly complicated matters, but crosses between a number of the best of these types and "Webster" and "Hope" are now in the F_2 stage, and are expected to give fully resistant types of agronomic value.

Occurrence of Grass Clumps in Wheat Crosses.

Attention has already been called to the occurrence of grass clumps in the F_2 generations of the crosses "Canberra" \times "Thew" and "Federation" \times "Thew". The same condition has been found in a number of other crosses that have been made. It has indeed been a limiting factor in some of the crosses which were made to give rust resistance, completely preventing any progress being made.

Grass clumps have occurred in the F_1 of a number of crosses. Notice was drawn to this happening by Mr. G. S. Gordon, of Werribee, in 1922. He had found that from crosses of "Indian F" with "Jonathan", only grass clumps resulted. He kindly made further crosses between these two varieties and forwarded the crossed grain for testing purposes. All the grains produced grass clumps, and although these were grown under the best garden conditions and watered when necessary, they could not be brought beyond this stage. They died without flowering.

The crosses which have been made and which show the same occurrence are as follows:

Hard Federation \times Cedar; Federation \times Cedar; Canberra \times Cedar; Gluyas \times Cedar; Wandilla \times Cedar; Yandilla King \times Cedar; Indian F \times Cedar; Cedar \times Indian F; Indian F \times Jonathan; Federation \times Jonathan; Jonathan \times Canberra; Federation \times Warren; Hard Federation \times Warren; Canberra \times Warren; "Sun \times Dawson" \times Federation; Yandilla \times Bobin; Bobin \times Ford; Bobin \times Florence; Florence \times Bobin; Bobin \times Thew; Federation \times Bombard; Federation \times Mediterranean C.I. 3332-3; Federation \times Italian Spring C. 4413; Persian Black \times Federation; Alberta Red \times Persian Black; Federation \times Iumillo; *T. sphaerococcum* B.L. \times Federation.

Grass clumps in the segregating generations have been noted by many workers. In the work under review, the occurrence of grass clumps in the F_2 generation has been observed in the crosses which are set out in the following table:

TABLE 19.

Occurrence of grass clumps in F₂ generations of certain wheat crosses, compared with the expectancy on a 13:3 basis.

Parents of Cross.	Observed.			Expected.		D. P.E.
	Totals.	Normal.	Grass Tufts.	Normal.	Grass Tufts.	
Gluyas × Thew	560	463	97	455	105	$\frac{8}{6.23}=1.3$
Thew × Wandilla	710	581	129	577	133	$\frac{4}{7.01}=0.6$
Thew × Gullen	585	485	100	375	110	$\frac{10}{6.37}=1.6$
Thew × Indian F	217	170	47	176	41	$\frac{6}{3.88}=1.5$
Thew × Riverina	101	78	23	82	19	$\frac{4}{2.65}=1.5$
Thew × Federation	296	232	64	240	56	$\frac{8}{4.53}=1.8$
Thew × Barooga	40	32	8	32.5	7.5	$\frac{0.5}{1.66}=0.3$
Thew × Duri	105	81	24	85	20	$\frac{4}{2.70}=1.5$
Bena × Thew	120	95	25	97	23	$\frac{2}{2.88}=0.7$
Yandilla King × Thew	335	272	63	272	63	$\frac{0}{4.82}=0$
Thew × Roseworthy	102	83	19	83	19	$\frac{0}{2.66}=0$
Thew × Marshall's No. 3	98	84	14	80	18	$\frac{4}{2.61}=1.5$
Marshall's No. 3 × Thew	150	116	34	122	28	$\frac{6}{3.22}=1.9$
Hard Federation × Florence	386	320	66	314	72	$\frac{6}{5.17}=1.2$
Florence × Hard Federation	199	158	41	162	37	$\frac{4}{3.71}=1.1$
Federation × Florence	145	128	17	118	27	$\frac{10}{3.17}=3.1$
Florence × Federation	193	153	40	157	36	$\frac{4}{3.66}=1.1$
Canberra × Florence	351	293	58	285	66	$\frac{8}{4.93}=1.6$
Florence × Gullen	366	292	74	297	69	$\frac{5}{5.04}=1.0$
Gullen × Florence	505	410	95	410	95	$\frac{0}{5.92}=0$
Florence × Wandilla	752	626	126	611	141	$\frac{15}{7.22}=2.1$
Florence × Yandilla King	100	80	20	81	19	$\frac{1}{2.63}=0.4$
Canberra × Clarendon	548	461	87	445	103	$\frac{16}{6.16}=2.6$
Clarendon × Waratah	166	137	29	135	31	$\frac{2}{3.39}=0.6$
Clarendon × Bena	172	142	30	140	32	$\frac{2}{3.45}=0.6$
Bena × Clarendon	184	159	25	150	34	$\frac{9}{3.57}=2.8$
Canberra × Bomen	469	387	82	371	88	$\frac{6}{5.70}=1.1$
Gluyas × Bomen	501	407	94	407	94	$\frac{0}{5.89}=0$
Yandilla King × Bomen	297	250	47	241	56	$\frac{9}{4.54}=2.0$
Canberra × Rieti	488	407	81	397	91	$\frac{10}{5.82}=1.7$
Ridit × Federation	196	170	26	159	37	$\frac{11}{3.69}=3.0$
Chinese White × Canberra	176	142	34	143	33	$\frac{1}{3.49}=0.3$
<i>T. sphaerococcum</i> S.B. × Federation	286	242	44	232	54	$\frac{10}{4.45}=2.2$

It will be seen that in some of the crosses the numbers of individuals available are small. The figures are given just as they were taken in the field.

In addition to these cases in which there has been the 13 : 3 ratio typical of the action of inhibitory factors, there have been three in which a 15 : 1 ratio occurred.

They are as follows:

TABLE 20.

Occurrence of grass clumps in F_2 generations of certain wheat crosses, compared with the expectancy on a 15 : 1 basis.

Parents of Cross.	Observed.			Expected.		D. P.E.
	Totals.	Normal.	Grass Clumps.	Normal.	Grass Clumps.	
Exquisite × Thew	161	149	12	151	10	$\frac{2}{2.07} = 1.0$
Bomen × Warden	319	298	21	299	20	$\frac{1}{2.92} = 0.3$
Firbank × Wandilla	258	243	15	242	16	$\frac{1}{2.62} = 0.4$

There have been occurrences of similar grass clumps in some of the barley, rye and oat work. Further studies involving numerous crosses are in progress dealing with these and the wheat grass clumps. Pending the completion of these, no attempt is made at this stage to discuss the mode of inheritance of this character.

Resistance to Puccinia graminis avenae.

Unexpected difficulties have been met with in this work. There have been numerous attempts to make crosses between varieties of oats at the Sydney University which have resulted in a very poor setting of grain. Mr. J. T. Pridham of Cowra has kindly supplied some crossed grain and a few results have been obtained. Losses from attack by grain moth have greatly hampered work.

The crosses available have been: 1, "Belar" (susceptible) × "Reid" (resistant); 2, "Ruakura" (susceptible) × "Richland" (resistant); 3, "Algerian" (susceptible) × "White Tartar" (resistant); 4, "Algerian" (susceptible) × "Joanette" (resistant).

The only rust used so far is *P. graminis avenae* 1. The reactions indicated have to do with this physiologic form.

In the F_1 seedling tests, there was a close approach to complete dominance of resistance. Thus in the first cross, the F_1 reaction was "2+" while the resistant "Reid" gave "2". In the second cross, the F_1 reaction was "0;" similar to that given by "Richland". In the third, the F_1 showed "2", similar to that given by "White Tartar". In the fourth cross, the F_1 reaction was "2", whilst "Joanette" showed "1".



"Belar" × "Reid".

Only in the case of the first cross have F_2 results of value been obtained. In the other cases, loss of grain by attack of army worm in the field or by grain moth in the laboratory after harvest has reduced the numbers available too greatly for the figures to have a real significance. But F_3 studies are planned which may give information regarding the genetics of resistance. In the cross "Belar" × "Reid", the same culture of *P. graminis avenae* 1 which had been used in the F_1 tests was used to inoculate a group of F_2 seedlings. There were 177 resistant : 58 susceptible plants, a close approach to a 3 : 1 ratio.

As regards resistance to *P. graminis avenae* 1, in the cross "Belar" × "Reid" there appears therefore to be a single dominant factor which determines resistance.

"Algerian" × "Joanette".

In this cross, owing to ravages of grain moth, only 16 viable grains were available for the F_2 test. Of the 16 seedlings tested at a time when "Joanette" gave resistant reactions, 10 were resistant and 6 were susceptible. These were planted out after test and grown to maturity with the exception of one plant which failed.

In the F_3 , the six susceptible F_2 plants were each homozygous for susceptibility. There were 272 seedlings in this test, an average of more than 45 for each family. Three of the families were homozygous for resistance. They comprised 142 seedlings, or an average of more than 47 per family. The remaining six families were heterozygous. They comprised 286 seedlings, an average of more than 47 per family. Of them, 214 were classed as resistant and 72 as susceptible. This is a very close approximation to the ratio of 214.5 resistant : 71.5 susceptible plants which is the expectancy on a single factor basis.

There appears, therefore, to be again a single dominant factor determining resistance to *P. graminis avenae* 1 in this cross.

SUMMARY AND CONCLUSIONS.

The initial results obtained during several years of work devoted to breeding varieties of wheat and oats for rust resistance are given.

Investigations of the technique of crossing showed that under existing conditions the method gave 75% of successful crossing in wheat. It was found that viable crossed grain could be obtained from heads on severed stalks kept in vessels of water in the plant house after pollination.

A determination was made of the effect which the stage of development of the grain has upon germination. Grain harvested only 17 days after pollination gave full germinations and practically normal seedlings. Grain only six days old gave nearly 40% germination with production of very spindly seedlings.

Numerous wide crosses were attempted. Utter failure was met with in all efforts to cross wheat and barley, and complete sterility was found in a cross between wheat and rye.

Many unsuccessful efforts were made to cross "Khapli" emmer with varieties of vulgare wheat. Attempts are being made by indirect methods to incorporate the "Khapli" resistance in vulgare wheats. A first examination of crosses between certain durum and vulgare wheats indicates that a single dominant factor for resistance to *P. graminis tritici* 43 is present in these durum varieties.

Crosses were made between "Canberra" and "Thew" to give resistance to the six forms of *P. graminis tritici* present in Australia prior to 1926. These parents

behave reciprocally in regard to their resistance and susceptibility to the two groups, each of three physiologic forms. The results of work with the F_1 , F_2 , and F_3 generations indicate the presence in each parent of a single dominant factor for resistance. Tests of later generations are given, leading to the development from this cross of the variety "Euston". Observations were made on the advent of Form 34 of *P. graminis tritici* in the breeding plot, and on the superseding of the other forms by Form 34.

In the "Canberra" \times "Thew" cross, the inheritance of resistance to Australian Form 1 of *P. triticina* was traced, and shown to be due to the operation of a single dominant factor for resistance. This is inherited independently of the factor for resistance to *P. graminis tritici* 46. Certain morphological characters in which the two varieties differ were also followed in their inheritance.

To link up with the "Canberra" \times "Thew" cross, studies were made of crosses between "Canberra" and "Federation", and between "Thew" and "Federation". Confirmatory evidence was obtained showing that resistance in "Canberra" and in "Thew" depends in each case upon a single dominant factor. In the variety "Thew", an additional independent dominant factor for resistance to Australian Form 1 of *P. triticina* is present, and is linked with a factor for resistance to one form of *Erysiphe graminis*.

The crosses "Riverina" \times "Thew" and "Gluyas" \times "Thew" also give evidence of the operation of a single dominant factor in "Thew" for leaf-rust resistance.

Examination of the cross "Federation" \times "Japanese Bearded" shows that in "Japanese Bearded" there is also present a single dominant factor for resistance to leaf-rust.

The general results of studies of other wheat crosses show that in all cases examined, the inheritance of resistance to Forms 43 and 46 of *P. graminis tritici* is due to a single dominant factor for resistance. On the other hand, the inheritance of resistance to Form 34 is due to one factor (or more) with clear dominance of susceptibility.

In many of the wheat crosses, the inheritance of the "grass clump" habit has been recorded. Grass clumps may occur in the F_1 and lead to sterility of the plant. In other crosses, counts in the F_2 show a ratio of 13 normals : 3 grass clumps, or of 15 normals : 1 grass clump.

A small amount of work dealing with inheritance of resistance to *P. graminis avenae* 1 points to the operation of a single dominant factor for resistance.

Despite the complexities inherent to the work, there would seem to be no valid reason why success should not be obtained in breeding fully resistant varieties which are also agronomically desirable. In this work controlled plant-house studies can be of the utmost assistance to the breeder.

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EXPLANATION OF PLATES XXXII-XXXIV.

Plate xxxii.
Wheat plants.

(a), (b), and (c) illustrate the “Federation” seedlings derived from grain of different ages, sown the same day and photographed the same day.

(a) Seedlings from grain 6 days old, “very spindly”.—(b) Seedlings from grain 10 days old, “spindly”.—(c) Seedlings from grain 20 days old, “normal”.—(d) Part of an F₂ generation of the cross “Canberra” × “Thew”, showing the occurrence of “grass clumps” amongst the normal plants.

Plate xxxiii.

Crosses between vulgare wheats and “Khapli” emmer.

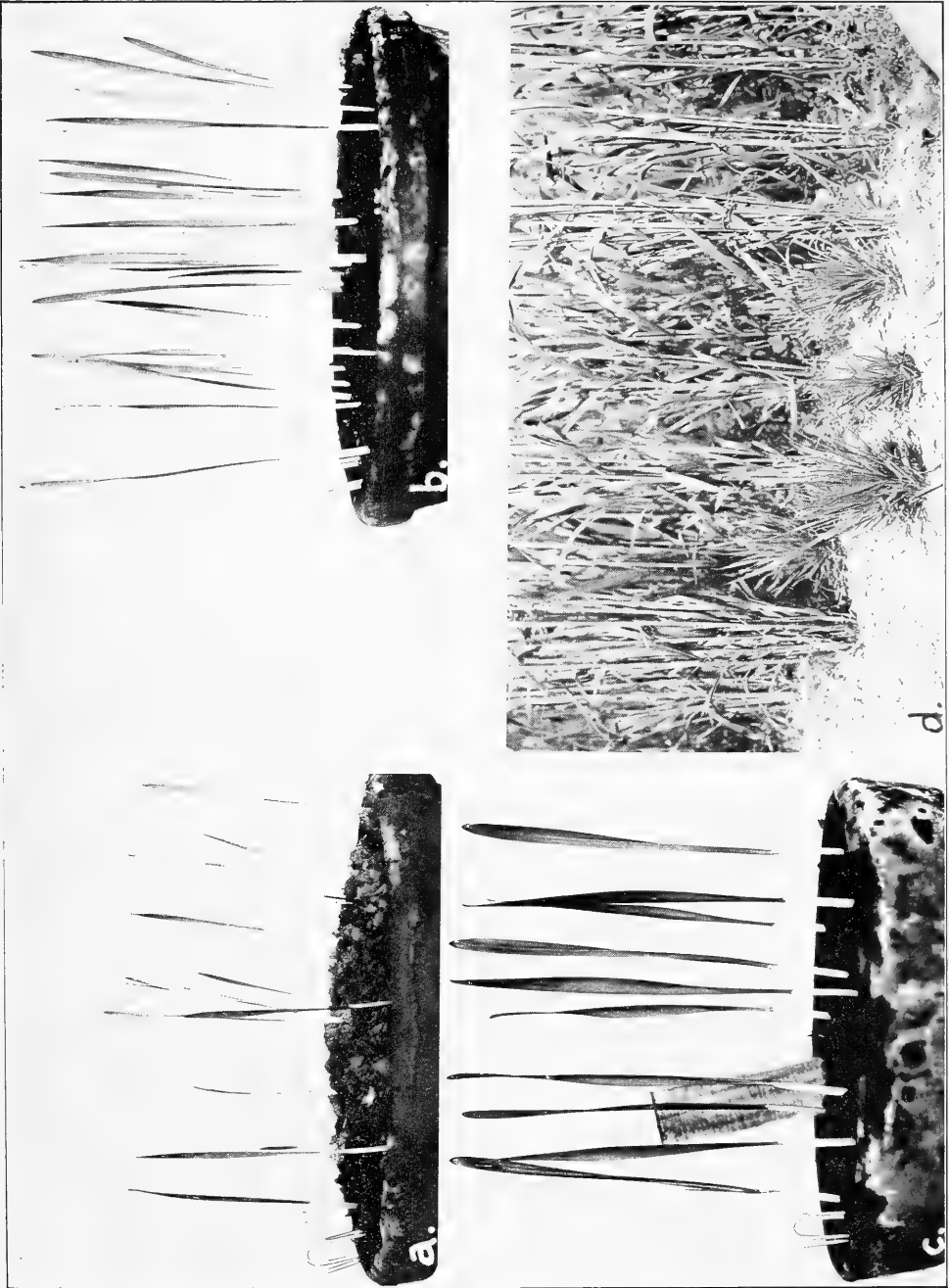
(a) Grain of “Federation”.—(b) Grain of “Khapli”.—(c) Grain produced as a result of crossing “Federation” and “Khapli”. Very shrivelled grain was obtained in all these crosses.—(d) Seedling leaves of the F₁ plants of “Federation” × “Khapli”, showing the “X” reaction produced by *P. graminis tritici* 34.—(e) The F₁ plants of crosses between vulgare wheats and “Khapli” made in 1927, growing in the open after having been tested in pots and transplanted. There are marked differences in the degrees of growth made by the plants, depending upon the particular vulgare variety used as the parent.

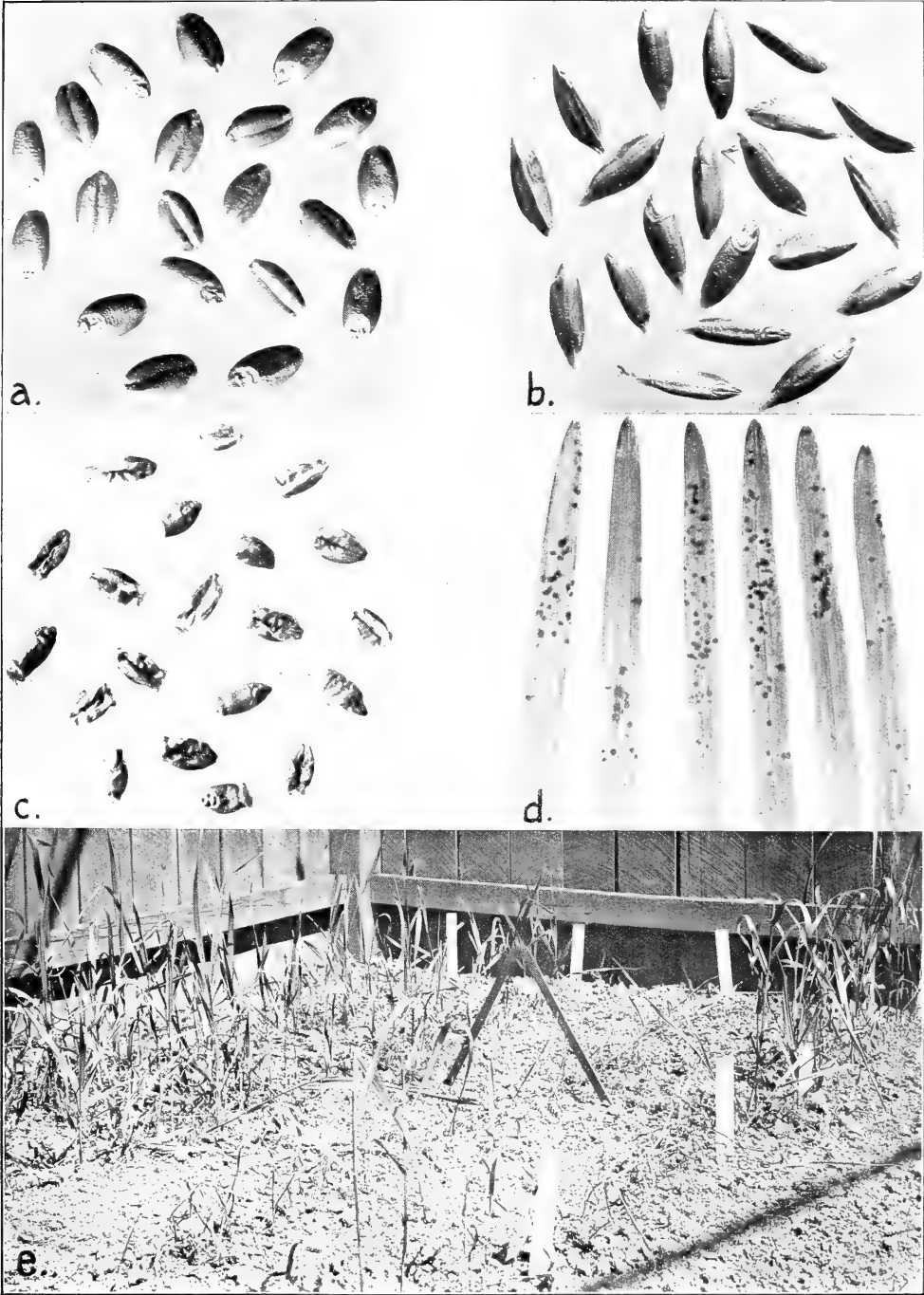
Plate xxxiv.

Crosses between vulgare wheats and "Khapli" emmer.

The same batch of F_1 plants illustrated in (d) of the preceding plate are here shown. They were photographed the same day. The normal growth and heading of wheat plants of other crosses which had been treated in exactly the same fashion are seen in the row at the left.









THE GEOLOGY OF THE SOUTH COAST OF NEW SOUTH WALES.

Part iii. THE MONZONITIC COMPLEX OF THE MOUNT DROMEDARY DISTRICT.

By IDA A. BROWN, B.Sc., Linnean Macleay Fellow of the Society in Geology.

(Plates xxxv-xxxix; three Text-figures.)

[Read 26th November, 1930.]

Introduction and Previous Records.

General Geology and Physiography.

The Sedimentary Series.

The Igneous Series:

- (i) Occurrence and Field Relations; (ii) Structures; (iii) Petrology of the Plutonic Rocks; (iv) Petrology of the Hypabyssal Rocks; (v) Petrogenesis;
- (vi) Age of the Igneous Rocks.

Comparison with similar Occurrences in other Parts of the World.

Summary.

Introduction and Previous Records.

Mount Dromedary is an imposing mountain, more than 2,600 feet in height, situated a few miles inland, on the South Coast of New South Wales, about two hundred and fifty miles south of Sydney. The main coast road, or Prince's Highway, between Sydney and Melbourne passes along the eastern foothills of the Mountain, through the two villages of Central Tilba and Tilba Tilba, which are the centres of the dairy-farming district situated on the fertile foothills of the Mountain.

The Mountain was named by Captain Cook on Saturday, 21st April, 1770, two days after the discovery of the east coast of Australia. In his Journal, a photostat copy of which is in the Mitchell Library, Sydney, he states: "at 6 o'clock we were abreast of a pretty high mountain laying near the shore which on account of its figure I named Mount Dromedary Lat^{de} 36° 18' s Long^{de} 209° 55' w / the shore under the foot of this mountain forms a point which I have named Cape Dromedary over which is a peaked hillick".

The late Mr. R. H. Cambage (1915) was of the opinion that Cook "regarded Montague Island as a part of the mainland extending easterly from the Mount and he called it Cape Dromedary", but Cook's "peaked hillick" undoubtedly refers to the Little Dromedary, a hill about 700 feet high, situated between the main mountain and the sea, forming a conspicuous feature of the coastal scenery when viewed from the ocean; and therefore it seems to the writer that the point named by Cook is probably the headland now known as Cape Dromedary.

Previous description of the geological nature of the area under consideration is confined to portion of the paper by W. Anderson (1892) "On the General Geology of the South Coast", which includes a sketch-map showing approximately the outer boundaries of the igneous rocks, without recognition of the position or extent of the various included rock-types.

The specimens and microsections described in Anderson's paper are now in the Mining Museum, Sydney, and were made available to the writer for examination by the courtesy of Mr. G. W. Card, late Curator of the Museum. Anderson's description of "augite granite" from Mount Dromedary is noted by Harker (1923, p. 37) in his "Petrology for Students". Brief reference has been made by H. I. Jensen (1912) to certain rock-types occurring at the foot of Mount Dromedary, and also (1910, 1914) to the soils that have been derived from them.

Reports on the goldfield of Mount Dromedary have been made by officers of the Department of Mines, New South Wales, and brief reference to the petrology has been made by Dr. W. R. Browne (1929) and the writer (1929).

GENERAL GEOLOGY AND PHYSIOGRAPHY.

Mount Dromedary consists of igneous rocks which have been intruded into a highly folded series of early Palaeozoic metamorphic rocks of sedimentary origin. A geological sketch-map of the district is given in Plate xxxv. Near the Coast, several patches of Tertiary sediments overlie the Palaeozoic series with a marked unconformity, while more recent sands and alluvium occur as raised beaches round the coastal lagoons and swamps of the district, and are to be described in a separate communication.

The Mountain rises to a height of 2,613 feet above sea-level, and consists entirely of igneous rocks (Plate xxxvi); the surrounding slates, quartz-schists, and related rocks rarely rise to 200 feet above sea-level. Differential erosion of the igneous and metamorphic rocks has produced characteristic topography, gently undulating country about the lower slopes of the mountain consisting of monzonite (Plate xxxvi), and relatively deeply dissected country in the slate area. These effects of differential erosion have an important bearing on the conservation and utilization of the soil.

The drainage has a radial arrangement with respect to the Mountain, which gives rise to many permanent streams: some of these may be harnessed for power in the future, although at present only one has been utilized as a permanent water-supply for the farms about the village of Tilba Tilba.

Tributaries of Dignam's Creek and Karea (Courier) Creek drain the southern slopes of the Mountain, flowing into Wallaga Lake and entering the sea north of Bermagui; the waters of the eastern slope fall into Tilba Tilba swamp, on the south side of the Little Dromedary, or else into tributaries of Victoria Creek, which enters Tilba Tilba Lake; the creeks on the northern slopes, Dromedary and Punkally Creeks, retain their meridional trend until they meet the drowned valley of the Wagonga River, entering the sea at Narooma. The north-western slopes of Mount Dromedary are unexplored, but evidently form the watershed of Reedy Creek, which crosses the Dignam's Creek road to Eurobodalla as a strong stream flowing to the north-north-west into Tuross River, and entering the sea through Lake Tuross.

The influence of the intrusion is not confined to the production of land forms; the soils developed as a result of weathering have characters quite distinct from those of the adjacent slates and quartzites. The igneous rocks of the Dromedary foothills are intermediate and basic types whose decomposition products are rich in plant foods, and include notable amounts of phosphoric acid. As a rule these soils are comparable with those of the Milton district and have been described by H. I. Jensen (1910, 1914). Unfortunately these soils have a limited distribution, the whole area of which is under cultivation for dairy-farming purposes.

The natural vegetation bears evidence of the rich character of the soil; the writer is not competent to give an adequate description of the indigenous flora, which alone would be an interesting ecological study. It is evidently a remnant of a sub-tropical flora which formerly existed much to the south of its present limits.

THE SEDIMENTARY SERIES.

The principal sedimentary rocks of the district are those of early Palaeozoic age, which have been considerably altered to quartzites, quartz-schists, knotted schists and phyllites. They are portion of the older Palaeozoic series already described by the writer (1930), and appear to be quite unfossiliferous. They are of argillaceous and arenaceous character; so far as is known at present there are no traces of calcareous sediments.

Although the normal trend of the strike directions for the series is north and south, in the vicinity of Mt. Dromedary there is considerable variation, evidently due to the thrust exerted by the igneous intrusion. This is clearly indicated on the map (Plate xxxv).

THE IGNEOUS SERIES.

(i) *Occurrence and Field Relations.*

The igneous rocks outcrop over an oval-shaped area of approximately twenty-five square miles, comprising the whole mass of Mt. Dromedary and extending in an easterly direction to the coast, five and a half miles distant from the Trigonometrical Station of Mt. Dromedary.

Montague Island, lying off the coast near Narooma, twelve miles in a direct line from the Dromedary Trigonometrical Station, consists of igneous rocks which have their exact counterparts on the mainland about Mt. Dromedary. Small outcrops of related types are known to occur near the township of Narooma, and probably others may be found when the dense coastal brush is further cleared.

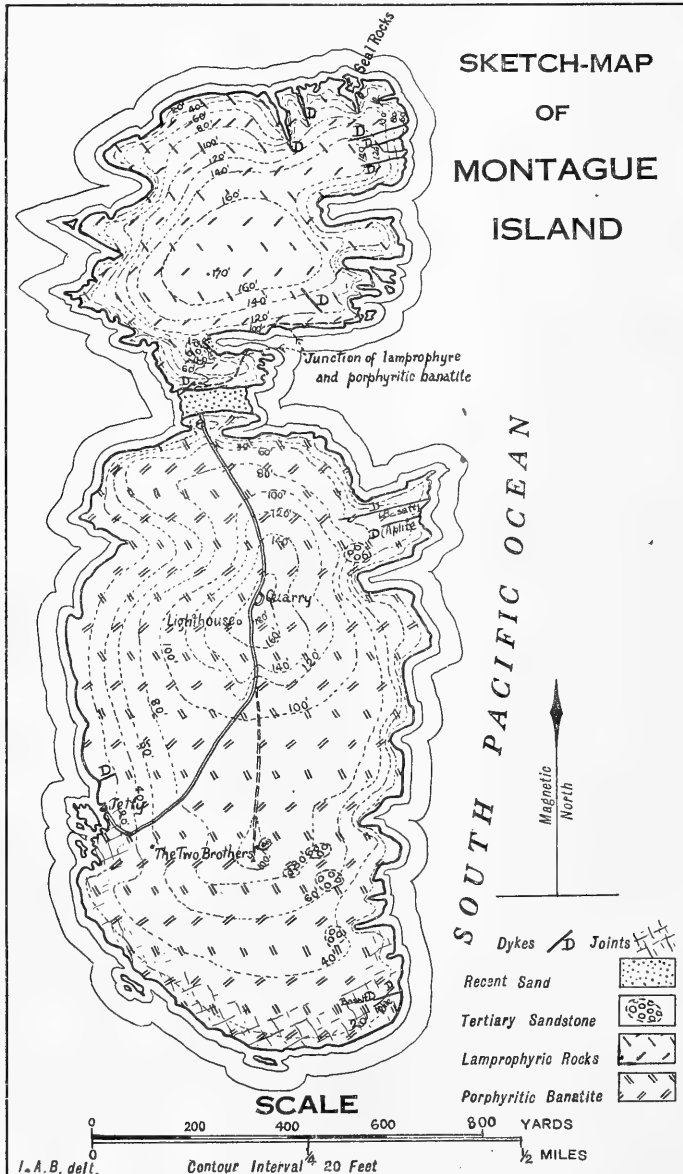
On his map of the igneous rocks of the mainland, W. Anderson (1892) distinguished three chief types, "Granite", "Andesite and Propylite" and "Augite-felspar-mica-rock". This mapping has been modified by the writer as a result of field-work, particularly in the eastern and southern portions of the area, but the north-western portion has not yet been mapped in detail. This part of the area consists of the steep, almost inaccessible, slopes of the mountain, which are covered with a dense growth of timber, undergrowth and vines.

Within the area shown on the map (Plate xxxv) there outcrops one of the most interesting series of plutonic rocks yet known to occur in New South Wales. The plutonic complex includes a series of monzonitic rocks ranging from ultrabasic to sub-acid types, a related series of nepheline-bearing monzonitic rocks, and a garnet-bearing series, all of which are probably consanguineous, an interesting assemblage of calcic, monzonitic and alkaline rocks.

Associated with the plutonic rocks are some hypabyssal types of monzonitic character, which are comagmatic with the plutonic series. These rocks outcrop at or near the borders of the main intrusion, usually between the plutonic mass and the adjacent sediments.

The relations between the plutonic and hypabyssal types are best revealed on Montague Island (Text-figure 1). The Island consists of two rocky masses united by a narrow strip of sand, only a few feet above sea-level. The southern "Island" consists of coarsely crystalline, porphyritic syenite or banatite, similar to one

of the types outcropping on the slopes of Mt. Dromedary, and the north "Island" is composed chiefly of hypabyssal types similar to those occurring on the main-land. The junction of the two rocks obviously formed a surface of weakness along which erosion has taken place; but fortunately a small remnant of the syenite still survives in the south-eastern portion of the north Island, and its contact with the hypabyssal types is well exposed in the cliff-sections.



Text-fig. 1.

The writer is indebted to the Commonwealth Navigation Department for permission to visit Montague Island, and to Mr. and Mrs. McCarthy for hospitality during the visit.

The "syenite" on Montague Island was quarried for the construction of the Lighthouse and the lightkeeper's residence on the Island, and the bases of six of the columns of the Pitt Street frontage of the General Post Office, Sydney, consist of stone from the Island. R. T. Baker (1909, Pl. vi) gives a coloured illustration of this building stone under the name of Montague Island granite.

(ii) *Structures.*

Jointing is a conspicuous structure in the igneous rocks wherever they are well-exposed and free of overlying soil. In the fine-grained banatite forming the upper portions of Mt. Dromedary, widely spaced master-jointing occurs, but it is better developed and more conspicuous in the porphyritic monzonite forming the top of the Little Dromedary, where the sheer western face of cliffs, a hundred or more feet in height, is due to the development of strong vertical jointing in a direction N. 30° E., with less pronounced jointing at right angles.

On Montague Island the structure is even more pronounced, and has been responsible for the initial development of the large tors, up to 25 or 30 feet in height, which are characteristic of the South "Island". Along the eastern coast of the South "Island", the joints running in a direction west of north are crowded together as shown in the photograph (Plate xxxvii). Towards the junction of the porphyritic monzonite of the South "Island" and the hypabyssal rocks of the North "Island", the two sets of joints at right angles to this direction have been planes of weakness along which the hypabyssal rocks have been intruded in dyke-like and sill-like fashion.

The hypabyssal rocks themselves are jointed in the same directions indicating that similar stresses operated on both series of igneous rocks.

Jointing is not so noticeable in the normal monzonites, as, on the whole, these have formed soils which are under cultivation; nevertheless, it may be seen in the road-cuttings and quarry near Central Tilba.

In the pyroxenite forming the rock platform at Poole's Point, north of the mouth of Tilba Tilba Lake, jointing occurs in two chief directions, N. 50° W. and W. 10° S.

The directions of the dykes through the igneous rocks and the adjacent sediments do not seem to conform to any simple arrangement; some of these dykes are indicated on the map (Plate xxxv); the majority of those which outcrop along the coast and on Montague Island strike north of east, others run east and west, and at right angles to this direction. The andesitic dykes on the top of Mount Dromedary, which are responsible for some of the auriferous deposits there, strike north of west.

There is a slight tendency towards a radial arrangement of the dykes about the Mountain, but many irregularities occur.

(iii) *Petrology of the Plutonic Rocks.*

Most of the specimens on which the following descriptions are based were collected by the writer, and are in the Museum of the Department of Geology, Sydney University, numbered M.401, etc., but reference is also made to the specimens collected and described by W. Anderson, 1892, which are in the Mining Museum, George Street North, Sydney.

Chemical analyses of the chief rock-types have been carried out by the writer in the laboratory of the Geological Department of the University of Sydney.

Monzonitic Series.

1. Banatite (Syenite).

The most acid members of the plutonic series outcrop on the upper slopes of the Dromedary Mountain, from the summit (2,613 feet) down to about 550 feet above sea-level, where the rock grades into a coarsely porphyritic type, comparable with that occurring on Montague Island.

A series of specimens collected along the track from Tilba Tilba township to the top of Mt. Dromedary shows a progressive variation in the character of the rock. The upper portion of the Mountain consists of rather fine-grained syenitic rock, which may be called banatite. It is pinkish-grey in colour and consists essentially of feldspathic minerals, with a small amount of finely divided ferromagnesian mineral; scattered phenocrysts of feldspar increase in size and abundance on the lower slopes of the Mountain, until the rock apparently merges into a coarsely porphyritic type of monzonite. Quartz is inconspicuous in the handspecimen, but the rock is rarely free from at least traces of iron ores, both oxides and sulphide. Near the top of the Mountain narrow auriferous veins of pyrites occasionally occur through the banatite, these being probably of magmatic origin, while the effects of deuteritic processes are evident throughout the finely-grained phases of the banatite. Thus it is difficult to obtain specimens of banatite which appear to be absolutely fresh.

Under the microscope the rock (Pl. xxxviii, fig. 1) appears to be hypidiomorphic granular with a strong tendency to monzonitic fabric; the average grain-size is from 1 to 2 millimetres. The minerals present are orthoclase (anorthoclase), plagioclase, quartz and hornblende, with smaller amounts of biotite, augite, sphene, apatite, iron ore, and alteration and deuteritic minerals including chlorite, epidote, calcite, kaolin and secondary feldspar (albite). Some specimens contain traces of fluor spar (M.404) and others have analcite and zeolite (M.453, M.465), which are probably of deuteritic origin.

Orthoclase occurs as subidiomorphic crystals and as irregular plates enclosing other minerals. Frequently there is a parallel intergrowth with plagioclase of the composition $Ab_{70}An_{30}$, which appears to be primary and which is distinct from the subsequent deuteritic alteration to albite, kaolin and carbonate material.

Plagioclase as subidiomorphic crystals 1 to 2 millimetres in length, and as somewhat larger phenocrysts, constitutes almost one-half of the volume of this rock. The mineral is slightly zoned, with well-developed twinning after albite and Carlsbad laws; the composition appears to be between $Ab_{60}An_{40}$ and $Ab_{70}An_{30}$ for the banatite series.

Quartz, although inconspicuous in the handspecimen, appears under the microscope to form an important part of the rock; the grains are always small, and usually take an interstitial rôle with respect to the more idiomorphic feldspars. In the norm it is present to the extent of 16 per cent. of the rock.

Hornblende is sparsely distributed throughout, and is similar in character to the variety commonly occurring in syenites. It is subidiomorphic, the grains being usually less than 2 millimetres in length; it is greenish-brown in colour, with rather weak pleochroism, and well-developed cleavage. This mineral seems to have been particularly susceptible to alteration, magmatic or otherwise, and is

now partly replaced by carbonate (probably calcite), vivid green chloritic material and epidote. In some specimens the alteration products include small amounts of a violet isotropic mineral, apparently fluorspar, whose presence indicates alteration of the original hornblende during the later phases of consolidation of the magma, rather than merely superficial weathering.

In addition to its occurrence as an alteration product of hornblende, calcite occurs in the interstices between idiomorphic feldspars as a product of primary crystallization. Grains of sphene and iron oxides have formed centres for the crystallization of the ferromagnesian mineral, hornblende. Some small irregular grains of biotite are included in larger plates of feldspar, and several grains of colourless pyroxene are scattered through the rock.

A chemical analysis of the freshest available specimen of this type is given in Column I, Table 1, where it is compared with analyses of several similar rocks.

The silica percentage is lower than that of a truly acid rock, while the relatively high alkali percentage shows the relationship of this rock to the monzonitic or alkaline series; nevertheless, there is a striking general resemblance to the analysis, quoted in Column V, of the Moruya granodiorite, which is a member of a typical subalkaline or calcic series, outcropping about 30 miles north of Mt. Dromedary.

The silica, alumina and total iron oxide percentages are very similar in the two rocks, the chief difference being that total lime and magnesia are about 2 per cent. less and the total alkalis $3\frac{1}{2}$ per cent. greater in the banatite than in

TABLE 1.

	I	Ia	II	III	IV	V
SiO ₂	64.49	1.075	65.54	64.64	63.86	65.72
Al ₂ O ₃	17.48	0.172	17.81	16.27	17.87	17.63
Fe ₂ O ₃	1.64	0.010	0.74	2.42	} 4.48	} 0.42
FeO	1.69	0.024	1.15	1.58		
MgO	0.66	0.016	0.98	1.27	0.99	1.73
CaO	3.28	0.059	1.92	2.65	3.33	4.36
Na ₂ O	4.16	0.067	5.55	4.39	4.10	3.14
K ₂ O	4.79	0.051	5.58	4.98	3.56	2.12
H ₂ O+.. .. .	0.52	—	} 0.54	0.27	} 0.84	} 1.03
H ₂ O—.. .. .	0.18	—		0.09		
TiO ₂	0.46	0.006	0.11	0.51		0.41
P ₂ O ₅	0.22	0.001	tr.	0.37		0.19
MnO	0.11	0.001	tr.	tr.		0.08
ZrO ₂	—					0.19
SrO				0.08		tr.
BaO			?	0.18		abs.
CO ₂	0.71	0.016	tr.	0.37		
SO ₃				tr.		
S	0.06	0.002				0.13
Cr ₂ O ₃	abs.					abs.
NiO, CoO	pr. tr.					
Cl				0.05		
Total	100.45		99.92	100.12		100.01
Sp. Gr.	2.653					2.729

TABLE 1a.

	I	II	III	IV	V
Quartz.. .. .	15·78	6·18	13·68		25·92
Orthoclase	28·36	32·80	29·47		12·23
Albite	35·11	47·16	37·20		26·72
Anorthite	11·12	7·23	10·01		20·85
Corundum	1·43	—	—		2·55
Zircon	—	—	—		0·37
Diopside		1·79	0·22		—
Hypersthene	2·66	2·96	3·23		8·26
Magnetite	2·32	1·16	3·48		0·70
Ilmenite	0·91	0·15	0·91		0·76
Apatite	0·34				0·34
Calcite	1·60				—
Pyrite	0·12				0·24

I. Banatite (Toscanose, I, 4", 2, 3). Mt. Dromedary, N.S.W., 1,175 feet above sea-level, track from Tilba Tilba to Summit. Anal. I.A.B.

Ia. Molecular numbers for I.

II. 'Syenite [Pulaskose, I, "5, (1)2, 3(4)]. Top of Highwood Peak, Highwood Mountains, Montana. L. V. Pirsson and W. L. Mitchell, anal. *U.S.G.S. Bull.* No. 237, 1905, p. 63. Norm in Washington's Tables (1916), p. 287.

III. Syenite [Toscanose, I", 4(5), 2, 3"]. Wright and Edward's Mine, Barker, Little Belt Mountains, Montana. W. F. Hillebrand, analyst. *Ann. Rept. U.S.G.S.*, 20, 1900, p. 466. Norm in W.T. (1916), p. 177.

IV. Banatite. Oberwald b. Steinau, Odenwald. Dr. Sonne (Lepsius). Quoted from W. C. Brøgger, *Die Eruptiv-gesteine des Kristianiagebietes*, II, 1895, p. 62.

V. Granodiorite (Yellowstonose, I(II), 4, 3, 4). Dorman, Long and Coy's Quarry, Moruya, N.S.W. Anal. I.A.B. These PROCEEDINGS, liii, 1928, p. 162.

the granodiorite, due to the somewhat greater abundance of felspar and corresponding scarcity of ferromagnesian constituents in the banatite, a mineralogical variation which is reflected in the slight difference in the specific gravity values of the two rocks.

The analyses quoted in Columns II and III not only represent individual rocks which are similar in composition to the banatite of Mount Dromedary, but are corresponding members of two igneous series in the Highwood Mountains and the Little Belt Mountains of Montana, which in many ways are analogous to the series at Mt. Dromedary.

These Montana rocks are described as syenites, although Pirsson (1895, p. 467) recognized the Barker syenite as "verging toward the monzonitic group of Brøgger", and (1905, p. 65) that the Highwood Peak syenite belonged to "the alkaline series of syenites".

Brøgger (1895, p. 63) applied the term "banatite" to the series of rocks intermediate between the monzonites and the adamellites, with a silica percentage between 62 and 66, a typical example of which is quoted in Column IV. On account of the similarity of the Mount Dromedary rock and Brøgger's type, the term banatite has been applied to the Mount Dromedary rock, although syenite might be permissible and useful as a field name.

2. Porphyritic Monzonite.

Towards the lower slopes of Mount Dromedary the somewhat finely-crystalline banatite grades into a more coarsely-crystalline phase in which large felspar crystals constitute about one-half the volume of the rock, and the groundmass itself is coarse grained. This phase has been traced along the eastern and north-eastern flanks of the mountain, between the banatite previously described and a coarse even-grained monzonite to be described later.

The upper portion of the Little Dromedary, R.9, Parish of Narooma, higher than about 500 feet above sea-level, consists of similar rock, and another weathered outcrop occurs north of this in portions 219, 69, and 328, Parish of Narooma.

The southern "Island" of Montague Island consists of rock which cannot be distinguished from this coarsely porphyritic monzonite. The rock has weathered to give huge, bare and rounded rock-masses on the slopes of the main Mountain and the Little Dromedary, and the large tors of Montague Island (Plate xxxvii).

The field relations are not very clear; it appears to grade into the banatite, but sometimes shows sharp boundaries against the monzonite exposed in the south-western part of Portion 220, Parish of Narooma. On Montague Island it is in sharp contact with members of the hypabyssal series, by which it is intruded along joint planes.

Individual specimens show slight variations, but all are characterized by large tabular phenocrysts of felspar, set in a coarsely-crystalline groundmass. The phenocrysts may be four or five centimetres in length, and consist of glassy-grey, simply-twinned crystals of orthoclase (not labradorite, as stated by Baker, 1909), with a sporadic distribution of smaller phenocrysts of plagioclase. Both plagioclase and orthoclase may be recognized in the groundmass, and the ferro-magnesian minerals appear to be hornblende and biotite; no quartz has been detected in the handspecimen.

The rock outcropping near the track from Tilba Tilba up Mount Dromedary, at a height of about 500 feet above sea-level, is representative of this type, a specimen of which was chosen for chemical analysis.

Under the microscope, the rock shows monzonitic fabric, and the grainsize of the groundmass is coarse, 2 to 5 millimetres. The idiomorphic orthoclase phenocrysts show Carlsbad twinning and well-developed cleavage. They are partly kaolinized. Small regularly-arranged inclusions of apatite, biotite, and augite are probably the cause of the opalescence evident in some of the phenocrysts; occasionally there is a parallel intergrowth with included plagioclase crystals, up to one millimetre in length.

The groundmass contains orthoclase, plagioclase, quartz, augite, hornblende, biotite, apatite, sphene, iron ore, and alteration products, including chlorite, epidote, kaolin, sericite, calcite, and albite.

The orthoclase of the groundmass is allotriomorphic and encloses crystals of the other minerals; it appears to have suffered some albitization; some of the felspar included here is really myrmekite-perthite.

Plagioclase is idiomorphic, and is slightly zoned. It is commonly twinned after Carlsbad, albite and pericline laws, and one section (M.518) shows crossed Baveno twinning, making a fourling (*cf.* Iddings, 1916, p. 209). The mineral is andesine of composition $Ab_{32}An_{45}$ to $Ab_{35}An_{35}$.

Quartz is present in small quantity as interstitial grains.

Occasionally small grains of colourless pyroxene, partly altered to and surrounded by greenish amphibole, indicate that although the augite evidently

crystallized first, magmatic conditions later favoured the production of hornblende and biotite.

The hornblende is subidiomorphic, and has a greenish-brown colour, with strong pleochroism; it occurs in close association with brown, pleochroic biotite, and both minerals have suffered alteration to chloritic and carbonate material, probably calcite.

Iron ore is relatively abundant as small irregular grains, and apatite appears as acicular needles and larger crystals.

The rock outcropping on the upper portions of the Little Dromedary resembles, in general, the type described above, but the material available is not so fresh and unaltered. The general mineral assemblage is similar, although there is evidently a deficiency in silica as compared with the Mountain type, which is indicated by the absence of quartz and the occasional presence of a small amount of allotriomorphic nepheline between the larger crystals of feldspar. There is some alteration of the nepheline to cancrinite (M.464).

At the western end of the Little Dromedary a similar coarse-grained variety contains rather less ferromagnesian mineral. The microslide shows the presence of albitized orthoclase, anorthoclase, and plagioclase; quartz is absent. Small amounts of hornblende, biotite, sphene, iron ore and apatite are present.

One specimen shows a vein containing radiating zeolite, and drusy cavities lined with idiomorphic feldspar crystals.

Galena has been reported from this locality and probably occurs in small quantity in these drusy cavities as last products of consolidation of the magma.

The outcrop of porphyritic monzonite in portions 219, 69 and 328, north of the Little Dromedary, is in most places so weathered that it has been quarried as "Granite Gravel" for road-making purposes. The solid rock shows phenocrysts of orthoclase, two centimetres in length, and not quite so abundant as in the Mountain monzonite. These are set in a fine-grained, light-coloured groundmass of aplitic appearance, and consisting of quartz, orthoclase, plagioclase, and chloritic material, the latter evidently being the remains of ferromagnesian minerals. It is probable that this rock was originally a more acid type than the other porphyritic varieties.

The Montague Island syenite is almost indistinguishable from the porphyritic monzonite outcropping on Mount Dromedary. Close examination shows that deuteric processes have been more active, resulting in the alteration of some of the essential minerals and in the production of certain accessory minerals. This is indicated in the handspecimen by the dull greenish-grey colour of the hornblende. Monzonitic fabric with lustre-mottling is well developed. As in the related types on the mainland, the large phenocrysts consist of simply twinned crystals of orthoclase; smaller crystals of oligoclase-andesine, of composition $Ab_{70}An_{30}$, included in the orthoclase produce monzonitic fabric in the rock. Colourless pyroxene, brown biotite, sphene, apatite and iron ore occur as inclusions in the orthoclase. The interstitial material of the groundmass includes a fibrous variety of green hornblende developed from colourless augite, and the hornblende in turn alters to green epidote. In some instances the interstices between the feldspar crystals are filled or partly filled by calcite, with small acicular crystals of epidote, set in a final residuum of quartz or calcite. The orthoclase contains a fair proportion of myrmekite-perthite (Sederholm, 1916, p. 134) and is partly replaced by calcite.

TABLE 2.

	I	Ia	II	III
SiO ₂	59.44	0.991	61.65	54.90
Al ₂ O ₃	19.58	0.192	15.07	17.44
Fe ₂ O ₃	0.31	0.002	2.03	} 9.64
FeO	3.91	0.054	2.25	
MgO	1.27	0.032	3.67	3.26
CaO	3.95	0.070	4.61	6.96
Na ₂ O	3.21	0.052	4.35	3.50
K ₂ O	6.60	0.070	4.50	3.51
H ₂ O +	0.88		0.41	} 1.23
H ₂ O -	0.12		0.26	
TiO ₂	0.54	0.007	0.56	0.71
P ₂ O ₅	0.07	0.001	0.33	0.51
MnO	0.07	0.001	0.09	0.46
SrO	—		0.10	
BaO	—		0.27	
CO ₂	0.49	0.011		
Cr ₂ O ₃	—		tr.	
Li ₂ O	—		tr.	
Total	100.44		100.15	
Sp. Gr.	2.679			

TABLE 2a.

	I	II
Quartz	4.74	6.60
Orthoclase	38.92	26.69
Albite	27.25	36.68
Anorthite	15.57	8.34
Corundum	1.43	
Diopside	—	10.10
Hypersthene	9.27	6.02
Magnetite	0.46	3.02
Ilmenite	1.06	1.06
Apatite	0.34	0.67
Calcite	0.10	

I. Porphyritic Monzonite [Pulaskose, (Monzonose) I(II), 5, 2, 3]. M.517. Eastern slope of Mount Dromedary, N.S.W., Tilba Tilba Track, 500 feet above sea-level. Analyst, I.A.B.

Ia. Molecular numbers for I.

II. Syenite [Monzonose, II, "5, 2, 3"]. Yogo Peak, Little Belt Mountains, Montana. Anal., W. F. Hillebrand. *Ann. Rept. U.S.G.S.*, No. xx, 1900, L. V. Pirsson, p. 473. Norm in Washington's Tables, p. 433.

III. Average Monzonite. W. C. Brögger. *Die Eruptivgesteine des Kristianiagebietes*, II, p. 51.

The analysis given in Column I of Table 2 is that of the coarse porphyritic monzonite on the eastern slope of Mount Dromedary. On account of the presence

of numerous large phenocrysts of orthoclase, a specimen weighing 600 grammes was sampled as in ore treatment, and divided several times before final grinding, in order to obtain as accurately as possible the average composition of this rock-type. It is considered that the phenocrysts form an essential part of the rock and are not of intratelluric origin, so no attempt was made to separate them from the groundmass.

The analysis is that of a monzonitic rock, with a silica percentage less than that required for banatite, and therefore an acid monzonite. Comparison with the analysis of Brøgger's average monzonite shows that the Mount Dromedary rock is a more acid type, which has lower percentages of iron, magnesia, and lime, and higher percentages of alkalis, evidently corresponding to less ferromagnesian and greater felspathic content in the rock compared with the average type. The higher potash percentage may be correlated with the phenocrysts of orthoclase. In the norm there is nearly 40 per cent. of orthoclase and even more plagioclase: in the mode there appears to be rather less plagioclase, its place being taken by pyroxene, containing lime, alkalis and alumina.

According to the C.I.P.W. classification the rock falls into the subrang Pulaskose, I(II), 5, 2, 3, being slightly more salic than Monzonose, II, 5, 2, 3.

The analysis quoted in Column II is that of another of the rocks from Yogo Peak, whose field relations to other members of that series, granite-porphry and monzonite, are similar to those of the Tilba rock, and whose composition is close to that of the porphyritic monzonite.

3. Coarse even-grained Monzonite.

Outcrops of this type occur round the flanks of the main Mountain and are particularly well exposed in the quarry near the A.B.C. Factory at Central Tilba, on the road to Wagonga, and in the cuttings for the main road between Central Tilba and Tilba Tilba villages. It also occurs in the low headland on the western side of Tilba Tilba Lake, Portion 39, Parish of Narooma. Naturally there are variations in the rock, both in grainsize and in the body-colour, depending on the field-relationships and mineral associations of the rock. Thus it is usually more finely-crystalline near the margin of the intrusion, where in some places it is actually in contact with the invaded sediments. There are two principal varieties of the coarse, even-grained monzonite, known locally and commercially as "grey granite" and "black granite". The field relations between these two varieties are obscure, and under the microscope there is little by which to distinguish them. Both types have been quarried as ornamental building-stones.

The "grey granite" in the handspecimen has a mottled black and white appearance, the light and dark coloured minerals being present in approximately equal proportions. The grainsize is even, the general effect being that of a rock whose absolute grainsize is about 3 to 4 millimetres. The minerals noticeable are plates of black biotite, between 1 and 2 centimetres in diameter, and crystals of feldspar 2 or more centimetres in length, with smaller grains of dull, black ferromagnesian mineral; no quartz is visible. The large plates of biotite and feldspar show a peculiar lustre-mottling on the cleavage surfaces, due to poikilitic inclusions of each other and of the other constituents, which accounts for the deceptive appearance of smaller absolute grainsize than is actually the case.

The "black granite" differs from the "grey granite" chiefly in the general body-colour of the rock; the same minerals are present, the grainsize may be slightly greater, but the feldspars have a dark appearance, an optical effect possibly

due to the mutual arrangement of the constituent minerals. A specimen in the Museum of the Geology Department of the University of Sydney, in the Osann Collection, of monzonite from Mt. Mulatto, Tyrol, is of similar texture, but the absolute grainsize is less.

Under the microscope the grey monzonite shows typical monzonitic fabric, large plates of orthoclase enclosing optically independent grains of plagioclase and other minerals (Plate xxxviii, fig. 3).

The minerals present include orthoclase, plagioclase, biotite, augite, hornblende, apatite, sphene, and iron ore, with some decomposition products.

The orthoclase occurs as large plates which are allotriomorphic, and enclose all the other minerals, thus appearing to have been the last mineral to have crystallized out. Twinning on the Carlsbad law sometimes takes place, and there may be marginal kaolinization. From one-third to one-half of the orthoclase occurs in myrmekite-like intergrowth with rods of a colourless mineral; these rods are so extremely fine that it is difficult to determine the exact character of the mineral. The refractive index is slightly greater than that of orthoclase, and the double refraction is weak: in a few instances larger sections of the rods show multiple twinning like plagioclase, but no more exact determination seems possible. A similar intergrowth appears in sections of the monzonite from Monte Mulatto, Tyrol, and in both cases a peculiar blue opalescence of the feldspars in the handspecimens is intimately related to the occurrence of this intergrowth.

The intergrowth (Pl. xxxviii, fig. 2) is not typical myrmekite, which, according to Sederholm's definition (1916, p. 134), "is an intergrowth of plagioclase and vermicular quartz". The appearance is similar to his figure 41, Plate vii, a photograph of a quartz-gabbro from Neder-Torneå, Finland, showing "potash-feldspar containing vermicular plagioclase and small drop-like inclusions of the same mineral" described by him (pp. 126 and 134) as myrmekite-perthite.

In the Mount Dromedary rock there seems no reason for supposing that the intergrowth is other than a primary structure, "formed in continuation of the crystallisation processes of the original magma of the rock" (Sederholm, p. 127), and in this case it is not a subsequent effect of contact metamorphism, which may be the cause in other instances, of myrmekitic structures.

Furthermore, there is no evidence of a replacement of plagioclase by the myrmekite-perthite, which occurs in rounded and irregular grains in exactly the same way as orthoclase, while the plagioclase retains its idiomorphic boundaries towards the potash feldspars (Pl. xxxviii, fig. 3).

Plagioclase is present as idiomorphic crystals varying in length from 1 to 5 millimetres, and is included in both potash-feldspar and biotite. The refractive index is greater than that of Canada Balsam. Twinning occurs after albite, Carlsbad and pericline laws, occasionally with interpenetration twinning. Zoning is only slightly developed. It is andesine of composition $Ab_{60}An_{40}$ to $Ab_{65}An_{35}$.

No quartz has been noticed in the "grey granite".

Biotite occurs as large tabular flakes, yellowish-brown in thin section, and strongly pleochroic. It has inclusions of iron ore, apatite, augite, green hornblende, and plagioclase.

The monoclinic pyroxene, while appearing as a dull-black mineral in the handspecimen, has only a pale greenish-grey colour in thin section. It occurs as idiomorphic to subidiomorphic crystals about one millimetre or less in length, with well-developed cleavage, and sometimes shows simple twinning. In many instances it shows marginal alteration to green hornblende, which has continued crystal-

lizing after the augite and produced also independent idiomorphic crystals. This hornblende has a bright-green colour in thin section and is pleochroic from green to yellowish-green, the variety common in syenites.

Sphene is scarce, but occurs as small irregular grains. Iron ore, chiefly ilmenite, and apatite are present as small grains.

The dark variety of the coarse even-grained monzonite, known commercially as "black granite" shows greater differences from the "grey granite" in the hand-specimen than it does in thin section.

It shows similar monzonitic fabric and contains all the minerals previously described as occurring in the grey variety. Determinations of the composition of the plagioclase show that it is consistently more basic than in the lighter coloured rock, ranging from labradorite $Ab_{47}An_{53}$ to andesine, $Ab_{60}An_{40}$. In addition, a small quantity of quartz is usually present.

The chemical analysis of the light-coloured monzonite is stated in Column I of Table 3. In all respects it is that of a typical monzonite, and is closely comparable with the monzonite of Monzoni, Tyrol, whose analysis, as given by Brøgger, is quoted in Column II.

TABLE 3.

	I	Ia	II	III	IV	V
SiO ₂	51.09	0.851	54.20	53.90	54.42	51.00
Al ₂ O ₃	16.11	0.158	15.73	15.32	14.28	17.21
Fe ₂ O ₃	3.11	0.019	3.67	3.60	3.32	2.41
FeO	6.58	0.092	5.40	5.13	4.13	4.23
MgO	4.69	0.117	3.40	2.41	6.12	6.19
CaO	9.10	0.163	8.50	7.30	7.72	9.15
Na ₂ O	3.29	0.053	3.07	3.73	3.44	2.88
K ₂ O	3.94	0.042	4.42	3.44	4.22	4.93
H ₂ O+	0.66		} 0.50 {	0.97	0.22	} 0.63
H ₂ O-	0.10			0.74	0.38	
TiO ₂	1.02	0.013	0.40	2.86	0.80	0.13
P ₂ O ₅	0.77	0.006	0.50	0.55	0.59	0.33
MnO	0.18	0.003	0.70	0.36	0.10	tr.
ZrO ₂				abs.		
SrO				tr.	0.13	0.14
BaO	abs.			0.06	0.32	0.34
CO ₂	abs.			0.03		
SO ₃				abs.		0.03
S				abs.		
Cr ₂ O ₃				abs.		
NiO, CoO				0.02		
Cl				0.02	tr.	tr.
F				abs.		
Li ₂ O				pr.	tr.	
V ₂ O ₅				0.02		
CuO				0.01		
Total	100.64		100.49	100.47	100.19	99.60
Sp. Gr.	2.871			2.779		

TABLE 3a.

	I	II	III	IV	V
Quartz.. .. .	—		4.44		
Orthoclase	23.35	26.1	20.02	25.02	23.91
Albite	20.44	26.2	31.44	28.82	9.96
Anorthite	17.51	15.8	15.01	11.12	19.46
Nepheline	3.98	—	—	—	7.95
Diopside	18.18	18.4	14.09	18.81	19.40
Hypersthene	—	3.3	1.50	1.80	—
Olivine.. .. .	8.12	2.8	—	5.98	8.29
Magnetite	4.41	5.3	5.34	4.87	3.48
Ilmenite	1.98	0.8	5.47	1.52	0.15
Apatite	2.02	1.3	1.34	1.34	0.67
Remainder		0.2			1.14

I. Coarse Monzonite ("Grey Granite"). [Shoshonose (Monzonose) II(III), 5, (2)3, 3]. Quarry, Central Tilba, N.S.W. Anal. I.A.B.

Ia. Molecular numbers for I.

II. Monzonite (Monzonose II', 5, 2', 3). Monzoni, Tyrol. Anal. V. Schmelk. W. C. Brögger, *Die Eruptivgesteine des Kristianiagebietes*, II, 1895, p. 24. Norm from Iddings, 1909, Vol. II, p. 209.

III. Monzonite-porphyr (Yogoite) [Shoshonose. II, "5, (2)3, 3(4)]. 2½ miles north of Milton, N.S.W. Anal. H. P. White. *Rec. Geol. Surv. N.S.W.*, VIII, 1905, 85. Norm in W.T., p. 479.

IV. Monzonite (Yogoite) [Monzonose, II(III), 5, 2, 3]. Yogo Peak, Little Belt Mountains, Montana. Anal. W. F. Hillebrand. *Ann. Rept. U.S.G.S.*, xx, 1900, p. 478. Also in W.T., p. 433.

V. Monzonite (Shoshonose, II, 5, 3, 3). Highwood Peak, Montana. Anal. E. B. Hurlburt. *U.S.G.S. Bull.* No. 237, 1905, pp. 79, 81.

The occurrence of hypabyssal monzonitic rocks at Milton, about 100 miles north of Mount Dromedary, has been described by G. W. Card (1905, 1915) and the writer (1925). These rocks have a chemical composition remarkably close to that of the Mt. Dromedary monzonite, and for comparison the analysis of one of the Milton rocks is given in Column III. It is probable that the analysis in Column I represents approximately the average composition of the magma from which the variety of rock-types in the Mt. Dromedary intrusion was derived. It is of special interest that this rock is chemically similar, not only to the Milton series, but also to the series of flows interbedded in the Permo-Carboniferous sediments of the Illawarra District, a fact which is surely more than a coincidence, and which will be discussed in more detail later.

The analyses quoted in columns IV and V are of similar rocks in the two series in Montana, which in general may be compared with the Mt. Dromedary series.

The norms of both the Tilba and Highwood Peak rocks contain nepheline and olivine, indicating undersaturation in silica, although these normative minerals do not occur in the mode in either case. The "Yogoite" contains some normative olivine, and normative quartz occurs in the Milton rock.

Finer-grained monzonites of the same general character occur near the margin of the intrusion surrounding the main Mountain, and are represented by specimens

from the north-eastern, southern and western flanks of the Mountain: to the east there is a series of specially differentiated types.

These monzonites differ chiefly in the fineness of their grainsize, which averages less than one millimetre. The monzonitic fabric is generally not so conspicuous as in the coarser types, although the same minerals are present in similar proportions. Usually there is a small amount of quartz present.

A peculiar variation of the rock is developed at Grassy Knob, on the main road between Tilba Tilba and Cobargo, 5 miles from the village of Tilba Tilba. The outcrop is shown on Anderson's map (1892) as an apophysis from the Mt. Dromedary intrusion. On account of the rough nature of the country and the dense vegetation here the writer has been unable to confirm the continuity of this outcrop with the main intrusion. The rock is unlike any other in the district, although doubtless it is related petrologically to the monzonitic series. It has a dioritic appearance in the handspecimen, being holocrystalline and fine-grained; the average grainsize is less than one millimetre. It appears to contain equal proportions of light and dark constituents, the latter being black biotite and dark-green glassy pyroxene crystals, about 5 mm. in length.

Under the microscope the rock is seen to be somewhat altered; it is holocrystalline, with variable grainsize and monzonitic fabric. It consists of orthoclase, plagioclase, augite, biotite, apatite, sphene, and iron ore. Secondary products include kaolin, epidote, chlorite, and interstitial calcite. Unlike all other types of this series, the rock contains only a very small amount of hornblende.

The orthoclase occurs as small plates enclosing idiomorphic plagioclase crystals, and is usually covered with kaolin. The plagioclase is labradorite of the composition $Ab_{40}An_{60}$.

The pyroxene occurs as idiomorphic crystals and irregular grains, almost colourless in the centre of a large crystal, and darker greenish-grey near the margin; it frequently shows multiple twinning and alteration to greenish chloritic material, or more rarely to greenish hornblende.

Biotite occurs as ragged flakes, containing poikilitic inclusions of all the other minerals. It is yellowish-brown in thin section, appearing somewhat bleached, and showing anomalous interference colours. Alteration to epidote occurs in lenticular areas along the cleavage surfaces. Apatite, sphene, and iron ore occur as small irregular grains.

4. Olivine-Monzonite.

Another marginal phase of the Dromedary mass outcrops two and a half miles from Tilba Tilba on the road to Cobargo, as a typical olivine-monzonite.

The rock is remarkably fresh. In the handspecimen it has a doleritic appearance, the dark minerals predominating. The average grainsize is a little more than one millimetre. The minerals visible macroscopically are prismatic augite, felspar and biotite.

Under the microscope (Pl. xxxviii, fig. 4) the rock is seen to be holocrystalline, the grainsize slightly variable, the average being about one millimetre, and the fabric is monzonitic. The minerals include both plagioclase and orthoclase, augite, olivine, biotite, sphene, apatite, and iron ore.

The plagioclase occurs as abundant idiomorphic, prismatic crystals, which show slight zoning, and twinning after Carlsbad, albite and pericline laws. They consist of andesine of the composition $Ab_{65}An_{35}$, and are set in a monzonitic fashion in allotriomorphic plates of orthoclase several millimetres in diameter.

The augite occurs as idiomorphic crystals up to 4 or 5 millimetres in length, thus appearing as small phenocrysts in thin section, or as groups of crystals producing local glomeroporphyritic texture. It is pale-green or greenish-grey in colour, sometimes showing slight colour-zoning, with well-developed prismatic

TABLE 4.

	I	I _a	II	III
SiO ₂	51.14	0.852	50.35	52.09
Al ₂ O ₃	16.91	0.166	15.76	11.93
Fe ₂ O ₃	1.34	0.008	2.32	1.84
FeO	7.27	0.101	7.30	7.11
MgO	5.88	0.147	7.40	12.48
CaO	9.68	0.173	10.12	7.84
Na ₂ O	1.92	0.031	2.75	2.04
K ₂ O	3.32	0.035	3.89	3.01
H ₂ O +	0.54	—	} 0.45	0.35
H ₂ O -	0.20	—		
TiO ₂	0.92	0.011	0.30	0.73
P ₂ O ₅	0.53	0.004	0.39	0.34
MnO	0.14	0.002	0.35	0.15
CO ₂				0.16
Cr ₂ O ₃				0.10
NiO, CoO				0.07
Cl				tr.
Total	99.79		101.38	100.24
Sp. Gr.	3.017			2.94

TABLE 4a.

	I	II	III
Orthoclase	19.46	22.8	17.79
Albite	16.24	11.0	17.29
Anorthite	27.80	18.3	14.46
Nepheline	—	6.5	—
Diopside	13.66	23.6	18.04
Hypersthene	11.28	—	12.04
Olivine	5.70	13.1	15.14
Magnetite	1.86	3.5	2.78
Ilmenite	1.67	0.6	1.37
Apatite	1.34	1.0	0.67

I. Olivine-Monzonite [Shoshonose, (Kentallenose) II(III), 5, 3(4), 3]. Two and a half miles from Tilba Tilba towards Cobargo, N.S.W. Anal. I.A.B.

I_a. Molecular numbers for I.

II. Olivine-Monzonite (? Kentallenose, 'III, 5', 3, 3). Smålingen, Sweden. Anal. V. Schmelck. W. C. Brøgger, Die Eruptivgesteine des Kristianiagebietes, II, 1895, pp. 46, 50. Norm quoted from Iddings, Vol. ii, p. 221. Also in W.T., p. 1003.

III. Kentallenite (Kentallenose, III, 5, 3, 3). Glen Shira, Argyllshire, Scotland. W. Pollard, Anal. Hill and Kynaston, Q.J.G.S., Vol. 56, 1900, p. 537. In W.T., p. 603.

cleavage and high extinction angle. Occasionally there is extremely weak pleochroism, but the extinction is always oblique, so that no rhombic pyroxene appears to be present. Twinning is common. The mineral is remarkably fresh, and shows no trace of alteration to amphibole, such as is frequent in other members of the series.

Olivine is fairly abundant as subidiomorphic grains up to one and a half millimetres in length, often quite unaltered; it may show irregular cracks along which alteration is taking place to green serpentinous material.

Biotite is not very conspicuous in thin section, as it contains numerous poikilitic inclusions, and appears as irregular interstitial grains, which are optically continuous over areas of several square millimetres. Sphene is scarce, apatite occurs as numerous small crystals, often acicular and included in plagioclase; iron ore is present as rounded grains and as a secondary product of olivine.

The order of consolidation appears to be approximately as follows: the minor constituents, apatite, sphene, and iron ore first, followed by the crystallization of olivine, augite, and plagioclase, then biotite and orthoclase forming a final mesostasis.

A chemical analysis of this rock given in Column I of Table 4 shows that it is a typical olivine-monzonite according to the definition of Brøgger, who gives the analysis, quoted in Column II, of an olivine-monzonite from Sweden; the latter is not a first class analysis, the figures for the alkalis apparently being accepted from a previous analysis (Brøgger, II, p. 63), and appearing to be somewhat high.

The analysis of a distinct, although related type, the kentallenite of Argyllshire, is quoted in Column III.

The three analyses are comparable so far as silica and alkalis are concerned, but differ in the relative proportions of alumina, magnesia and lime: the olivine-monzonites from Tilba and Sweden are very similar, but contain about 5 per cent. more alumina and a correspondingly smaller amount of magnesia than the kentallenite. This difference of chemical composition is expressed mineralogically by a greater proportion of felspar in the olivine-monzonite and an increase of olivine and augite in the kentallenite.

Thus the two rock types are not identical, as is sometimes erroneously stated (Hatch, p. 206), although they are related to one another and also to the shonkinite group, as pointed out by Hill and Kynaston (1900).

5. Olivine-Shonkinite.

Another interesting differentiation product of the Dromedary magma forms a small hill on which the village of Tilba Tilba is situated, in the "saddle" between Mount Dromedary and the Little Dromedary. It covers less than 40 acres in area, and is bounded on the west and north by medium-grained monzonites, on the south by a lamprophyric member of the complex, and on the east by the Tilba Tilba Swamp; unfortunately alluvium and soil totally obscure its contact with these rocks.

The rock is black, holocrystalline, medium-grained and rather heavy; some variation in the composition of the rock evidently occurs, but is difficult to observe in the handspecimen, which appears to consist of pyroxene, some black mica showing lustre-mottling, and a felspar sometimes exhibiting blue opalescence.

Under the microscope (Plate xxxviii, fig. 5) the rock is holocrystalline, with gabbroic fabric; the average grainsize is 1 to 2 millimetres. Different thin

sections, even of the same handspecimen, show slight mineralogical variations, but the rock appears to consist essentially of about equal proportions of augite and orthoclase, with small quantities of biotite and olivine, and accessory apatite and iron ore. Some sections show, in addition, one or more of the following minerals: nepheline, anorthoclase, microcline, and plagioclase, which, however, are not present in sufficient quantity seriously to affect the composition of the rock.

The pyroxene is a greenish-grey variety of diopside, whose form is idiomorphic to subidiomorphic, the crystals being from 1 to 3 millimetres in length. It frequently shows simple twinning and basal salite striation is particularly well developed. The pyroxene constitutes about 40 per cent. of the rock.

Olivine is fairly abundant as crystals up to a millimetre in length. It is clear and colourless, and shows characteristic decomposition along cracks; it has crystallized before the pyroxene.

Brown mica occurs as irregular grains which are optically continuous over distances of about 3 centimetres, but which enclose grains of olivine, diopside, and the minor accessory minerals in a poikilitic fashion. It is a brown, strongly pleochroic variety, possibly lepidomelane.

The orthoclase is the most important light mineral present, and occurs as allotriomorphic grains which enclose all the other minerals. In reflected light it may show blue opalescence, in grains which are quite clear and transparent in transmitted light: the effect is possibly due to ultramicroscopic inclusions. From the chemical analysis of the rock it seems probable that the soda-molecule is present to some extent in the orthoclase, and in one rock section typical anorthoclase has been identified. A few grains of microcline also occur and plagioclase may be present in some instances; it is labradorite at least as basic as $Ab_{45}An_{55}$, and shows albite, Carlsbad and pericline twinning, and may also show zoning. A small amount of nepheline has also been detected.

Apatite occurs as well-formed crystals somewhat larger than usual, and iron ore as irregular grains.

The chemical analysis of a specimen of shonkinite from Tilba Tilba village is given in Column I of Table 5.

The analysis is peculiar, but remarkably like that of the average shonkinite as given by L. V. Pirsson (1900), which is quoted for comparison in Column II. Combined with a low silica percentage the alkalis, particularly potash, are high; lime, magnesia and iron are also high, while alumina is low. The norm indicates less orthoclase than is present in the mode, where probably the soda molecule combines to form soda-orthoclase; there is less plagioclase actually present than shown in the norm, so that probably the pyroxene contains some alumina, as does also the mica, lepidomelane, the presence of which may account for the high percentage of ferric oxide.

By comparison with the analyses quoted in the other columns, it is apparent that the Tilba rock is a typical shonkinite, a somewhat rare type, and one which is found only in association with monzonitic or alkaline rocks. It occurs in the Montana region (L. V. Pirsson, 1900-1905), in the Bearpaw, Highwood, Little Belt and Crazy Mountains; in Celebes and Borneo (Iddings, 1915), and in a few other localities.

According to the C.I.P.W. classification the Tilba Tilba rock falls into the subrang Kentallenose, and its relation to the olivine-monzonite and kentallenite may be seen by reference to the analyses in Table 4. In the shonkinite the

TABLE 5.

	I	Ia	II	III	IV
SiO ₂	48·34	0·806	48·90	46·73	43·98
Al ₂ O ₃	11·79	0·116	11·07	10·05	12·28
Fe ₂ O ₃	2·31	0·014	3·32	3·53	3·49
FeO	7·72	0·107	6·33	8·20	7·70
MgO	9·59	0·240	9·06	9·27	8·00
CaO	12·76	0·228	11·59	13·22	11·19
Na ₂ O	1·60	0·026	2·15	1·81	1·33
K ₂ O	3·17	0·034	4·55	3·76	5·06
H ₂ O+	0·68	—	} 1·13	} 1·24	1·61
H ₂ O-	0·04	—			0·12
TiO ₂	0·88	0·011	0·98	0·78	2·24
P ₂ O ₅	0·87	0·006	1·10	1·51	1·81
MnO	0·15	0·002		0·28	0·51
SrO				?	0·12
BaO				?	0·16
CO ₂	pr.				
S					0·10
Cl				0·18	0·12
F					0·15
Total	99·90		100·18	100·56	99·97
Sp. Gr. . . .	3·085				

TABLE 5a.

	I	II	III	IV
Orthoclase	18·90		22·24	23·63
Albite	6·29		1·05	—
Anorthite	15·57		8·06	12·51
Leucite	—		—	5·01
Nepheline	3·98		7·95	5·96
Diopside	34·08		38·19	25·05
Olivine	13·48		11·54	11·82
Magnetite	3·25		5·10	5·10
Ilmenite	1·67		1·67	4·26
Apatite	2·02		3·70	4·37

I. Shonkinite [Kentallenose, III, 5(6), 3, 3]. Tilba Tilba village, N.S.W. Anal. I.A.B.

Ia. Molecular numbers for I.

II. Typical Shonkinite. Average of three analyses of shonkinites from Montana, L. V. Pirsson, Petrography of the Little Belt Mountains, Montana. *Ann. Rept. U.S.G.S.*, xx, 1900, p. 484.

III. Shonkinite [Shonkinose, III(IV), 6, 2, "3]. Square Butte, Highwood Mountains, Montana. L. V. Pirsson Anal. *Bull. U.S.G.S.*, No. 237, 1905, p. 102. Norm in W.T., p. 671.

IV. Marosite (Shonkinite) [Ottajanose, III, 6, (2)3, 2]. Celebes, Anal. E. W. Morley. Iddings and Morley, *Journ. Geol.*, xxiii, 1915, p. 240. Norm in W.T., p. 677.

percentage of lime is greater than that of magnesia, whereas in the kentallenite the magnesia is less than the lime; both differ from the olivine-monzonite in containing about 5 per cent. less alumina, with a corresponding increase in the total magnesia and lime. These relations are expressed mineralogically by the greater relative proportion of feldspars over ferromagnesian minerals in the olivine-monzonite; of ferromagnesian over feldspar in the kentallenite; and of orthoclase over plagioclase in the shonkinite.

6. Nepheline-Monzonite and Shonkinite.

Below the porphyritic monzonite outcropping on the top of the Little Dromedary, there occurs a most interesting series of nepheline-bearing rocks, related mineralogically to the monzonite, shonkinite and ijolite on the one hand, and to the garnet-bearing pyroxenite and jacupirangite on the other.

They include the rocks described by Anderson (1892, p. 148) as "augite granite", and quoted as such by Harker (1923, p. 37), but their true mineralogical and chemical composition places them quite outside the granite family. These rocks are light-grey in colour, and as they apparently consist of about equal proportions of white and black minerals, they might be called mesocratic; they are usually more finely crystalline than the normal monzonites, the grain size is even, the absolute value always being less than 5 millimetres.

The minerals macroscopically visible include feldspars, both orthoclase and plagioclase, nepheline and pyroxene. In general the lighter-coloured rocks containing most abundant orthoclase occur at higher levels on the hill-slope than the more melanocratic phases containing a greater relative proportion of feldspathoid. In view of the fact that the specific gravity of nepheline (average 2.6) is somewhat greater than that of orthoclase (2.55), and that the relative proportion of pyroxene also increases downwards, the distribution of these minerals suggests gravity differentiation in place.

Under the microscope the rocks are seen to be holocrystalline, even-grained, the average being from 1 to 4 or 5 millimetres in different specimens. The texture is hypidiomorphic granular, with a strong tendency to poikilitic or monzonitic fabric.

The minerals include orthoclase, plagioclase and nepheline in varying proportions; colourless and green pyroxene and a much smaller amount of greenish-brown amphibole; olivine and biotite are typically absent, but appear in a few abnormal types. Accessory minerals which may be present include sphene, apatite, iron ore, garnet (melanite), sodalite, analcite (?), cancrinite, calcite, and zeolite; some kaolin also occurs as an alteration product of orthoclase.

Variation in the proportions of felsic and mafic minerals, and of feldspars and feldspathoid, has produced a rock series ranging from nepheline-syenite or monzonite to a variety of nepheline-shonkinite, corresponding to Washington's (1901) "covite" or basic foyaite (Pl. xxxviii, fig. 6). Intermediate varieties show affinities to theralite (Monte Mulatto), essexite (Salem) and similar types.

Orthoclase is present throughout the whole series, and is usually more abundant in the rocks outcropping on the upper slopes of the Little Dromedary. It occurs in allotriomorphic grains, 2 or 3 mm. in diameter, and encloses previously formed minerals in a poikilitic or monzonitic manner; it comprises about 20 per cent. of the rock as a rule, and on the whole is remarkably free from alteration; in some cases deuteric albitization has taken place.

Plagioclase is generally subordinate in amount to the orthoclase, forming subidiomorphic crystals less than 1 mm. in length. It is andesine of composition $Ab_{60}An_{35}$ to $Ab_{60}An_{40}$.

Nepheline resembles orthoclase in its general mode of occurrence as large allotriomorphic plates enclosing other minerals. Usually it has been the last of the essential minerals to crystallize, but may occur in graphic intergrowth with orthoclase, from which it may be distinguished by its refractive index and double refraction. In ordinary light, owing to slight decomposition, it shows a dusty appearance in streaks parallel to the direction of cleavage, and has straight extinction. It is uniaxial and negative in convergent light. Occasionally there is slight alteration to cancrinite, with its bright interference colours and uniaxial negative interference figure, and less frequently to a colourless or yellow radiating zeolite, resembling hydropnephelite.

Two distinct varieties of pyroxene are present, both monoclinic, and differing chiefly in colour. The variety which evidently crystallized first is colourless or greenish-grey in thin section, and forms the cores of larger subidiomorphic crystals, which are from 2 to 5 millimetres in diameter. This pale-coloured variety merges into a darker green variety at the borders of the larger crystals, and the latter variety, which is probably sodic, also forms abundant individual crystals. The effect of the obvious change of chemical composition is shown not only by colour zoning, but also by a variation in the value of the extinction angle. Numerous tiny inclusions may occur in the outer zone of the green pyroxene. Simple twinning is well-developed.

Frequently the pyroxene is surrounded by a rim of greenish-brown hornblende, in crystallographic continuity with the enclosed pyroxene. It is difficult to determine whether or not the small patches of amphibole apparently included in the pyroxene are due merely to sections along an irregular surface of the ferromagnesian mineral; there is always a close association of the various ferromagnesian minerals, and rarely does the amphibole form entire individual crystals, although it constitutes up to 10 per cent. of the rock. The amphibole is strongly pleochroic, and the typical cleavage is well developed. One section includes a bluish-green amphibole, probably a sodic variety.

Small amounts of colourless olivine occur in a couple of sections. It is biaxial and negative, with reddish decomposition product, and is probably fayalite, or an iron-rich variety of olivine that is not uncommon in nepheline-syenites.

In both the rocks containing fayalite there is a development of reddish-brown mica, which is not typical of the normal nepheline-monzonite. The mica is probably lepidomelane.

Of the minerals termed accessory, none appears to play an important part in the rock, and the total amount in any specimen rarely exceeds about five per cent.

Small amounts of a pale-coloured variety of sphene occur as irregular grains; apatite is not conspicuous, and there is little iron ore.

The most constant accessory minerals, partly secondary, are those usually associated with nepheline. Cancrinite occurs not only as flecks through nepheline, but also as definite plates up to a millimetre or more in diameter: these are allotriomorphic and interstitial with respect to the feldspars and nepheline, and have the appearance of a mineral of late primary or deuteric crystallization. In thin section it is colourless, with low refractive index and medium double refraction; it is uniaxial negative.

Zeolite is of fairly common occurrence; sometimes it is interstitial but more frequently it is a replacement of nepheline. It is probable that at least two varieties of zeolite are present, the interstitial variety having the properties of

TABLE 6.

	I	Ia	II	III	IV	V
SiO ₂	46.04	0.767	49.70	46.47	46.99	46.50
Al ₂ O ₃	19.46	0.191	18.45	18.77	17.94	16.48
Fe ₂ O ₃	3.80	0.024	3.39	3.55	2.56	3.80
FeO	6.20	0.086	4.32	4.83	7.56	7.47
MgO	3.74	0.093	2.32	3.90	3.22	3.46
CaO	9.72	0.173	7.91	7.28	7.85	6.14
Na ₂ O	3.49	0.056	5.33	3.73	6.35	4.19
K ₂ O	4.91	0.052	4.95	4.65	2.62	4.54
H ₂ O+	0.69		1.09	4.93	0.65	3.57
H ₂ O-	0.31		0.25	—	—	0.21
CO ₂	abs.		—	0.34	—	0.28
TiO ₂	0.92	0.011	1.33	1.21	2.92	2.40
P ₂ O ₅	0.84	0.006	0.40	0.14	0.94	1.13
MnO	0.23	0.003	tr.	sp.	tr.	0.15
BaO					abs.	0.08
Total	100.35		99.44	99.80	99.60	100.40
Sp. Gr.	2.912				2.919	2.765

TABLE 6a.

	I	II	III	IV	V
Orthoclase	28.91	29.47		15.57	26.7
Albite	1.05	11.00		18.86	18.3
Anorthite	23.07	11.68		12.79	12.8
Nepheline	15.34	18.46		18.74	9.4
Diopside	15.95	17.98		16.24	8.8
Olivine	6.29	—		5.31	7.0
Wollastonite	—	1.04		—	—
Magnetite	5.57	4.87		3.71	6.0
Ilmenite	1.67	2.58		5.32	4.5
Apatite	2.02	1.01		2.35	2.7

I. Covite (Nepheline-shonkinite), (*cf.* Borolanose, II", 6, "3, 3). East of the Little Dromedary, near Central Tilba, N.S.W., Por. 185, Parish of Narooma. Anal. I.A.B.

Ia. Molecular numbers for I.

II. Covite (Shonkinite), [Borolanose, II, 6, 2, 3(4)]. Schoolhouse, Magnet Cove, Arkansas. Anal. H. S. Washington. *Journ. Geol.*, ix, 1901, p. 612. In W.T., p. 565.

III. Theralite. Val dei Coccoletti, Monte Mulatto, Predazzo. Anal. M. Dittrich. J. Romberg, *Sitz. Akad. Wiss. Berlin*, i, 1902, p. 743. In W.T., p. 910. Altered rock, no norm allotted.

IV. Essexite (Essexose, II", 6, 2, 4). Salem Neck, Essex County, Mass. Anal. H. S. Washington. *Journ. Geol.*, vii, 1899, p. 57. In W.T., p. 567.

V. Lamprophyre (— II, 6, 3, 3). 7 miles SE. of Robertson, N.S.W. Anal. H. P. White. *Mem. Geol. Surv. N.S.W.*, Geol. 7, p. 338.

thomsonite, and the commoner variety, replacing nepheline in scaly aggregates, being hydronephelite.

Associated with the zeolites and cancrinite is a colourless, isotropic mineral, which microchemical tests show to be sodalite.

The specimen selected for chemical analysis is representative of the type in which nepheline is relatively abundant, and plagioclase is least evident; it is from the eastern slope of the Little Dromedary, portion 185, parish of Narooma. Although this rock shows certain mineralogical resemblances to the type described above as shonkinite from the village of Tilba Tilba, in the handspecimen it is mesocratic, whereas the shonkinite is decidedly melanocratic.

Nepheline partly takes the place of the orthoclase of the shonkinite, and the principal pyroxene is the green sodic variety, instead of the colourless diopside of the shonkinite.

These mineralogical differences are expressed chemically, as may be seen by a comparison of the statement of the analysis given in Column I, Table 6, with those of the Tilba Tilba and other typical shonkinites given in Table 5. The rocks contain similar percentages of silica and iron oxides, but the shonkinite has higher lime and magnesia, with lower percentages of alumina and alkalis than the rocks under consideration. These facts show that the rocks are distinct types, although mineralogically they may both be considered as varieties of shonkinite.

At Magnet Cove, Arkansas, there is a rock which is remarkably similar to that of the Mount Dromedary District. It was first described by J. F. Williams as a "fine-grained nepheline-syenite", and afterwards analysed by Washington (1900, p. 339). This analysis is quoted in Column II. The rock was then referred to the shonkinite group on account of its general likeness to the rocks so named by Pirsson (1895), but at the same time certain differences were noted. Later, Washington (1901, p. 614) reconsidered the name of the rock, and stated: "For this leucocratic, holocrystalline combination of orthoclase (alkali-felspar) . . . and less nephelite, with hornblende and aegyrite-augite, of granitic structure, and with the composition like that given in the analysis above, I would propose the name Covite."

Comparison of handspecimens and microsections of this rock and that at Mt. Dromedary, as well as of their chemical analyses, show rocks so similar that the adoption of Washington's name covite is considered to be quite justified. It will be shown later that the covite bears a relationship to the main monzonitic series at Mt. Dromedary similar to that found by Washington to occur between the covite and the foyaite-ijolite series at Magnet Cove.

The norms of the two rocks, although differing from their modes, show an extraordinary similarity; it is to be remembered that normative nepheline is assumed to contain soda but no potash, whereas in nature this is not the case; this fact explains the smaller amount of normative nepheline than is present in the mode.

The differences in the lime percentages place the two rocks in adjacent ranges according to the C.I.P.W. classification. The Tilba rock falls into a subrang with a melanite-syenite from Assynt, and with two rocks from Mt. Mouriah, Java, both from alkaline provinces.

It has already been stated that some varieties of the nepheline-bearing rocks of the Little Dromedary may be referred to nepheline-monzonites, and others show affinities to specialized alkaline rock-types; therefore it is not surprising to find that the chemical analysis, even of the covite, should show resemblance to such

rocks described as theralite and essexite, whose analyses are quoted in Columns III and IV. The analysis of the theralite is very close to that of both the covites, and its occurrence in the classic region of monzonitic rocks is of more than passing interest. The analysis is taken from Brenner's paper on the Kola Peninsula (1920), but no detailed descriptions of the other characters of the rock are available to the writer.

The typical essexite from Salem neck, Essex County, Mass., was described by Sears (1891) and later by H. S. Washington (1899, p. 53), whose analysis is quoted in Column IV. It shows a strong general resemblance to the other analyses, the chief difference being in the distribution of the alkalis; as Washington states (p. 57), "The low silica and high lime and alkalis will be noticed, showing the basic monzonitic character of the rock."

He has already noted of the covite (1901, p. 613), "it cannot be put with the essexites or theralites (although chemically closely resembling these) on account of the lack of plagioclase". In the Little Dromedary occurrence some plagioclase-bearing types are associated with the covite, and certain individual specimens might be referred to these groups. Unfortunately considerable confusion exists in petrographic literature with regard to the definition of the names theralite and essexite, the terms frequently being interchanged. The nomenclature has been discussed by several writers, including Iddings (1913, Vol. ii, pp. 231, 246) and Shand (1927, pp. 287-291).

The analysis quoted in Column V is that of a lamprophyre intruding the Hawkesbury Sandstone (Triassic) near Robertson, N.S.W. It is chemically similar to the covite, and falls into the same subrang, but differs in its mineralogical constitution and mode of occurrence.

Gabbro Series.

Dark gabbroic rocks form the coastal platform known locally as Poole's Point, Portion 72, Parish of Narooma, about a mile north of the mouth of Tilba Tilba Lake. Their field-relations to other rocks are partly obscured by sand-dunes, beach-deposits and soil formation. On the northern side they are apparently intrusive into quartz-schists and slates. There are no rock exposures between the coastal cliffs and the Lagoon (see map, Plate xxxv), but a somewhat similar rock outcrops on the western side of Tilba Tilba Lake, in Portion 39, where it is associated with a marginal phase of the coarse-grained monzonite, which is intrusive into slates.

The types considered here are those called by Anderson (1892, p. 158) "augite-felspar-mica rock". He mentions their occurrence on the coast and also in Portion 375, Parish of Wandellow, near Dignam's Creek, on the western side of Mount Dromedary. At the latter locality these basic rocks occur only as inclusions in a mass of lamprophyric rock, which contains also fragments of other members of the monzonitic series. On the southern and particularly the western slopes of the Little Dromedary, Portion 32, Parish of Narooma, fragments of pyroxenite are sometimes included in the nepheline-monzonite. The best exposure is in Portion 32, in a timbered paddock at the head of a small creek running into Tilba Tilba Swamp, where the shattered fragments of pyroxenite appear to be cemented together by the fine-grained monzonite. Boulders several feet in diameter occur on the northern side of Tilba Tilba Swamp.

Macroscopically the rocks are black, heavy, coarsely-grained and gabbroic, and consist essentially of pyroxene; some varieties contain plates of black mica,

which show lustre-mottling, others contain a small amount of felspathic material. These variations are most clearly seen in thin section.

Three chief varieties may be distinguished: 1, Olivine-gabbro or pyroxene-granulite; 2, Biotite-gabbro or essexite; 3, Pyroxenite or jacupirangite.

1. Olivine-gabbro or Pyroxene-granulite.

The handspecimen shows a black, holocrystalline rock, flecked with 5 to 10 per cent. of white felspathic crystals, which are individually less than 1 millimetre in diameter: the rock appears to consist chiefly of pyroxene crystals up to 5 millimetres in length set in a finer-grained groundmass of pyroxene and feldspar.

Under the microscope the mafic minerals predominate only slightly over the felsic; the rock (Pl. xxxix, fig. 1) is holocrystalline, with slightly variable grain-size; the augite crystals are from 0.5 to 5.0 millimetres in diameter and the feldspars rarely exceed 0.5 millimetre in length; thus the fabric tends to become granulitic, with subidiomorphic augite crystals set in a plexus of relatively small subidiomorphic feldspar grains. In addition to augite and plagioclase, there are present olivine, iron ore, apatite and sometimes traces of biotite.

The pyroxene is a colourless or greenish-grey variety of augite, with well-developed cleavage, and sometimes salite striation. It is usually free from alteration products.

The olivine occurs as small rounded grains and as larger idiomorphic crystals; it is colourless, shows characteristic cracking, with only slight alteration along the cracks, and has a biaxial negative interference figure in convergent light, which is characteristic of fayalite or olivine rich in FeO.

The plagioclase is labradorite of the composition $Ab_{10}An_{90}$, and shows twinning after albite, Carlsbad and pericline laws.

Iron ore includes both oxides and sulphide, and is present to the extent of about 10 per cent. of the rock.

2. Essexite or Biotite-gabbro.

A related type occurs on the northern side of Tilba Tilba Swamp, south-west of the Little Dromedary (M667), and as inclusions in the lamprophyric rock exposed in Portion 375, Parish of Wandellow, on the western side of Mount Dromedary.

The rock (Pl. xxxix, fig. 2) has usually a granitic texture, but in one case ophitic fabric is developed. Olivine is not so abundant as in the olivine-gabbro, but its place is taken by strongly pleochroic mica, probably lepidomelane, which makes about 15 to 20 per cent. of the rock, together with traces of orthoclase.

The pyroxene has a slightly darker colour than that of the olivine-gabbro, and resembles that of the olivine-shonkinite and olivine-monzonite previously described. Indeed the essexite and the shonkinite bear a kind of complementary relationship to the olivine-monzonite, in that, although the pyroxenes are similar in all three types, the monzonite contains about equal proportions of labradorite and orthoclase, while orthoclase is the principal feldspar in the shonkinite, and plagioclase is the chief feldspar in the essexite.

No chemical analysis of the rock is available.

The essexite appears to be similar to the fine-grained varieties of Brøgger's (1894) "olivine-gabbro-diabase" of the Christiania district, specimens of which are in the University Collection. In Norway, as at Tilba, "there is not the

slightest trace of the ordinary changes met with in regionally metamorphosed gabbro". Rosenbusch (1906, p. 404) has classified these rocks as "essexite", and this nomenclature is adopted in the case of the Mount Dromedary rocks.

At Brandberget, in the Gran District, Norway, the olivine-gabbro-diabases pass through a basic phase into pyroxenite, and a similar rock-association is developed at Tilba.

3. Pyroxenite or Jacupirangite.

Ultrabasic pyroxenites containing little or no felspar form the rock-platform at Poole's Point, and occur elsewhere as inclusions in the monzonitic series.

The rocks are black, heavy, and usually coarsely crystalline. They consist essentially of pyroxene with small amounts of biotite and felspar. Thin sections (Pl. xxxix, fig. 3) show the rocks to be holocrystalline; the grain-size is even and medium. The texture is hypidiomorphic granular. Augite constitutes almost 90 per cent. of the rock; small amounts of olivine and reddish-brown mica are usually present, and iron ore and apatite occur as accessories; a greenish-brown variety of hornblende may be present to the extent of about 5 per cent., and plagioclase may occur in like quantity.

The pyroxene is a monoclinic variety, and is of a greenish-grey colour, with slight pleochroism. Cleavage is well developed, salite striation is present and simple twinning also occurs.

The hornblende, if present, may form individual crystals, interstitial with respect to the augite, or may occur as spots scattered through the augite, when it appears to be due to a paramorphic change of the pyroxene. The mineral is greenish-brown in colour and appears somewhat bleached; the pleochroism is marked, but not so strongly as usual. Its maximum extinction angle is 27° . Where it is primary it has crystallized after iron ore, olivine, augite, and biotite.

Olivine occurs as rounded grains up to 1 millimetre in diameter, is colourless in thin section, and shows characteristic cracking and slight alteration to green serpentinite. It is biaxial negative, and thus is probably fayalite.

Mica occurs as ragged flakes about 1 millimetre in diameter, and has been the last mineral to crystallize. In some specimens the inclusion of grains of minerals of earlier crystallization has produced an effect of lustre-mottling on the cleavage surfaces. The colour in thin section is reddish-brown, and the pleochroism is very strong, from pale lemon-yellow to deep reddish-brown. It is probably lepidomelane.

Plagioclase plays quite a minor part in the majority of specimens and exists only as interstitial grains. Albite and pericline twinning are particularly well-developed; Carlsbad twins are more uncommon. It is labradorite-bytownite of composition $Ab_{30}An_{70}$.

Apatite crystals, and iron ore, including magnetite and pyrites, occur as small grains through the rock.

There is some variation in the fabric of the rock.

The analysis of a typical specimen of pyroxenite from Poole's Point (M.476) is stated in Column I of Table 7: it shows an ultrabasic rock rich in lime, magnesia, and iron oxides, with correspondingly low alumina. The norm contains small percentages of orthoclase and feldspathoids which have not been detected in the mode. The higher percentage of normative plagioclase indicates that the modal pyroxene contains some alumina. According to the C.I.P.W. classification

TABLE 7.

	I	Ia	II	III	IV	V
SiO ₂	43·63	0·727	45·05	38·39	38·38	43·53
Al ₂ O ₃	7·52	0·074	6·50	7·05	6·15	7·24
Fe ₂ O ₃	6·45	0·040	3·83	9·07	11·70	11·10
FeO	8·57	0·119	7·69	6·17	8·14	8·70
MgO	13·67	0·342	12·07	11·58	11·47	11·51
CaO	17·12	0·305	18·82	19·01	18·60	10·19
Na ₂ O	0·36	0·006	0·94	0·74	0·78	2·88
K ₂ O	0·50	0·005	0·78	0·75	0·13	1·39
H ₂ O+	0·46			0·33	0·54	1·34
H ₂ O-	0·25		2·40	0·14	0·18	0·43
TiO ₂	1·24	0·015	2·65	4·54	4·32	1·90
P ₂ O ₅	0·10	0·001	0·15	0·82	0·17	tr.
MnO	0·20	0·003		0·32	0·16	—
X				0·24		
BaO				tra.		
S				0·42		
CO ₂	abs.			0·32	abs.	abs.
Total	99·97		100·88	99·89	100·72	100·21
Sp. Gr.	3·393					

TABLE 7a.

	I	II	III	IV	V
Orthoclase	1·67	—	—		8·34
Albite	—	—	—		13·62
Anorthite	17·51	11·12	13·62	12·79	3·06
Nepheline	1·70	4·26	3·41	3·69	5·96
Leucite	0·87	3·92	3·49	0·44	
Diopside	52·87	62·19	44·50	50·33	37·42
Olivine	12·80	5·32	5·88	3·78	10·57
Ca. orthosil.	—	0·95	5·50	4·30	
Magnetite	9·28	5·57	7·89	14·15	16·01
Ilmenite	2·28	5·02	8·66	8·21	3·65
Haematite	—		3·68	1·92	
Apatite	0·34	0·34	2·02	0·34	

I. Pyroxenite [Montrealose IV, (1)2₂, 2', 2]. Poole's Point, north of the mouth of Tilba Tilba Lake. Anal. I.A.B.

Ia. Molecular numbers for I.

II. Pyroxenite [Brandbergose, IV, (1)2₁, "3, 2]. Brandberget, Gran, Norway.

Anal. L. V. Schmelk. W. C. Brøgger, *Q.J.G.S.*, 1894, p. 31. In W.T., p. 716.

III. Jacupirangite (Paulose, IV, 2₂, "3, 2). Magnet Cove, Arkansas. Anal. H. S. Washington. *Journ. Geol.*, ix, 1901, p. 620. In W.T., p. 720.

IV. Jacupirangite [Paulose, "IV, 2(1)2, "3, 2]. Jacupiranga, San Paulo, Brazil. Anal. H. S. Washington. *Journ. Geol.*, ix, 1901, p. 620.

V. Davainite (Hornblendite), (Montrealose, "IV, 2₂, 2, 2). Garabal Hill, Loch Lomond, Scotland. Wyllie and Scott, *Geol. Mag.*, (v)x, 1913, p. 502. In W.T., p. 719.

the analysis falls into the subrang Montrealose, containing gabbros, essexites and felspathoidal basalts.

Probably the analysis of the pyroxenite from Brandberget, Norway, described by Brøgger (1894, p. 34) and quoted in Column II, approximates more closely to that of the Tilba rock than that of any other yet recorded. This is of special interest on account of the association, at Brandberget and elsewhere in the Gran district, of this pyroxenite and the olivine-gabbro-diabase or essexite, which has already been compared with a similar type at Tilba. The Brandberget pyroxenite carries a higher percentage of titania, evidently contained in the pyroxene, which shows typical violet colour in thin section (Slide 1515).

A specimen of pyroxenite from Randvikholmen Island, Christiania Fjord, collected by Dr. C. E. Tilley and now in the Sydney University Geological Museum, shows, in thin section, a rock having a close mineralogical and textural resemblance to the Tilba rock.

Rocks of similar chemical composition are the jacupirangites. The analysis of the type specimen from Jacupiranga, Brazil, is quoted in Column IV, and that of a jacupirangite from Magnet Cove, Arkansas, in Column II. The silica percentages are slightly lower than in the pyroxenites, although this difference is lessened if it is considered that the TiO_2 partly replaces the SiO_2 .

Washington (1901) has discussed the significance of the term jacupirangite applied by Derby (1891) to types at Jacupiranga, Brazil, and states (p. 621), "From the microscopical examination of specimens which Professor Derby sent me, it is evident that the 'Jacupirangites' of Brazil vary from rocks rich in nephelinite and which are true ijolites closely analogous to those of Magnet Cove and Finland, through rocks composed predominantly of pyroxene, with small and varying amounts of magnetite and nephelinite, to types extremely rich in magnetite and with no nephelinite, or only traces of this mineral. Accepting then the name jacupirangite for the medium type, the application of this name to the Magnet Cove rock is abundantly justified, since the only difference is the comparatively unimportant one of size of grain, both being holocrystalline." The American rocks contain violet-brown titaniferous augite. Washington states that the "closest known analogue of these rocks is probably the pyroxenite of Brandberget", and notes that the chief differences are in SiO_2 and Fe_2O_3 . These are also the chief differences between the American and Tilba rocks.

Direct comparison of the Tilba Tilba rock and a thin section of a chip of the specimen of jacupirangite from Magnet Cove analysed by Washington, shows the similarity of these rocks to one another.

The jacupirangite from Ilädo, Alnö, is finer-grained than the Tilba rock and contains more apatite and calcite.

It therefore seems evident that the known varieties of the Tilba Tilba pyroxenite closely approach the type known as jacupirangite, although the silica percentage is just sufficiently high to prevent the crystallization of nephelinite, an essential constituent of true jacupirangite.

H. Rosenbusch (1906, p. 222), W. H. Twelvetrees (1902), and F. P. Paul (1906, p. 15) have described jacupirangite from Port Cygnet, Tasmania, which occurs in association with nephelinite-syenite at Regatta Point, but unfortunately no chemical analysis is available.

The analysis quoted in Column V is that of the Davainite from Garabal Hill, described by Wyllie and Scott (1913). It is really an altered pyroxenite, and

shows affinities to the pyroxenites and jacupirangites also quoted. It is quite comparable with the Tilba pyroxenite, the chief difference being in its higher percentage of Fe_2O_3 , and correspondingly lower CaO percentage.

Melanite Series.

Intimately associated with the principal monzonitic and nepheline-bearing series is a group of rocks which are characterized by the presence of green pyroxene, with varying amounts of melanite (garnet). These rocks occur chiefly to the east and south-east of Central Tilba, approximately between the coarser monzonites of the Mt. Dromedary foothills and the finer nepheline-monzonites of the Little Dromedary area; a related type outcrops near the Cobargo Road, two and a half miles from Tilba Tilba. On the whole the field-relationships of these rocks with respect to the main series are not well defined, on account of cultivation. The outcrop on the Cobargo Road occurs between the olivine-monzonite and the invaded sediments, and this phase contains small inclusions of the country rock. On the south-western end of the Little Dromedary a narrow dyke of this series intrudes the coarse-grained porphyritic monzonite, and on the north-western slopes of the Little Dromedary the garnet-bearing rock is apparently intrusive into the nepheline-monzonite. The specimen described by Anderson (1892) as containing garnet, comes from the north-eastern slope of the Little Dromedary.

1. Ijolite.

Probably the least basic member of this series is the ijolite outcropping on the Cobargo Road, between the olivine-monzonite and the quartz-schists. It is slightly porphyritic in augite phenocrysts about 5 millimetres in length, set in a dioritic groundmass whose average grainsize is about one millimetre. There is a slight development of lustre-mottling on the cleavage faces of the white constituent.

Under the microscope the rock (Pl. xxxix, fig. 4) appears holocrystalline, with variable grainsize and poikilitic fabric. The minerals present are chiefly pyroxene, nepheline, and melanite, with some orthoclase, plagioclase, olivine, sphene, apatite, sodalite, and iron ore.

The pyroxene occurs both as idiomorphic phenocrysts and as an important constituent of the groundmass. The central portion of the phenocrysts consists of almost colourless pyroxene, surrounded by an outer zone of green pyroxene, which also forms small idiomorphic crystals. The olivine occurs only as small rounded grains in the colourless pyroxene of the phenocrysts. The pale pyroxene has the characters of normal diopside, but the green variety is decidedly pleochroic, with prismatic cleavages at right angles and high extinction angle. Colour-zoning is marked and the interference colours are masked by the strong natural colour of the mineral. Simple twinning occurs.

The chief light-coloured constituent is nepheline, which occurs as large allotriomorphic plates enclosing the green diopside and other minerals in a poikilitic manner. Traces of the basal cleavage are visible, and extinction is parallel to this direction. The refractive index is less than that of Canada Balsam, and the mineral is uniaxial and negative. It shows alteration to a colourless, isotropic mineral with a low refractive index, probably sodalite.

A small amount of orthoclase also is present, distinguishable from the nepheline by the refractive index and its biaxial figure in convergent light.

Plagioclase is quite accessory, and occurs as idiomorphic laths less than one millimetre in length. The composition is that of Labradorite, $Ab_{45}An_{55}$.

A variety of light-brown garnet, probably melanite, occurs in noticeable quantity in association with green pyroxene as allotriomorphic grains; it has the appearance of a primary mineral on normal crystallization. Sphene, apatite, and iron ore occur as small grains.

No chemical analysis of this rock is available. The rock appears to correspond, at least mineralogically, with the type known as ijolite, and particularly with that occurrence at Magnet Cove, Arkansas, described by Washington (1900, p. 400; 1901, p. 618) and previously called "Ridge type of eleolite-garnet-syenite" by Williams (1890).

Actual comparison with a chip and microsection of the specimen analysed by Washington, from near Dr. Thornton's, Magnet Cove, shows some differences of texture, due partly to the fact that the Tilba rock shows greater idiomorphism of the pyroxene, while the garnet of the Magnet Cove rock is more abundant and of a darker colour than that of the Tilba specimen.

Although the rock belongs essentially to the green pyroxene-melanite series, the presence of nepheline relates it to the covite and nepheline-monzonites of the Little Dromedary, while the presence of plagioclase, orthoclase, and normal diopside with inclusions of olivine shows its affinity to the olivine-monzonite.

2. (?) Kedabekite—Melanite-melteigite-jacupirangite.

East and south-east of Central Tilba, chiefly in Portions 41, 71 and 218, there outcrops a continuous series containing green pyroxene and melanite, similar to that of the ijolite. These rocks differ from the ijolite in that nepheline is accessory or absent, and its place is taken largely by the basic plagioclase, anorthite.

The proportion of melanite varies from a few per cent. to approximately 50 or 60 per cent. of the rock. Usually the rock is massive, but in one instance (M.489) there is distinct banding, due to the parallel arrangement of alternate layers of pyroxene and anorthite. The garnet-rich varieties weather in a characteristic fashion, so that the apparently idiomorphic garnet crystals, about 4 millimetres in diameter, form a resistant crust over the rock surface, after the other constituents have weathered away.

Under the microscope a series of sections of 16 specimens show a progressive variation in the content of garnet with antipathetic variation in that of the other constituents, especially green pyroxene. The texture is holocrystalline and the grainsize is relatively even and medium; the fabric is hypidiomorphic granular. The minerals present are green pyroxene and garnet, anorthite, nepheline, orthoclase, sphene, apatite, iron ore, and alteration products, kaolin, cancrinite or scapolite, and finely-divided zeolites. (See Plate xxxix, figs. 5, 6.)

The green pyroxene is the most important mineral, occurring as idiomorphic to subidiomorphic crystals from one to two millimetres in length. The colour is usually yellowish-green to grass-green, but the intensity varies slightly in different specimens; occasionally the cores of the larger crystals are almost colourless. Pleochroism is strong, yellow, yellowish-green and green, and prismatic cleavage in two directions at right angles is well developed. The extinction angle on sections parallel to (010) is 45 degrees (*i.e.*, $Z \wedge C = 45^\circ$). The mineral has crystallized after the minor accessory minerals and partly during the early stages of crystallization of the melanite. There is no doubt that the mineral is a mono-

clinic pyroxene in spite of its unusual colour and strong pleochroism. No chemical analysis of the separated mineral has been made, but a consideration of the composition of the rock, given in Column I of Table 8, indicates that it is probably low in alumina and alkalis, and rich in lime, magnesia, and iron oxide, closely approximating the composition of diopside-hedenbergite. In the Fen District, Norway, a similar pyroxene occurs in rocks of the ijolite-melteigite series, which closely resembles the rock-series under consideration. W. C. Brøgger (1920, p. 60) gives the calculated average composition of the green pyroxene of the melteigite-jacupirangite, whose complete analysis is quoted in Column III of Table 8, as

SiO ₂	50.29
Al ₂ O ₃	4.49
Fe ₂ O ₃	3.74
FeO	7.60
MnO	0.30
MgO	8.83
CaO	23.27
Na ₂ O	1.37
K ₂ O	0.11
	100.00

This composition is close to that of the average for the Melteig series, as well as that of Alnö, and may represent the variety present in the Tilba rock.

O. A. Derby (1891, p. 319) describes a rock of the jacupirangite series at Ipanema, Brazil, containing green pyroxene, which he refers to acmite.

The green pyroxene of the ijolite series at Magnet Cove probably contains a large percentage of the aegyrine molecule, on account of the high alkali content of the rock, as given by Washington (1901, p. 618). There are slight differences in the colours of these pyroxenes in thin section, the shade of colour evidently being a function of the presence of either iron or soda.

Other somewhat similar rocks containing green pyroxene include kedabekite (Federof, 1901), stated by Iddings (1913, Vol. II, p. 170) to consist of anorthite, hedenbergite and garnet.

Garnet is present in almost every member of this rock-series, appearing in the handspecimen as a black mineral with a submetallic lustre. In thin section it is yellowish to light-brown in colour, translucent and completely isotropic. When present in small quantity it appears only as an interstitial mineral; as the proportion increases it assumes the form of irregular allotriomorphic grains, or of idiomorphic crystals 4 or 5 millimetres in diameter. It occurs in close association with green pyroxene, either as irregular patches through and around the pyroxene, or as cores in the garnet crystals (Plate xxxix, fig. 6).

In the malignites of the Kruger alkaline body associated with the Okanagan composite batholith, described by Daly (1906, 1912) there appear to be somewhat similar relations between the garnet and pyroxene. Daly states, however (1906, p. 350), "Microscopic study shows that much of the melanite in the Kruger rocks is of magmatic origin, but that perhaps much more of it has replaced the pyroxene during dynamic metamorphism."

In the Ontario malignites described by A. C. Lawson (1896) the garnet is considered to be primary. There is no doubt of the primary origin of the garnet in the melteigite-jacupirangite series of Brøgger (1920) and in the ijolite of Magnet Cove, Arkansas, and elsewhere, as at The Kola Peninsula and Alnö.

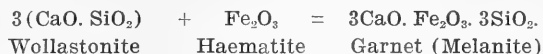
Among the granite-gneisses of the Southern Eyre Peninsula, South Australia, Dr. C. E. Tilley (1921, pp. 121, 123) has found garnet and secondary pyroxenes developing from original augite as a result of metamorphism, reactions which may be expressed in terms of chemical equations. The illustrations in his paper clearly show a reaction zone between the original pyroxene and the garnet, a feature which is entirely absent from the garnet-bearing rocks of the Mount Dromedary district. There seems no reason for believing that the garnet here is other than a normal product of crystallization from a magma of somewhat unusual character. Its relation to the pyroxene is similar to that which commonly occurs between olivine or rhombic pyroxene and a monoclinic pyroxene of later crystallization.

Sir T. H. Holland (1896, p. 22) has described the production of garnet from pyroxene as a result of the dynamic metamorphism of two series of rocks, the Charnockite series of the Madras Presidency, Southern India, and a group of rocks in Bengal, which he believes to have been originally pyroxene-plagioclase rocks. In these rocks definite reaction borders occur "between the garnet and the ferromagnesian silicate". Similar occurrences in other parts of the world are cited by Sederholm (1916). He states, "The garnet seems often to have been formed towards the end of crystallisation processes, either during the waning phases of the solidification of a magma or during a later period of metamorphism, and is often, if not always, a crystalloblastic mineral which has replaced constituents of earlier date."

L. L. Fermor (1913) came to the conclusion that the presence of garnet in the kodurite rocks of Madras, India, indicates conditions of high pressure during the formation of this rock series, the garnet thus acting as a "geological barometer".

No separate chemical analysis of the garnet of Mt. Dromedary has been made, but the analysis of a rock containing a large percentage of garnet is given in Column II of Table 8.

The high percentages of lime and ferric oxide are undoubtedly related to the garnet content, and are reflected in the norm by high proportions of wollastonite and haematite. These may be considered to combine in the mode according to the equation



It is evident that the garnet is the variety melanite (andradite); the relatively high titania percentage in the rock may indicate its presence in the melanite, but there is insufficient to form true schorlomite, as at Magnet Cove, or iivaarite, as in the ijolite at Iivaara, Finland, a fact which is confirmed by the microscopic examination.

The light-coloured constituents include anorthite, nepheline, orthoclase and their alteration products. These frequently occur in such a finely divided condition that their real identity is difficult to determine.

Fresh plagioclase forms idiomorphic to subidiomorphic crystals about one millimetre in diameter. The content varies from 10 or 15 per cent. to more than half of the rock, the average being about 20 or 25 per cent. The extinction angle indicates anorthite; in some sections the felspar is partially replaced by a finely-divided aggregate of a more highly doubly-refracting mineral whose refractive index is about 1.60. This is probably a scapolite, whose composition (4 CaO. 3 Al₂O₃. 6 SiO₂) resembles that of anorthite (CaO. Al₂O₃. 2 SiO₂).

A few odd grains of nepheline and orthoclase have been detected in some slides, but neither mineral appears to play an important part in the constitution of the rock. A light coloured variety of sphene occurs sparingly as irregular grains in most sections, and small crystals of apatite are also present. Both oxide and sulphide of iron are present in small quantity.

TABLE 8.

	I	Ia	II	IIa	III	IIIa	IV	V
SiO ₂ ..	44.28	0.738	40.26	0.671	43.58	0.726	48.05	52.53
Al ₂ O ₃ ..	10.13	0.099	10.95	0.107	7.80	0.076	15.35	19.05
Fe ₂ O ₃ ..	4.04	0.025	12.16	0.076	4.23	0.026	1.86	4.77
FeO ..	6.21	0.086	3.38	0.047	6.09	0.085	7.53	2.10
MgO ..	8.42	0.210	2.16	0.054	6.46	0.161	12.53	1.99
CaO ..	21.86	0.390	26.30	0.470	21.93	0.391	11.02	5.75
Na ₂ O ..	0.31	0.005	0.44	0.007	1.10	0.018	1.26	4.03
K ₂ O ..	0.69	0.007	1.33	0.014	1.33	0.014	0.19	7.30
H ₂ O+ ..	1.29	—	0.64	—	1.27	—	0.45	1.49
H ₂ O- ..	0.29	—	0.28	—	0.07	—	0.15	0.13
TiO ₂ ..	1.28	0.016	1.68	0.021	2.51	0.031	0.49	0.07
P ₂ O ₅ ..	1.35	0.009	0.89	0.006	2.58	0.018	—	0.28
MnO ..	0.23	0.003	—	—	0.22	0.003	0.28	0.13
CO ₂ ..	abs.	—	abs.	—	0.10	0.002	0.44	0.27
ZrO ₂ ..	—	—	—	—	0.04	—	—	—
Cr ₂ O ₃ ..	—	—	—	—	—	—	0.14	—
(Co, Ni)O ..	—	—	—	—	—	—	0.11	—
CuO ..	—	—	—	—	—	—	0.05	—
S ..	—	—	—	—	0.21	0.006	0.20	—
SrO ..	—	—	—	—	—	—	—	0.19
BaO ..	—	—	—	—	0.02	—	—	0.09
Cl ..	—	—	—	—	0.02	—	—	—
F ..	—	—	—	—	0.24	0.006	—	—
Total ..	100.38	—	100.47	—	99.80	—	100.10	100.17
Sp. Gr. ..	3.237	—	3.425	—	—	—	2.95	2.719

TABLE 8a.

	I	II	III	IV	V
Orthoclase	—	3.06	7.78	1.11	43.37
Albite	—	—	5.76	10.48	11.53
Anorthite	24.74	23.91	12.23	35.58	12.23
Nepheline	1.24	1.99	1.99	—	12.21
Leucite	3.05	3.71	—	—	—
Diopside	57.27	11.66	41.72	15.17	10.86
Hypersthene	—	—	—	23.47	—
Olivine	—	—	—	8.95	—
Wollastonite	0.58	35.96	11.14	—	0.23
Ca. Orthosil.	0.86	—	—	—	—
Magnetite	5.80	6.03	6.03	2.78	6.96
Haematite	—	8.00	—	—	—
Ilmenite	2.43	3.19	4.71	0.91	0.15
Apatite	3.02	2.02	6.05	—	0.67
Calcite	—	—	0.20	—	—
Pyrites	—	—	0.36	—	—

I. (?) Kedabekite (*cf.* Brandbergose, IV, 1-2₁, 3, 2). Portion 41, Parish of Narooma, $\frac{1}{2}$ mile east of Central Tilba, N.S.W. Analyst, I.A.B.

Ia. Molecular numbers for I.

II. Melanite Melteigite (*cf.* Brandbergose, IV, 2₁, 3-4, 2). Portion 71, Parish of Narooma, $\frac{1}{2}$ mile south-east of Central Tilba, N.S.W. Analyst, I.A.B.

Iia. Molecular numbers for II.

III. Melteigite-jacupirangite [Brandbergose, IV, "2₁, 3, 2(3)]. Melteig, Fen District, Norway. Anal. A. Rødland. W. C. Brøgger, *Die Eruptivgesteine des Kristianiagebietes*, iv, 1920, p. 18.

IIIa. Molecular numbers for III.

IV. Eucrite [Auvergnose, III, 5, 4(5), "5]. North-east of Allival Rum, Scotland. Anal. W. Pollard, *Summ. Prog. Geol. Surv.*, 1903, p. 56. Quoted from A. Harker, *Geology of the Small Isles of Inverness-shire*, *Mem. Geol. Surv. Scotland*, 1908, p. 98. Norm in W.T., p. 649.

V. Biotite-melanite-nephelite-syenite or Malignite [Borolanose, II, (5)6, 2, 3]. Kruger Mt., Okanagan Range, British Columbia. Anal. Prof. Dittrich. R. A. Daly, *North American Cordillera, 49th Parallel, Part I*, pp. 451-2. *Mem. Geol. Surv. Canada*, 38(1), 1912. Norm in W.T., p. 565.

Chemical analyses of two members of the garnet-bearing series were carried out, one (M.499) containing practically no garnet, and the other containing about 50 per cent. of melanite.

As the silica percentage of each rock is less than 45, they must be classed as ultrabasic. Their other characters are somewhat unusual; the alumina and alkali percentages are low, while iron oxides and particularly lime are high. The norm of M.499 agrees closely with the mode, containing diopside-hedenbergite approximately of the composition (5 CaO. 4 MgO. FeO. 10 SiO₂). In the other rock the felspathic content is similar to that of M.499, but the place of the normative minerals wollastonite and haematite is taken by melanite, according to the chemical equations given above. According to the C.I.P.W. classification both rocks fall near the subrang Brandbergose, in which four analyses are quoted in Washington's tables, page 717. These include a cromaltite from the alkaline province of Assynt, Scotland, described by Shand (1910), and pyroxenites from Gran, Norway, and from Predazzo, Tyrol, both of which occur in association with monzonitic or alkaline rocks, although these particular rocks are basic and low in alkalis.

The analyses of the Tilba rocks resemble some of the jacupirangites already quoted in Table 7, except for the higher magnesia percentages of the latter.

In Column III is quoted the analysis of a melteigite-jacupirangite from the Fen Region, Christiania, one of a series described by W. C. Brøgger (1920, p. 18). It shows a very close similarity with that given in Column I, and according to the C.I.P.W. classification would fall into the same subrang, Brandbergose. The slightly higher alkali percentages of the Norwegian rock are mainly responsible for the differences in the norms, although the total amount of feldspar approximates that of the Tilba rock. Specimens of the chief types described by Professor Brøgger and collected by Dr. C. E. Tilley from the Fen District are in the Geological Museum of the University of Sydney, and are available for direct comparison with the rocks under consideration. Among these is a specimen of melanite-melteigite, which has striking resemblances, both in the handspecimen and in thin section, to the garnet rock at Tilba. This type is not described in detail by Brøgger, but is evidently the variety mentioned by him (pp. 52, 58) as borolanite-melteigite, from 100 metres SSW. of Melteig.

The proportions of the several minerals in the two rocks are similar. The green pyroxene in the Norwegian rock differs slightly in habit from the Tilba

rock, and the garnet is a darker colour. Apatite is more abundant, but the sphene and feldspars are similar in the two rocks.

The eucrites of Rum, Scotland, described by A. Harker (1908, p. 97), consist essentially of basic plagioclase and pyroxene, both rhombic and monoclinic. For comparison the analysis of one of these eucrites is quoted in Column IV of Table 7. Higher silica, alumina, and magnesia, and lower iron oxide and lime percentages indicate a rock fundamentally different from the Tilba rocks, although both consist of basic plagioclase and pyroxene. They are quite unlike one another in thin section.

Kedabekite from Elizabethpol, Russia, is another type apparently somewhat like that at Tilba; according to Iddings (p. 170) it consists of "anorthite, hedenbergite and garnet". It was so named by E. C. Federof (1901) in a publication which is not available in Australia. In its chemical composition as given in Washington's Tables (p. 767) it differs chiefly by its higher content of alumina (19.38%) and correspondingly low magnesia (2.90). The other oxide percentages are close to those of the Tilba rocks. ($\text{SiO}_2 = 44.11$, $\text{Fe}_2\text{O}_3 = 5.17$, $\text{FeO} = 5.44$, $\text{CaO} = 21.98$, $\text{Na}_2\text{O} = 0.50$, $\text{K}_2\text{O} = 0.13$.)

The garnet-bearing types of borolanite described by Shand (1909, 1910, 1927) show mineralogical and textural differences from the Tilba rocks, and the analyses contain more than 10 per cent. of alkalis. The series includes a melanite-pyroxenite containing 22 per cent. of lime.

The malignites, so named by A. C. Lawson (1896), are defined by him as "basic, holocrystalline, plutonic rocks, rich in alkalies and lime". Orthoclase is a prominent mineral throughout the family, often as porphyritic crystals, and in one variety melanite is also essential. Although the lime percentages are high (10 to 14 per cent.), they are only about half those in the Tilba and Melteig rocks, whereas the total alkalis in the malignites are more than 10 per cent. as compared with 1 or 2 per cent. in the other rocks. It is evident therefore that the Tilba and Melteig rocks are not malignites. For comparison, the analysis of a typical malignite from the Kruger Mountain, Okanagan Range, is quoted in Column V of Table 8.

Other garnet-bearing rocks, which may have some resemblance to those of the Tilba district, are the skarn-rocks of the Fennoscandinavian geologists. V. M. Goldschmidt (1911, p. 213) describes these as a product of pneumatolytic metamorphism of limestone. P. Eskola (1914, p. 225) gives petrographic descriptions of tremolite-skarn, hornblende-skarn, pyroxene-skarn and andradite-skarn, the last two varieties apparently being comparable with the Tilba rocks, inasmuch as they consist essentially of dark-green hedenbergite and andradite (melanite). Unfortunately no chemical analyses of skarn-rocks are available, although the individual minerals have been separated and analysed.

Skarn-rocks of this nature have been developed in the Tallong district, New South Wales, by the intrusion of granodiorite into limestone, the occurrence of which has been described by W. G. Woolnough (1910, pp. 799-806). About 30 feet from the contact the limestone has been recrystallized into rather pure marble; nearer the contact silication has taken place, and iron, alumina, magnesia and other constituents evidently introduced from the granodioritic magma have produced a number of lime-silicate contact-minerals. In thin section, some varieties of the altered limestone show features almost identical with those of the intermediate varieties of the Tilba garnet-bearing series; green, pleochroic pyroxene, allotriomorphic melanite and small amounts of almost indeterminate feldspathic

material: in addition there is a small amount of calcite, which has not been detected in the Tilba rock.

(iv) *Petrography of the Hypabyssal Rocks.*

The hypabyssal rocks which are associated with the plutonic complex at Mount Dromedary occur as (1) segregation veins and patches in the plutonic series, (2) irregular intrusions, and (3) dykes through various phases of the whole igneous complex and the adjacent sediments.

Nearly one hundred microsections of these rocks have been examined.

(1) Segregation Veins.

These are not of common occurrence, but have been noticed in the coarse-grained monzonite near Central Tilba, in the nepheline-monzonites of the Little Dromedary area, and in the olivine-monzonite outcropping two and a half miles from Tilba Tilba, on the road to Cobargo. Probably some of the aplitic dykes described later are of the nature of segregation veins.

The "grey" monzonite occurring in the quarry opposite the A.B.C. Factory, Central Tilba, contains an interesting segregation vein, about six inches in width, on each side of which the monzonite gradually becomes darker in colour, thus resembling the "black" variety of monzonite. Orthoclase crystals, three centimetres in length, and showing simple twinning, are arranged with their long axes at right angles to the direction of the vein, and show lustre-mottling due to the poikilitic arrangement of the inclusions of augite and biotite. In thin section, this border phase of the vein shows perfect monzonitic fabric, the large plates of orthoclase forming a matrix in which all the other minerals are set. The minerals include idiomorphic basic oligoclase ($Ab_{70}An_{30}$), colourless or pale greenish-grey augite, biotite, and iron ore; apatite is present to the extent of nearly 10 per cent. of the rock. Much of the orthoclase shows intergrowth with another feldspar, as myrmekite-perthite. The centre of the vein is a pegmatitic phase, consisting chiefly of orthoclase crystals 2 or 3 centimetres in length, amongst which idiomorphic, hexagonal plates of biotite and prismatic crystals of augite are scattered. The microscope again shows the presence of a considerable amount of myrmekite-perthite and apatite, and a little interstitial quartz.

There is perfect gradation between the various types described, and there is little doubt that this vein formed as a result of contraction during the crystallization of the normal monzonite.

Small patches and veins of a similar character occur in the fine-grained nepheline-monzonites of the Little Dromedary. These are always more coarsely crystalline than the enclosing rock, and also more felspathic. One specimen (M.453) shows irregular patches of white plagioclase, pink orthoclase and elongated crystals of black pyroxene.

Similar veins through the olivine-monzonite on the Cobargo Road consist almost entirely of feldspars, which have been altered to a large extent to a mass of finely-divided, colourless, highly doubly-refracting minerals.

(2) Irregular Intrusions.

The hypabyssal rocks occurring as irregular intrusions are the most important group in this series, and include the types described by Anderson (1892) as varieties of andesite.

The aplitic granite outcropping near the mouth of Tilba Tilba Lake probably belongs to this group, its injection having taken place after that of the more basic types. This may account for Anderson's observation (1892, p. 150) that the "granite" has intruded the andesites. Beach-sand and soil have obscured the contact, described by Anderson, on each of four occasions when the writer has visited the locality. The "granite" is not comparable with the plutonic rocks forming Mount Dromedary, and therefore its relation to the andesitic series has no bearing on the relative ages of the main plutonic and hypabyssal series.

The basic hypabyssal rocks outcrop in three principal areas on the mainland, and appear in association with porphyritic monzonite on Montague Island. These outcrops are indicated on the geological sketch-maps of the mainland (Plate xxxv) and Montague Island (Text-figure 1), being situated south and west of Tilba Tilba Lake, south of Tilba Tilba village, west of Mount Dromedary, and on the north "Island" of Montague Island.

In the two first-mentioned occurrences the rocks outcrop between the plutonic series and the invaded sedimentary rocks; the third intrudes only the slate series at the surface, but contains fragments of the plutonic series, which evidently occurs below the surface; and on Montague Island the lamprophyres have intruded the porphyritic monzonite.

The rocks occurring south and west of Tilba Tilba Lake are black or bluish-grey in colour, and contain small phenocrysts of hornblende, augite, plagioclase, and occasionally biotite, set in an aphanitic groundmass. It is difficult to apply correct names to the varieties of these rocks in the absence of chemical analyses; the terms hornblende-andesite and augite-andesite used by Anderson, or lamprophyre, are satisfactory field-names.

Including the specimens collected by Anderson, twenty micro-sections of the rocks from this locality are available. A number of the Mines Department specimens show a brecciated structure in thin section; augite and sometimes plagioclase occur as phenocrysts in a hypohyaline groundmass, which may show signs of flow-structure. On the whole these rocks may be described as lamprophyres and andesitic breccias.

Other specimens having a more uniform and less altered appearance may show phenocrysts of plagioclase, surrounded by a narrow zone of orthoclase, similar to that of the banakites of the monzonitic province at Milton. In addition, phenocrysts of yellowish-green hornblende, with a narrow black border probably consisting of finely-divided iron ore, appear to be pseudomorphs after colourless augite, which also occurs as small phenocrysts. Less frequently porphyritic biotite may appear. Sometimes the groundmass is holocrystalline, at other times cryptocrystalline or hypohyaline.

West of Tilba Tilba Lake the hypabyssal rocks show much less brecciation in the hand-specimen than those forming the Head south of the entrance to the Lake, although traces of the structure are still evident in thin section. There is some variation in the relative proportion of ferromagnesian phenocrysts and aphanitic groundmass, which is cryptocrystalline or hypohyaline in thin section.

The chemical analysis by Mr. J. C. H. Mingaye, of a specimen of hornblende-andesite from a mile west of the entrance to Tilba Tilba Lake is quoted in Column I of Table 9, from Anderson's paper (1892).

Comparison with the analyses of the monzonite-porphyry from Milton, and the latitic Bumbo flow of the Illawarra District, quoted in Columns II and III, shows the chemical composition of the three rocks to be remarkably similar. The

TABLE 9.

	I	Ia	II	III
SiO ₂	52.12	0.869	53.90	52.42
Al ₂ O ₃	18.47	0.181	15.32	18.05
Fe ₂ O ₃	3.40	0.021	3.60	4.30
FeO	4.77	0.067	5.13	3.60
MgO	5.11	0.128	2.41	3.60
CaO	8.71	0.155	7.30	6.14
Na ₂ O	3.07	0.050	3.73	3.75
K ₂ O	3.29	0.035	3.44	4.14
H ₂ O+	0.46	}	0.97	1.07
H ₂ O-			0.74	1.47
P ₂ O ₅	0.25	0.002	0.55	0.34
MnO	tr.		0.36	0.28
TiO ₂	tr.		2.86	1.16
SO ₃	tr.		abs.	
CO ₂			0.03	0.04
Cl			0.02	tr.
Ni, CoO			0.02	0.03
BaO			0.06	0.11
V ₂ O ₅			0.02	0.05
CuO			0.01	0.05
Total	99.65		100.47	100.60
Sp. Gr.			2.779	2.722

TABLE 9a.

	I	II	III
Quartz	—	4.44	—
Orthoclase	19.46	20.02	24.46
Albite	25.15	31.44	31.44
Anorthite	26.69	15.01	20.29
Diopside	11.68	14.09	6.39
Hypersthene	0.43	1.50	1.96
Olivine	9.25	—	—
Magnetite	4.87	5.34	3.97
Ilmenite		5.47	2.28
Apatite	0.67	1.34	0.67

I. Hornblende-andesite (Shoshonose, II, 5, 3, 3"). Tilba Tilba Lake, one mile west of the entrance. Anal. J. C. H. Mingaye. W. Anderson, 1892. Norm in W.T., p. 479.

Ia. Molecular numbers for I.

II. Monzonite Porphyry [Shoshonose, II, "5, (2)3, 3(4)]. Two and a half miles north of Milton, N.S.W. Anal. H. P. White. Norm in W.T., 479.

III. Bumbo Flow (Shoshonose, II, 5, "3, 3"). Average of several specimens from Bumbo Quarry, Kiama, N.S.W. Anal. H. P. White. In W.T., 479.

rocks are typically monzonitic, containing a relatively high percentage of alkalis for a medium percentage of silica. The analyses are also close to that of the monzonite from the Central Tilba quarry, given in Column I of Table 3, and

indeed the four analyses belong to the same subrang, Shoshonose, of the C.I.P.W. classification. The affinities of this group have been discussed (Brown, 1925) in reference to the Milton occurrence.

The norm shows approximately 20 per cent. of orthoclase; under the microscope a small amount may be seen surrounding the plagioclase phenocrysts, but evidently more is included in the groundmass or is occult.

The chemical analysis shows that the rocks are not really normal andesites or lamprophyres, but are hypabyssal equivalents of the monzonitic series, which may be called latites, thus indicating their magmatic consanguinity with the plutonic monzonitic series.

South of Tilba Tilba village the main road or Prince's Highway runs through a cutting in fine-grained lamprophyric rocks, which outcrop only on the surrounding hill. The rocks usually have a lighter colour than those west of Tilba Tilba Lake, and contain numerous fragments of igneous and sedimentary rocks. Phenocrysts of a ferromagnesian mineral are set in a fine-grained holocrystalline groundmass.

Under the microscope colourless augite crystals several millimetres in length are set in a groundmass consisting of plagioclase, orthoclase, biotite, apatite, and iron ore, which closely resembles some of the medium-grained phases of the Milton monzonite-porphphyry.

West of Mount Dromedary a small outcrop of igneous rocks occurs in portions 151 and 375, Parish of Wandellow. The mode of occurrence appears to be that of a volcanic neck or plug. Some phases of the matrix are similar to the brecciated andesitic rocks forming the headland south of Tilba Tilba Lake, others resemble the rocks south-west of Tilba Tilba village and Milton. The latter rocks are porphyritic or glomeroporphyritic in idiomorphic augite crystals up to 4 millimetres in length, set in a holocrystalline groundmass of plagioclase surrounded by a rim of orthoclase, with biotite, augite, and iron ore.

In this occurrence the fragmental inclusions consist of amphibolized pyroxenites, essexite, and recrystallized monzonites, which may constitute nearly half the volume of the rock.

The hypabyssal rocks on Montague Island are lamprophyric types, which contain phenocrysts of colourless augite in a cryptocrystalline or hypohyaline groundmass, sometimes impregnated with iron ore. Local brecciation also occurs. The rocks resemble those outcropping near Tilba Tilba Lake.

(3) Dykes through the igneous series and adjacent sediments.

Dykes are fairly numerous but rarely exceed a few feet in width, and their outcrops usually cannot be traced very far. They are either aplitic or lamprophyric in character.

(a) *Aplitic*.—Narrow acid dykes occur through the lamprophyre and monzonite on Montague Island. In thin section they show an aplitic, even-grained rock, consisting of subidiomorphic orthoclase with interstitial quartz and a small amount of bleached biotite.

On the northern foothills of the Little Dromedary an aplitic dyke about 12 feet in width may be traced in an east and west direction for about half a mile through nepheline-monzonites. The handspecimen appears to consist of white and grey felspar, which, in thin section, is seen to be orthoclase. It occurs as large phenocrysts and smaller grains, between which some interstitial quartz is present.

Specimens of another aplitic dyke east of Central Tilba show replacement of

the original feldspar phenocrysts by radiating zeolite. The groundmass is feldspathic, and shows orthophyric fabric.

It is significant that these final phases of differentiation are not specially acid, but show a concentration of alkalis by the abundance of alkaline feldspars.

(b) *Lamprophyric*.—Some andesitic and lamprophyric dykes also occur, but they are not conspicuous. In thin section they appear to be similar to the rocks occurring as irregular intrusions. No chemical analyses of the dyke rocks have been made, so that it is not possible to determine whether the aplitic and lamprophyric types are complementary. Field evidence alone suggests that the aplitic dykes are more likely to be final products of consolidation of the monzonitic plutonic series, and that the more basic types are offshoots of the newer latitic series.

(v.) *Petrogenesis of the Igneous Rocks.*

(a) Genetic Relationships.

(i) *Field Evidence*.—The occurrence of an outcrop of igneous rocks such as that of the Mount Dromedary District, isolated from similar formations by outcrops of sedimentary rocks over large areas, naturally suggests a certain unity of origin and perhaps of character.

Closer observation in this area, however, reveals such a bewildering variety of rock-types, that more definite proof is demanded to show the genetic relationships of these igneous rocks. The field evidence consists of the association of two main groups of rocks, one consisting of holocrystalline types, the other of more finely crystalline or aphanitic types; this association appears to be more than accidental, as it is repeated several times, the relationships being similar in each case, namely, that the aphanitic types are arranged at or near the border of the outcrop of the holocrystalline rocks.

The latter form a series ranging from sub-acid to ultrabasic types, and have a definite arrangement in space, sometimes showing a gradual transition from one type to another, at other times showing abrupt changes in lithology, yet all occurring together in a limited area.

(ii) *Mineralogical Evidence*.—The study of the plutonic types under the microscope in a large measure confirms the supposition of their comagmatic origin, but suggests that, although magmatic differentiation has produced a main series or suite, apparently secondary differentiation has also taken place, and at least two smaller series with unusual characters have been formed.

The table (p. 678) shows in a qualitative fashion the mineralogical constitution of the chief plutonic types which have been described in more detail in the foregoing text. The table clearly indicates the existence of a principal monzonitic series, with two related but distinct series, one characterized by the presence of nepheline, the other by the presence of melanite.

In the monzonitic series the chief ferromagnesian mineral is a colourless pyroxene, which increases in importance from the acid to the ultrabasic end of the series; in addition a greenish-brown amphibole occurs in the more acid members of the series, while olivine is found in the remaining more basic members: the last two minerals rarely occur together. Biotite is present to some extent throughout the monzonitic series, but is characteristically absent from the subsidiary series.

As usual in such series, the composition of the plagioclases forms a general index of the basicity of the rock, showing a fairly regular gradation from andesine

of composition $Ab_{70}An_{30}$ in the banatite to bytownite of composition $Ab_{30}An_{70}$ in the pyroxenite (jacupirangite).

Orthoclase is present to some extent in all except the pyroxenite, increasing in importance towards the acid end of the series. The other felspathic minerals, anorthoclase, microcline, and myrmekite-perthite, have a limited and sporadic distribution. There are merely traces of nepheline in any of the monzonitic rocks of the main series.

Quartz takes a minor part in a few of the more acid types.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Iron Ore	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Olivine								x	x	?	x	x	x	x	x	x
Melanite														x	x	x
Colourless Pyroxene ..	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Green Pyroxene.. ..									x	x	x	x	x	x	x	x
Hornblende	x	x	x	x	x	x			x	x			x			
Biotite	x	x	x	x	x	x	x	?			?	x	x			
Anorthite															x	x
Bytownite (Ab_{30}) ..													x			
Labradorite (Ab_{40-45}) ..						x		x			x	x		x		
Andesine.. .. .	x	x	x	x	x		x	x	x	x						
Albite	x	x														
Orthoclase	x	x	x	x	x	x	x	x	x	x		x		x	?	?
Anorthoclase	?	?						?	x							
Microcline			?					?								
Myrmekite-perthite ..			x	x	x											
Nepheline		?	x					?	x	x				x	?	?
Quartz	x	x			?											
Apatite	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Sphene	x	x	x	x	x	x	x	x	x	x				x	x	x
Sodalite					?				x	x				x		
Fluorite	?															
Calcite		?														
Analcite					?				?	?						
Cancrinite									x	x				x		
Chlorite																
Scapolite.. .. .															x	

(1) Banatite (Syenite). (2) Porphyritic Monzonite. (3) Porphyritic Nepheline-Monzonite. (4) Coarse Grey Monzonite. (5) Coarse Black Monzonite. (6) Monzonite (Grassy Knob). (7) Olivine-Monzonite. (8) Olivine-Shonkinite. (9) Nepheline-Monzonite. (10) Nepheline-Shonkinite (Covite). (11) Pyroxene-Granulite or Olivine-Gabbro. (12) Biotite-Gabbro or Essexite. (13) Pyroxenite or Jacupirangite. (14) Ijolite. (15) Pyroxenite (Kedabekite). (16) Melanite-Pyroxenite or Melteigite-Jacupirangite.

The minor accessory minerals, iron ore, apatite and sphene, are present in small amounts throughout the entire series; in the acid members of the monzonitic series there are traces of minerals characteristic of late primary or deuteritic crystallization, including calcite, fluorspar, chlorite, fibrous green amphibole, and deuteritic albite.

The series containing nepheline shows its connection with the monzonitic series mineralogically by the presence of orthoclase with varying amounts of intermediate or basic plagioclase. It contains some colourless pyroxene, thus resembling the main series, but is distinguished by the additional presence of

alkaline green pyroxene, which is developed to the exclusion of the alkali-bearing ferromagnesian mineral, biotite, of the monzonitic series.

Although obviously undersaturated in silica, it is noteworthy that olivine is seldom developed in the nepheline-bearing series; when it has been observed, it appears to be the somewhat rare, optically negative iron-olivine, fayalite. This may be due to the low magnesia content of the rock.

The presence of greenish-brown amphibole in both series is possibly controlled by physical rather than purely chemical conditions during the consolidation of the rock.

In addition to small quantities of iron ore, apatite, and sphene, there are also small amounts of cancrinite, sodalite, calcite and perhaps analcite, which may be partly primary, and which often accompany the felspathoids.

The consanguinity of the monzonitic and garnet-bearing rocks is less apparent. The latter appear to be more basic than the main series; the plagioclase is anorthite, and usually there are only traces of orthoclase and nepheline; the ferromagnesian mineral is a green pyroxene, which is somewhat similar to that in the nepheline series, thus showing an indirect relationship to the main series. The ijolite appears to be a connecting link between the two: here the plagioclase is not quite so basic as in the garnet series, the rock contains both colourless and green pyroxene, with fairly abundant nepheline, and melanite is also present in this rock as well as in a few members of the nepheline-bearing series.

The trend of the mineralogical evidence therefore indicates magmatic consanguinity of the garnet-bearing and monzonitic series.

The magmatic relations between the plutonic and hypabyssal or volcanic series of andesitic and lamprophyric rocks are shown more clearly by the chemical than by the mineralogical evidence. Nevertheless, there are some mineralogical characters that suggest a comagmatic origin: the plagioclase phenocrysts frequently show a narrow outer zone of orthoclase, a common feature of the volcanic monzonitic rocks banakite and absarokite, and one which is characteristic of the monzonitic series at Milton, eighty miles to the north of Mt. Dromedary.

(iii) *Chemical Evidence.*—The chemical evidence establishes the consanguinity of the rocks under consideration even more definitely than the mineralogical evidence. A table of the chemical analyses of typical specimens from Mt. Dromedary is given below, the analyses being arranged in order of decreasing basicity: these include (1) principal types of the monzonitic series, (2) the covite, representing the nepheline-bearing group, (3) a typical member of the latite group, and (4) the two end-members of the garnet-bearing series.

The analyses show the rocks to be relatively low in silica; with a decrease in alumina and alkalis there is an increase in lime, iron and magnesia corresponding approximately to the relative proportions of alkali feldspars and ferromagnesian minerals. The total amount of alkalis lies between 5 and 10 per cent., that of potash always being greater than soda.

The chemical character of the series is also reflected in the table of norms, in which the rocks are arranged in the same order as before. The low silica content is expressed in the absence of quartz, except in the two most acid rocks of the series, while, with one exception, olivine and felspathoids appear in the norms of all the other rocks. Orthoclase is generally dominant over combined albite and nepheline, anorthite is consistently high throughout, a reflection of the high alumina and lime content. Diopside, hypersthene and olivine show an increase from the acid to the basic end of the series as demanded by the increasing

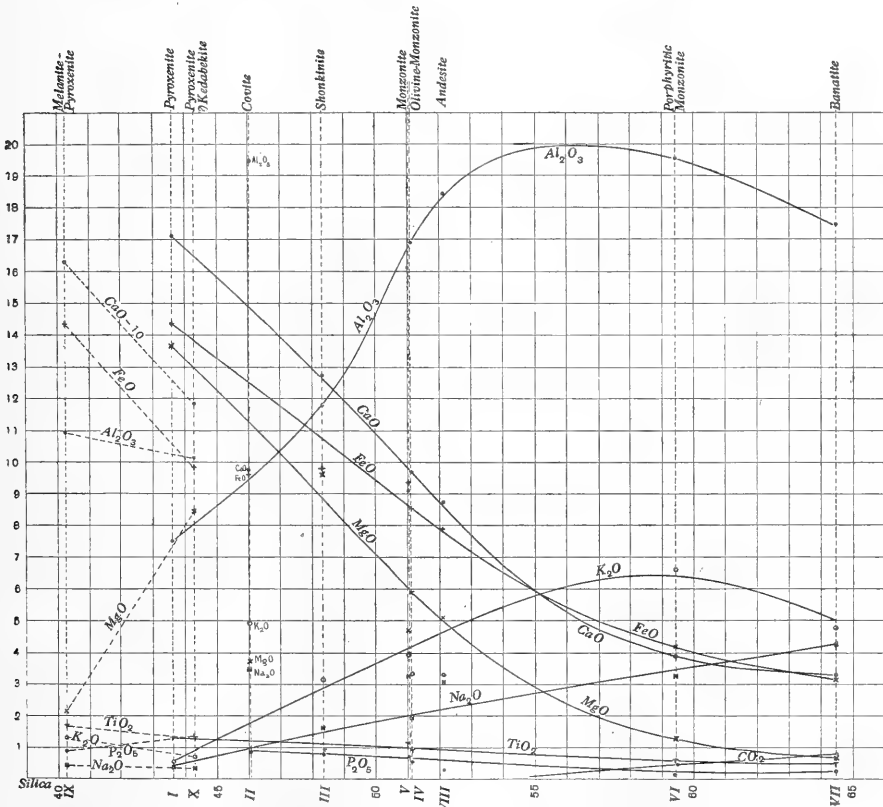
percentages of iron, lime and magnesia, and iron oxides and apatite are relatively high.

	I	II	III	IV	V	VI	VII	VIII	IX	X
SiO ₂ ..	43·63	46·04	48·34	51·14	51·09	52·12	59·44	64·49	44·28	40·26
Al ₂ O ₃ ..	7·52	19·46	11·79	16·91	16·11	18·47	19·58	17·48	10·13	10·95
Fe ₂ O ₃ ..	6·45	3·80	2·31	1·34	3·11	3·40	0·31	1·64	4·04	12·16
FeO ..	8·57	6·20	7·72	7·27	6·58	4·77	3·91	1·69	6·21	3·38
MgO ..	13·67	3·74	9·59	5·88	4·69	5·11	1·27	0·66	8·42	2·16
CaO ..	17·12	9·72	12·76	9·68	9·10	8·71	3·95	3·28	21·86	26·30
Na ₂ O ..	0·36	3·49	1·60	1·92	3·29	3·07	3·21	4·16	0·31	0·44
K ₂ O ..	0·50	4·91	3·17	3·32	3·94	3·29	6·60	4·79	0·69	1·33
H ₂ O+ ..	0·46	0·69	0·68	0·54	0·66	} 0·46	0·88	0·52	1·29	0·64
H ₂ O- ..	0·25	0·31	0·04	0·20	0·10		0·12	0·18	0·29	0·28
TiO ₂ ..	1·24	0·92	0·88	0·92	1·02	tr.	0·54	0·46	1·28	1·68
P ₂ O ₅ ..	tr.	0·84	0·87	0·53	0·77	0·25	0·07	0·22	1·35	0·89
MnO ..	0·20	0·23	0·15	0·14	0·18	tr.	0·07	0·11	0·23	abs.
CO ₂ ..	abs.		pres.		abs.		0·49	0·71	abs.	abs.
S ..								0·06		
BaO ..								tr.		
Total ..	99·97	100·35	99·90	99·79	100·64	99·65	100·44	100·45	100·38	100·47
Sp. Gr. ..	3·393	2·912	3·085	3·017	2·871	—	2·679	2·653	3·237	3·425

I. Pyroxenite. II. Covite. III. Shonkinite. IV. Olivine-Monzonite. V. Coarse Monzonite. VI. Andesite (Latite). VII. Porphyritic Monzonite. VIII. Banatite. IX. Pyroxenite (Kedabekite). X. Melanite-Pyroxenite or Melteigite-Jacupirangite.

	I	II	III	IV	V	VI	VII	VIII	IX	X
Quartz							4·74	15·78	—	
Orthoclase	1·67	23·91	18·90	19·46	23·35	19·46	38·92	28·36	—	3·06
Albite	—	1·05	6·29	16·24	20·44	25·15	27·25	35·11	—	
Anorthite	17·51	23·07	15·57	27·80	17·51	26·69	15·57	11·12	24·74	23·91
Nepheline	1·70	15·34	3·98		3·98		—	—	1·24	1·99
Leucite	0·87						—	—	3·05	3·71
Corundum							1·43	1·43	—	
Diopside	52·87	15·95	34·08	13·66	18·18	11·68	—	—	57·27	11·66
Hypersthene				11·28		0·43	9·27	2·66	—	
Olivine	12·80	6·29	13·48	5·70	8·12	9·25	—	—	—	
Wollastonite							—	—	0·58	35·96
Ca. Orthosil.							—	—	0·86	
Magnetite	9·28	5·57	3·25	1·86	4·41	4·87	0·46	2·32	5·80	6·03
Haematite							—	—	—	8·00
Ilmenite	2·28	1·67	1·67	1·67	1·98		1·06	0·91	2·43	3·19
Apatite	0·34	2·02	2·02	1·34	2·02	0·67	0·34	0·34	3·02	2·02
Pyrite								0·12		
Calcite							1·10	1·60		
Class	IV	II*	III	II (III)	II (III)	II	I (II)	I	IV	IV
Order	(1)2 ₂	6	5(6)	5	5	5	4"	4"	1-2 ₁	2 ₁
Rang	2	3	3	3(4)	(2)3	3	2	2	3	3-4
Subrang	2	3	3	3	3	3"	3	3	2	2
Magmatic Name	Montreatose	cf. Borolanose	Kentallenose	Shoshonose	Shoshoseno (cf. Monzonose)	Shoshonose	Pulaskose (cf. Monzonose)	Toscanose	No Name	No Name

The variation in chemical constitution is shown more clearly when the analytical results are plotted on a form of variation-diagram, such as the type used by Harker (1909, p. 129), where the silica percentages are used as abscissae and the other oxides are plotted as ordinates. In this diagram (Text-figure 2) the garnet-bearing and nepheline-bearing rocks are considered independently of the monzonitic series, which makes it possible to draw relatively even curves through the mean positions of the points plotted to represent the various oxides in the monzonitic series.



Text-fig. 2.

(1). The range of silica percentage in the latter group is about 21 per cent., from ultrabasic with 43-63 per cent. to subacid with 64-49 per cent. of silica. The form of the curves is distinctive, and may be compared particularly with that figured by Harker (1909, p. 132) as a "Generalised Variation-Diagram for the Plutonic Complex of Magnet Cove, Arkansas, from Analyses given by Washington (1901)". In this case the range of silica (about 15 per cent.) is not so great

as that at Mt. Dromedary, although the shapes of the curves for the individual oxides are closely comparable: thus the alumina curve rises sharply from the basic end of the series until about 50 per cent. of silica is present, then continues as a flat, slightly convex curve; total iron oxides decrease from the basic to the acid end as a slightly concave curve; the curves for lime and magnesia show marked sympathy, both descending from the basic to the acid end as approximately parallel curves, that of lime being higher than magnesia in both the Magnet Cove and Mt. Dromedary series. The curves for potash and soda rise from the basic to the acid end; for the Mt. Dromedary series these two curves do not intersect as they do in the Magnet Cove series. Phosphorus and titania show flat curves, almost straight lines, falling slightly towards the acid end.

Two of the rocks in the series show slight variations from the normal curves. In the shonkinite the percentage of magnesia is greater than, and the percentage of iron is less than that required by the normal curves: this must be due to some difference in the composition of the dominant ferromagnesian mineral, augite.

It may be noticed also that two of the rocks, the olivine-monzonite and the coarse-grained monzonite, possess about the same amount of silica, but show slight, although distinct, differences in the percentages of the other oxides. On the whole the olivine-monzonite appears to conform with the normal, while the coarse-grained monzonite has lower percentages of alumina, lime and magnesia, and correspondingly higher percentages of iron and total alkalis than the olivine-monzonite. The olivine-monzonite is a relatively fine-grained marginal phase of the intrusion.

The diagram thus shows not only the variation within the Mt. Dromedary series, but also confirms the mineralogical evidence of the similarity of this and the Magnet Cove series.

Another interesting point is that in both series there has been developed a type of nepheline-shonkinite, covite, which is not a direct product of serial differentiation. Plotted according to the percentage of silica in the Mt. Dromedary covite, the positions for the abscissal points for iron, lime and magnesia fall much below, and those for alumina and alkalis much above, the curves for the respective oxides in the monzonitic series.

In his treatment of the magmatic differentiation at Magnet Cove, Arkansas, Washington (1901) has used a modification of a type of variation-diagram used by Pirsson (1900) for the Yogo Peak rocks in the Little Belt Mountains of Montana, in which the relative distances from the petrographic centre of the igneous mass are represented by the abscissal distances, and the molecular proportions of all the oxides (including silica) are used as ordinates. For the Yogo Peak series of four chemical analyses the curves are practically linear; for the Magnet Cove rocks (four analyses) they are distinctly flat curves.

By choosing a point about 1,000 feet below the Mount Dromedary Trigonometrical Station as the probable petrographical centre, and making allowance for the vertical as well as for the horizontal distribution of the rock-types, a diagram very similar to that of Magnet Cove was obtained for the six analyses of the Mt. Dromedary monzonitic series. (Text-figure 3.)

The accompanying table shows the molecular proportions on which the diagram is based.

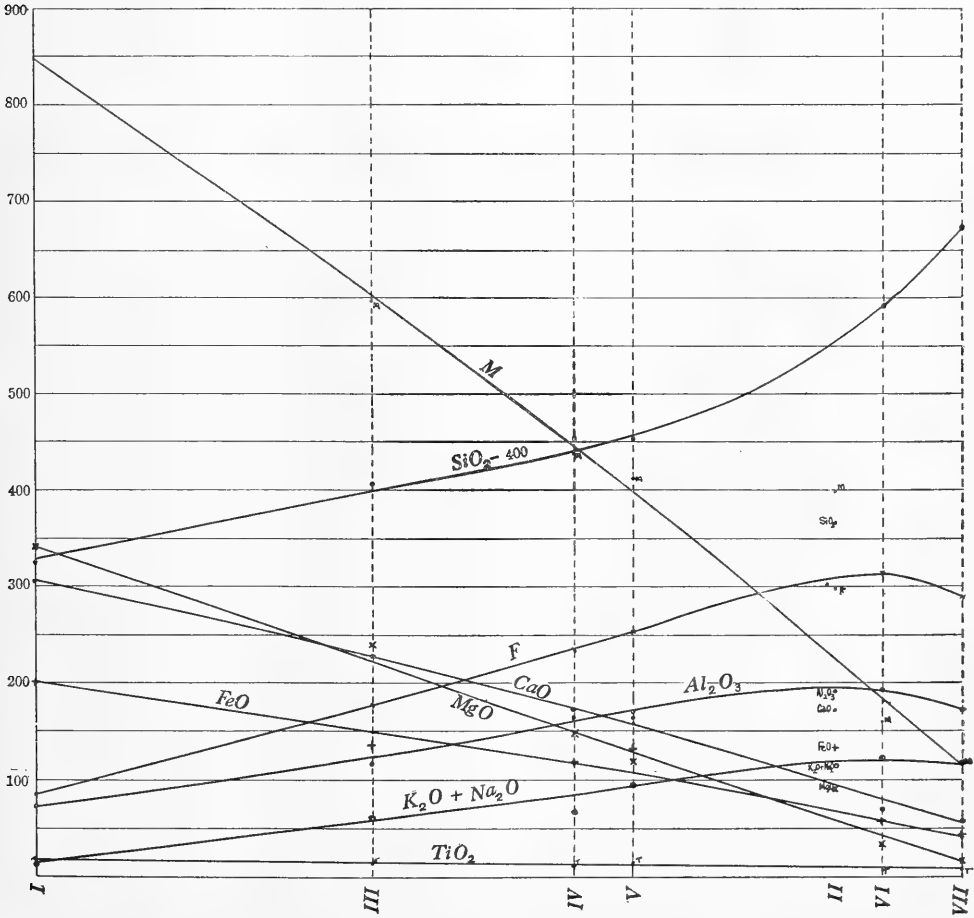
Total iron is calculated as FeO, and the curves F and M have the same significance as that assigned by Washington, F representing the sum of the ascending

curves, alumina and alkalis, and M the sum of the descending curves of the mafic constituents, lime, magnesia, and total iron as ferrous oxide.

The diagram shows remarkable regularity of the curves, which, however, are not straight lines, although over the basic end of the series they are approximately linear, as at Yogo Peak; as the series is traced towards the acid end, the curves simulate those obtained by Washington for the Magnet Cove Series, where that of silica becomes concave (upwards) while the others remain linear.

The Mt. Dromedary curves go beyond this stage, and with increasing silica the curves for alumina and alkalis become convex (upwards). The remarkable regularity of the curves suggests that where this type of diagram can be obtained for a given series, it represents the simplest and perhaps the best picture of the differentiation of the series.

As Washington states (1901, p. 657), "As all the curves are so smooth and well defined, it seems highly probable that equations for them could be found and that their properties as such could be discussed. In this way we could get



Text-fig. 3.

Table of Molecular Numbers.

	I	II	III	IV	V	VI	VII	VIII	IX	X
SiO ₂ ..	0.727	0.767	0.806	0.852	0.851	0.869	0.991	1.075	0.738	0.671
Al ₂ O ₃ ..	0.074	0.191	0.116	0.166	0.158	0.181	0.192	0.172	0.099	0.107
Fe ₂ O ₃ ..	0.040	0.024	0.014	0.008	0.019	0.021	0.002	0.010	0.025	0.076
FeO ..	0.119	0.086	0.107	0.101	0.092	0.067	0.054	0.024	0.086	0.047
Total FeO	0.200	0.133	0.136	0.118	0.131	0.109	0.058	0.044	0.137	0.199
MgO ..	0.342	0.093	0.240	0.147	0.117	0.128	0.032	0.016	0.210	0.054
CaO ..	0.305	0.173	0.228	0.173	0.163	0.155	0.070	0.059	0.390	0.470
Na ₂ O ..	0.006	0.056	0.026	0.031	0.053	0.050	0.052	0.067	0.005	0.007
K ₂ O ..	0.005	0.052	0.034	0.035	0.042	0.035	0.070	0.051	0.007	0.014
TiO ₂ ..	0.015	0.011	0.011	0.011	0.013		0.007	0.006	0.016	0.021
P ₂ O ₅ ..	0.001	0.006	0.006	0.004	0.006	0.002	0.001	0.001	0.009	0.006
MnO ..	0.003	0.003	0.002	0.002	0.003		0.001	0.001	0.003	
CO ₂ ..							0.011	0.016		
F.. ..	0.085	0.299	0.176	0.232	0.253	0.265	0.314	0.290	0.111	0.123
M ..	0.847	0.399	0.596	0.438	0.411	0.392	0.160	0.119	0.737	0.729

I. Pyroxenite. II. Covite. III. Shonkinite. IV. Olivine-Monzonite. V. Coarse Monzonite. VI. Andesite (Latite). VII. Porphyritic Monzonite. VIII. Banatite. IX. Pyroxenite (Kedabekite). X. Melanite-Pyroxenite or Melteigite-Jacupirangite.

an exact knowledge of the law of differentiation, in this particular case (Magnet Cove) at least."

To find an equation for a given curve is one of the most difficult problems of mathematics. The curves for the Mt. Dromedary series clearly indicate that the variation in the oxides cannot be represented by straight lines, a method which frequently has been adopted in petrological literature. A little consideration suggests that even if magmatic differentiation proceeded to its ultimate limit, the mathematical equations represented by the curves are probably bounded functions, for silica cannot increase without limit in an enclosed magma-chamber. Again, since the curves for the molecular proportions show such regularity, it seems probable that they all may be governed by the same underlying law, and may represent functions of the same mathematical form.

The curves for the function $\text{Sinh } nx$, for various values of n , have a general similarity to those given in the diagram, over a limited distance for $f(x)$. This is a bounded infinite series, which, if applicable to the rock series under consideration, will allow SiO₂ to have a definite maximum value, after which the curve will fall rapidly: since the other curves shown in the diagram, except CO₂, are falling in the same direction, it is obvious that some additional constituents will come into the series. This is approaching the limit of differentiation, when the volatile constituents are accumulating in the top of the magma-chamber, unless they have some means of escape into the country rock. This concentration of volatile constituents is a well-recognized final phase of differentiation, and at Mt. Dromedary is indicated by an appreciable amount of magmatic CO₂ in the two most acid of the analysed rocks, while traces of fluorine are known to occur in other specimens.

Under normal conditions these gases are free to escape, thus changing the conditions in the magma-chamber, and necessitating a recalculation of the relative percentages of the remaining constituents. It is conceivable that in some cases

the composition of the original magma might be such that in the final stages of consolidation, with release of the volatile constituents, the relative proportions of the oxides, particularly those of alumina and alkalis to silica, might increase sufficiently to produce alkali-rich rocks like nepheline-syenites and aplites, while in other cases where there was a good excess of silica in the original magma, the final phases of consolidation would consist of quartz-veins.

That the curves shown in the accompanying diagram might be represented by a function such as $\text{Sinh } nx$ is merely put forward as a suggestion perhaps worthy of testing on a series which has differentiated in a confined magma-chamber under quiet conditions, where gravity has been able to exert its full influence.

The curve, $y = \text{Sinh } nx$, is the differential of the curve for $\text{Cosh } nx$, which is the catenary, the form assumed by a heavy chain of uniform density hanging freely under gravity, and thus might represent the concentration of various constituents at a particular level in the magma. In the ideal case, the upward forces in the magma, molecular attraction and viscosity of the magma, acting against the force of gravity, might be analogous to the upward pressure at the points of attachment at the ends of the heavy chain.

(2). The position of the covite in this series is a matter of some doubt. In the field it occurs under the porphyritic banatite, so if it be assigned a position such as that shown in the diagram at II (Text-figure 3), silica, alumina, and total alkalis are more or less below the normal curves; and lime, iron and magnesia are all above them, the rock thus bearing exactly the same relation to the monzonitic series, as Washington found the covite to bear to the ijolite-jacupirangite series of Magnet Cove.

Washington has discussed in detail the apparent abnormality of the covite, and arrives at the conclusion that it is not a primary differentiation product, but the result of secondary or complementary differentiation of some portion of the main series. He concludes (p. 669) that since "the crystallisation of minerals from a molten magma is an exothermic change". . . "It is therefore conceivable that the solidification of a laccolithic mass may give rise to sufficient heat to remelt portions of it, which might easily remain liquid long enough for secondary differentiation to take place."

(3). The only analysis representing the composition of the latite group outcropping near Tilba Tilba Lake available at the present time is that made by J. C. H. Mingaye in the chemical laboratory of the Department of Mines, N.S.W., in connection with Anderson's work in 1892.

This analysis is quoted in the table above. It has already been pointed out that it closely resembles the analyses of the coarse-grained monzonite from the Central Tilba Quarries, the monzonite-porphry of Milton, and the Bumbo flow of latite or orthoclase-basalt of the Illawarra District. Naturally the norms of these rocks are very similar, and all fall into the same sub-rang, Shoshonose, according to the C.I.P.W. classification. Those of the analyses which have been published already are included in Washington's Tables, where they are grouped with monzonites and their hypabyssal equivalents.

When Mingaye's analysis is plotted on the variation-diagram for the monzonitic series at Mt. Dromedary (Text-figure 2) the points lie within one per cent. of the theoretical values required by the curves for the same silica percentage. It is considered that this not only shows undoubtedly the consanguinity of the monzonite and latite series at Mt. Dromedary, but also indicates that the composition of the magma from which the plutonic series was differentiated was

approximately that of the latite, and suggests that the origin of the magma is ultimately related to those of the Milton and Illawarra occurrences.

(4). The analyses and plots (Text-figure 2) of two end-members of the melanite series do not show any direct chemical relationship to the monzonitic series, although it is considered that the mineralogical evidence previously described shows their indirect relationship through the nepheline-bearing series. The individual chemical characters have been considered under the petrographical descriptions.

Compared with the basic end of the monzonitic series they are low in magnesia and iron oxides, with higher lime, alumina, and alkalis.

Summarizing, the trend of all the available evidence, field, mineralogical and chemical, indicates fairly clearly that the rocks of the four groups which have been considered, the monzonitic, the nepheline-bearing, the latitic, and the melanite-bearing, show varying degrees of magmatic relationship, and that probably they have all been derived from the same original magma.

(b). The Nature of the Intrusion.

Reference to the geological sketch-map of the Mt. Dromedary District shows a somewhat irregular, oval-shaped outcrop of igneous rocks surrounded by altered sedimentary rocks. Few vertical sections of the folded sedimentary series are available except along the sea-coast (Plate xxxvii, fig. 3), but the general trends or strike-directions have been determined in many places, and are indicated on the map. A study of these directions shows that the igneous mass has forced its way into the old sediments, either cutting them off abruptly, as on the south-eastern slope of Mt. Dromedary, or else bowing the beds round the igneous mass and changing the strike-directions by as much as 45 degrees from the normal, clear evidence of the intrusive nature of the igneous mass.

As the intrusion was able to exert such lateral force, it is probable that considerable vertical force was exerted also, and that the cover was lifted as a dome over the top, although only a few remnants survive. A small outcrop of slaty rock forms a capping on the hill above the olivine-monzonite on the road from Tilba Tilba to Cobargo, and the general field-relations of the slates and monzonites about a mile east and north-east of Central Tilba suggest that the slates here are portions of the original sedimentary cover.

Further evidence of the intrusive nature of the occurrence is afforded by the slight contact metamorphic effects superimposed on the more widely-spread regional metamorphism of the series. Thus on the south-eastern slopes of Mt. Dromedary the sandy quartz-schists have been hardened for a distance of 15 or 20 feet from the contact, and similar effects occur elsewhere. Near the Tilba Tilba Cemetery and south-east of Tilba Tilba Swamp, some of the softer, more aluminous bands of the country rock have been converted into spotted and knotted schists, containing incipient crystals of andalusite.

Although there can be no doubt of the intrusive nature of the igneous rock, the form of the intrusion is not so apparent. The size and shape of the intrusion, and the general internal arrangement of the rock-types, so far as is revealed, suggest that it is in the form of either a laccolith or a stock.

The longest diameter of the outcrop of the igneous types is between eight and nine miles in length, in an east-west direction through the Dromedary Trigonomical Station, the direction of the hypothetical section shown on Plate xxxv.

The plutonic rocks occur from below sea-level to the top of the mountain

(2,613 feet) so that the central portion of the mass has a minimum thickness of the order of 2,700 to 3,000 feet, or approximately half a mile.

In plan, the disposition of the monzonitic types is normal, in that the more basic phases are arranged peripherally with respect to the more acid, while there seems good reason for believing that the same orderly arrangement prevails in vertical section, and that the more basic phases occur successively beneath the more acid. Thus the upper portion of the Mountain consists of fine-grained banatite, which in its upper portion has been affected by pneumatolytic and deuteric agencies, and which gradually passes into a porphyritic phase at its lower boundary (see Plate xxxvi). An "outlier" of the porphyritic monzonite occurs on the top of the Little Dromedary.

Typical monzonite outcrops on the lower slopes surrounding the Mountain and, on the whole, this phase is in contact with the intruded sediments, which here may be considered as portions of the roof of the intrusion. The more basic pyroxenite or jacupirangite occurs at a lower level, and outcrops naturally only along the sea-shore near Poole's Point. Indirect evidence of its probable occurrence below the monzonite further inland is afforded by the occurrence of related types, essexite and shonkinite, at low altitudes, and the presence of inclusions of pyroxenite and related types in the fine-grained monzonites on the western and southern slopes of the Little Dromedary, as well as in the small latitic neck in the Parish of Wandellow, west of Mt. Dromedary.

The evidence so far strongly suggests a laccolithic character for the intrusion.

On the other hand the nature of the invaded sediments does not seem favourable for the development of this type of intrusion: usually laccolithic intrusions are concordant, occurring in horizontally-bedded strata, or along a surface of weakness such as an unconformity. Here the rocks are thin-bedded, highly-folded sediments, which are much jointed, and no definite evidence of unconformity at Mount Dromedary has been recognized up to the present time. Nevertheless, it is known that in this region, igneous injection has taken place between sediments of Ordovician and Devonian ages, either along an unconformity or else along a faulted junction. One such occurrence is near Cobargo, within 10 miles of Mt. Dromedary, so that the possibility of intrusion here under similar circumstances should not be overlooked.

In the Little Belt Mountains of Montana, at Yogo Peak and its easterly extension, there is a somewhat similar series of igneous rocks, which was described by Weed and Pirsson (1895, p. 467), and later by Pirsson (1900, p. 564). The principal rock-types are granite-porphry, banatite, monzonite, and shonkinite, a series comparable with that at Mt. Dromedary. The intrusion is "from half a mile to a mile in width and several miles in length", with the more basic portions at each end. Pirsson is of the opinion that the "Yogo Peak intrusion is of the nature of a stock, in which differentiation took place *in situ*" (1900, p. 564), or alternatively that laccolithic differentiation took place below, "followed by a later upward movement of the mass".

In the Highwood Mountains of Montana there are several volcanic stocks which have been described by Pirsson (1905), and which show an irregular arrangement of the included rock-types. Associated with these stocks are three other occurrences containing rocks of the same series, syenite and shonkinite, at Shonkin Sag, Palisade Butte and Square Butte. Pirsson was at first of the opinion that Square Butte was of the nature of a stock, but after the study of the Shonkin Sag occurrence he considered that the three intrusions are laccoliths,

"in different stages of dissection", and accordingly he modified his section through Square Butte.

Again, at Loch Borolan in north-west Scotland a similar sequence of granite, syenite, melanite-syenite, melanite-nepheline-syenite and melanite-pyroxenite occurs as a laccolith, according to the interpretation of Shand (1909-10, 1927).

R. Balk (1925, p. 685) gives a section through the granite at Bethel, Vermont, in which the igneous rock assumes a laccolithic form, although the country-rock is a "finely plicated, very fine grained quartz-muscovite-biotite schist". (T. N. Dale, 1923, p. 84).

A consideration of all the known facts therefore gives support to the idea that the form of the intrusion at Mount Dromedary is really laccolithic; also there is a possibility that it may have been an interformational intrusion, whose cover has been completely eroded.

(c) History of the Intrusion.

The history of the intrusion appears to have been a complicated one; as a whole the igneous rocks are intrusive into altered sediments, and the intrusion probably assumes a laccolithic form.

The magma which produced the principal monzonitic series was injected first, and the nepheline-bearing series was probably derived from some phase of the monzonitic complex by secondary differentiation. The relation of the melanite-bearing series is less evident, but the series may be intrusive into the monzonitic. The latitic rocks have intruded the plutonic series, and a number of aplitic and lamprophyric dykes are at least partially later than all other rocks of the complex, having been injected along joint planes and potential fissures in both the monzonitic and latitic series. The closing phase of igneous activity was accompanied by metalliferous deposition on a small scale; the veins of auriferous pyrites associated with the dykes on the top of Mt. Dromedary are to be referred to this phase.

The field, mineralogical, and chemical evidence indicates that the rocks previously described have a common origin, although the degree of consanguinity varies. Probably a volume of magma of the composition of the latite was injected into the position now occupied by the Mt. Dromedary complex. This mass has an area of 25 to 30 square miles and a thickness of about 3,000 feet in its central portion, thinning out towards the margins. The simplest explanation of the field-association of the members of the monzonitic series is that differentiation took place *in situ* by means of fractional crystallization and the sinking of crystals under gravity, as postulated by Bowen (1915, 1919), Harker (1909, p. 317, 1913) and others. This idea of the differentiation is represented diagrammatically in the section on Plate xxxv.

This type of laccolithic differentiation is well recognized in occurrences such as at Shonkin Sag (Pirsson, 1905), Loch Borolan (Shand, 1909-10, 1927), and the laccolites of Duluth (Van Hise and Leith, 1911, and others), Sudbury (Coleman, 1907, Coleman and others, 1929) and Bushveld (Brouwer, 1917, Daly and Molengraaf, 1924).

If the differentiation did not take place *in situ*, a similar process must have occurred at a lower depth, with successive injections of the various phases into positions similar to those required under the former hypothesis. The gradual transition of the fine-grained banatite into the porphyritic monzonite indicates that these two phases at least belong to the same period of intrusion: the actual

junction between the porphyritic monzonite and the coarse-grained monzonite is rarely exposed, although in general the former outcrops at higher levels than the latter. In some of the smooth rock-exposures on the mountain slopes west of Tilba Public School, the two distinct types come into sharp contact with one another, with no apparent contact-metamorphic effects in either rock. South-west of Tilba Tilba village a dyke-like mass of porphyritic-monzonite, about two feet in width, apparently intrudes the monzonite. Evidently some movement took place during the consolidation of the banatite, with partial injection of the banatite into the partially consolidated monzonite, a process not altogether incompatible with the idea of gravitative differentiation in place, and one which is recognized by Coleman (1907), Daly (1914), Bowen (1915) and others.

The coarse monzonite and the pyroxenite are not exposed in sharp contact, but the low headland on the western side of Tilba Tilba Lake exposes a basic phase of the monzonite which, with its low feldspar content, approaches the composition of the typical pyroxenite occurring on the opposite side of the Lake.

The bulk of the evidence is thus in favour of laccolithic differentiation in place.

The nepheline-bearing series presents some puzzling features. These rocks appear to underlie the porphyritic monzonite of the top of the Little Dromedary, and within themselves show a variation in mineral constitution and specific gravity suggestive of gravitative differentiation and also of lateral segregation of alkalis away from the main monzonitic intrusion, which is reminiscent of Harker's descriptions (1917) of the Mull District, where the alkaline facies occurs about the borders of the more calcic, indicating lateral creep of alkaline magma. Bowen (1915) recognizes a similar arrangement of the alkaline and subalkaline rocks on a large scale.

The chemical composition of the nepheline-shonkinite or covite, low in silica, iron, lime and magnesia, and high in alkalis and alumina, is one which might be produced by the squeezing out of residual liquid from a partially crystallized magma of monzonitic composition.

The physico-chemical conditions of the crystallization of magma are so imperfectly known that one hesitates to express an opinion as to the stage at which particular members of an igneous series are completely crystallized. If the magma had reached the stage when the pyroxenite was potentially solid, and the overlying monzonite was largely crystalline, with a strong crystal mesh, and the banatite had differentiated sufficiently to form a lower porphyritic phase, it is conceivable that physical disturbance of the laccolith at this stage might produce apparent intrusive relationships of the porphyritic banatite with respect to the monzonite, and that the altered physical conditions within the monzonite might result in the squeezing out of the still-liquid alkaline portion to form the nepheline-monzonites, with possible recrystallization of the solid phase.

That some such disturbance took place is suggested not only by the facts mentioned previously, but also because the olivine-monzonite, a marginal phase of the monzonitic stage, appears to be the normal product of differentiation according to the variation-diagram (Text-figure 2), whereas the coarse-grained grey monzonite (analysed) varies distinctly from this normal, and the black monzonite (not analysed) is a quartz-bearing type, which is intimately related to the grey variety in the field.

It is therefore suggested that the magma which produced the nepheline rocks of the Little Dromedary was derived from the more normal phase of the im-

perfectly crystallized monzonitic magma, by the squeezing out of liquid magma during a physical disturbance of the laccolithic mass.

This is a special application of the principles of crystallization-differentiation such as postulated by Bowen (1915), combined with the views of Harker (1917) regarding the manifestation of alkaline rocks as a result of earth movement. The subsequent crystallization of the alkaline magma evidently was effected more rapidly than that of the normal monzonite, for more finely-crystalline rocks were produced, although gravitative differentiation took place to some extent.

The origin of the melanite-bearing series or melteigite-jacupirangites is much more obscure. The rocks apparently intrude the nepheline-monzonites in some places, while in other places there seems to be a gradual transition from the one series to the other, as though the garnet were partly of pneumatolytic origin, or at least had been formed during the final phases of consolidation of the rock.

The available evidence is insufficient to show conclusively the origin of this interesting series. Mineralogically it appears to be indirectly related to the nepheline-bearing and monzonitic series. The chemical composition of the series as a whole is distinctive, although the least basic member somewhat resembles the pyroxenite-jacupirangite in composition, suggesting that it may be a product of secondary differentiation of this basic phase of the more normal monzonitic magma. The series is peculiar in containing high percentages of lime, combined with low amounts of iron and magnesia, thus resembling the melteigites described by Brøgger (1920) from the Fen Region, Christiania, which also occur in association with rocks of definitely alkaline facies.

At Loch Borolan, Scotland (Shand, 1909, 1910, 1927), at the Kruger Mountain, British Columbia (Daly, 1912), and in the Rainy River District, Ontario (Lawson, 1896), garnet-bearing rocks again occur in association with alkaline types.

It would thus appear that the origin of the garnet-bearing rocks is related to that of the alkaline rocks with which they are usually associated.

Theories to account for the distribution and origin of alkaline rocks include those of A. Harker (1909, 1917), N. L. Bowen (1915, 1919), R. A. Daly (1910, 1914), H. I. Jensen (1908), C. H. Smyth (1913, 1927), S. J. Shand (1927), and others, who emphasize different factors which lead to the manifestation of alkaline rocks at the surface of the earth.

A study of the geographical distribution of the alkaline rocks shows that they frequently occur as marginal facies of granodioritic batholiths, or as separate intrusions some distance in advance of the batholiths which have been injected into the growing continental mass, thus occurring in a zone of fracture between the continent and the adjacent area of marine sedimentation. This zone is often a region of former shallow-water sedimentation, in which the formation of calcareous organic deposits is not unlikely, and may be a natural reason for the frequent association of alkaline igneous and calcareous sedimentary rocks.

Unless the magma possessed some initial peculiarity such as that postulated by Jensen (1908), the real cause of the formation of alkaline rocks seems to be a relative desilication of more normal magma, which may be brought about either by a process of differentiation in the magma itself, or else by assimilation or partial assimilation of foreign material, particularly limestone, with subsequent differentiation. The former hypothesis is that supported by Bowen, while the latter theory is held by Daly and Shand.

The occurrence of lime-garnet-bearing rocks in association with monzonitic or alkaline rocks, such as those at Mount Dromedary, might then be the result of

either (i) pure magmatic differentiation, (ii) assimilation of limestone by the magma, with subsequent differentiation, or (iii) contact metamorphism of limestone beds, with the introduction of silica, iron, magnesia and alumina from the magma.

Consideration of the chemical composition of the garnet-bearing series with reference to the normal monzonitic series, shown graphically in the variation-diagram (Text-figure 2), indicates that it is not a product of serial differentiation of the monzonitic magma; if the series be the result of complementary or secondary differentiation of a magma, say, of the composition of the pyroxenite-jacupirangite, no similar case is known to the writer, and it is difficult to account for the unusually high percentages of lime and other peculiarities. It is, therefore, considered improbable that the garnet-bearing rocks are due entirely to magmatic differentiation.

On the other hand, their close similarity to silicated limestones or skarn-rocks, such as those developed at Tallong, which are undoubtedly due to contact metamorphism of limestone, certainly indicates that the possibility of contamination by limestone should not be overlooked.

No calcareous rocks are known to outcrop within 50 miles of the Mount Dromedary igneous complex and there seems no evidence for supposing that any exist beneath the older Palaeozoic schists, phyllites and quartzites of the region; certainly none occurs close to the intrusion and the positions of the outcrops of the garnet-bearing rocks are such as to preclude the possibility that they are due to simple contact metamorphism. If, however, bands of limestone, so far undiscovered, are intercalated in the older Palaeozoic schist series, it is conceivable that during injection through the sedimentary series the magma may have incorporated masses of limestone, completely dissolving the rock, and allowing the carbon-dioxide to escape, with the subsequent formation of lime-rich rocks, such as those under consideration.

Similar conditions evidently prevail in the Fen District, Norway, where the nearest limestone outcrop is 40 to 60 kilometres distant from the Melteig series. In accepting Daly's hypothesis and applying it to the Fen series of melteigites, Brøgger (1920, p. 357) supposes the existence of older limestone beneath the Pre-Cambrian granite of the district.

If such has been the origin of these rocks, then the melteigites of Mount Dromedary and Melteig may be regarded as special developments of skarn-rocks, not in the country rock, but within the igneous mass itself.

The production of nepheline-bearing rocks would be a natural corollary of the limestone-assimilation hypothesis of Daly, which recently has been supported by the field evidence of C. E. Tilley (1929). This may be the explanation of their occurrence in the Mount Dromedary district. In the absence of definite field-evidence the solution of the problem of the origin of both series must await future investigation.

(vi) *The Age of the Igneous Rocks.*

Although some references have been made concerning the field-relations of the various members of the igneous complex, their relative ages have not been expressly stated.

As a whole the plutonic series is considered to be older than the hypabyssal latites on account of the intrusive relationship of the latter towards the porphyritic

monzonite on Montague Island, and also because of the inclusion of plutonic types in the latitic neck, west of Mount Dromedary.

This is in agreement with O. von Huber's determination of the order of eruption of similar series in the classic region of Monzoni, Tyrol (see Daly, 1914, p. 482), but both W. C. Brøgger (1895, p. 114) and W. Penck (1911, p. 341) maintain that the reverse order of intrusion took place for the series at Monzoni and Predazzo.

The plutonic series is believed to be the result of differentiation, in place, of a magma intruded during a single period, the order of consolidation of the rock-types being normal, that is, from the ultra-basic pyroxenite to the acid banatite. The nepheline-bearing and melanite-bearing rocks may be due to secondary differentiation within the laccolite, although they sometimes appear to show intrusive relationships towards the monzonitic rocks.

The hypabyssal dyke-rocks appear to be of slightly later date, the aplitic phases being the youngest of the complex.

Of the absolute age of the intrusion there is little definite field-evidence, beyond the fact that it is intrusive into older Palaeozoic sediments, and is therefore of Post-Silurian age.

Consideration of the chemical composition of the series as a whole shows its remarkable similarity to that of the Milton and Illawarra monzonitic occurrences, which are of Permo-Carboniferous age, and suggests that the three occurrences may have been approximately contemporaneous, the South Coast being a monzonitic petrographical province during late Permo-Carboniferous time.

The only other published description of monzonite in this State is that of the Kiandra olivine-bearing quartz-monzonite (Browne and Greig, 1922, p. 260) but no evidence of its age is recorded.

The subalkaline granodioritic intrusions of south-eastern New South Wales are of late Devonian or post-Devonian age; the lamprophyric and monchiquitic dykes and sills of the Illawarra District (Harper, 1915) have distinctly alkaline affinities, and probably belong to the post-Cretaceous or early Tertiary period of igneous activity in New South Wales. Between these intrusions, both in geological time and in composition of the magma, are the monzonitic intrusions and extrusions of the South Coast, indicating a progressive variation in the alkalinity of the injected magma throughout geological time. The somewhat less alkaline analcite-bearing basalts of late Tertiary age are associated with different types of earth movement, and possibly have a different origin.

In the absence of more definite evidence it therefore seems highly probable that the intrusion at Mount Dromedary took place in late Palaeozoic, Permo-Carboniferous time.

COMPARISON WITH SIMILAR OCCURRENCES IN OTHER PARTS OF THE WORLD.

The variety of co-magmatic rock-types occurring in the Mount Dromedary complex makes it one of more than ordinary interest from a petrographic point of view. Many of the rock-types are of rare occurrence and some are described for the first time in Australia. Except for the quartz-monzonite at Kiandra (Browne and Greig, 1922) no truly plutonic monzonitic series has been recorded from this State; the nepheline-bearing monzonites and shonkinites, and the melanite-bearing ijolite and pyroxenites are the first of their kind known to occur in Australia.

The Mount Dromedary series as a whole shows many of the characteristics of Harker's (1909, p. 91) Atlantic branch, although none of these features is very pronounced, as the rocks are mostly monzonitic, or intermediate between his Atlantic and Pacific types.

The writer knows of no single province in which all the types occurring at Mount Dromedary are represented: throughout the descriptive portion of the paper comparative references have been made to a number of isolated occurrences of similar rock-types, and repeated references to some of these indicate a few series which show remarkable resemblances to portions of the Mount Dromedary complex.

The most important of these are the monzonitic series of the Highwood Mountains, Montana, and the Little Belt Mountains, Montana; the ijolite-jacupirangite series of Magnet Cove, Arkansas; the melteigite series of the Fen District, Norway; and in some respects the series of Loch Borolan, Scotland.

Of the Highwood Mountains, Montana, Pirsson (1905, p. 20) states, "the general geology . . . is that of a group of extinct or greatly eroded volcanoes. . . . On the south-east of the mountains, and scarcely separated from them, is a restricted area of intruded sheets and laccoliths".

The plutonic rocks include a syenite (pulaskose) and monzonite (shoshonose) from Highwood Peak stock, which are chemically similar to the banatite and monzonites of Mount Dromedary, whose analyses are given in Tables 1, 3 and 4; while the laccoliths of Shonkin Sag, Palisade Butte and Square Butte consist of syenite and shonkinite, rocks very similar to those occurring at Mount Dromedary whose analyses are quoted in Table 5. The ultrabasic types are not developed in the Highwood Mountains.

In the Little Belt Mountains a somewhat similar sequence occurs. The most important intrusion is that of Yogo Peak and its north-easterly extension, the petrography of which was described by Pirsson (1900). Here the chief plutonic types are granite-porphry, syenite (banatite), monzonite and shonkinite, whose analyses, quoted in Tables 1, 2 and 5, are also comparable with the Mount Dromedary types. The intrusion is considered to be in the form of a broad thick dyke (p. 564), between half a mile and a mile in width, and several miles in length. The arrangement of the various types is analogous to that at Mount Dromedary: in plan, the granite-porphry occupies the central portion of the outcrop; this grades into banatite (syenite) followed by monzonite, with shonkinite at each end of the intrusion.

Reference has been made several times in this paper to the foyaite-ijolite series of Magnet Cove, Arkansas, described by Williams (1890) and Washington (1900, 1901). The series as a whole is less acid than that at Mount Dromedary, although a parallel series of differentiated rock-types has been produced. Those showing close resemblance to the Mount Dromedary types include the ijolite, covite and jacupirangite, the analyses of the last two being quoted in Tables 6 and 7 respectively. According to Washington the spacial arrangement of the various members of the series is anomalous, in that the more basic types occupy the central portion of the occurrence. Harker (1902), in reviewing Washington's papers, suggests that the central exposure of more basic rock may be the uplifted base of the lower of two laccoliths, the form possibly assumed by the intrusion.

The garnet-bearing rocks of Loch Borolan (Shand, 1909, 1910), and the Fen District, Norway (Brøgger, 1920), are somewhat like the melanite rocks of the Tilba District, and reference has been made to them above in this connection.

SUMMARY.

The paper includes a geological sketch-map and description of a complicated series of igneous rocks outcropping in the Mount Dromedary District and on Montague Island, on the South Coast of New South Wales.

The igneous complex is intrusive into metamorphosed sediments of early Palaeozoic age. The main intrusion outcrops over an oval-shaped area of about twenty-five square miles, and probably assumes a laccolithic form, having a thickness of about 3,000 feet in the centre, and thinning out towards the margin. Several smaller intrusions occur at or near the border of the main laccolith.

The igneous complex consists of plutonic and hypabyssal types. The plutonic series contains three main groups: (i) a normal monzonitic series consisting of banatite, porphyritic monzonite, quartz-monzonite, olivine-monzonite, shonkinite and pyroxenite (jacupirangite), (ii) a nepheline-bearing series, including ijolite, nepheline-monzonite and nepheline-shonkinite (covite) and (iii) a melanite-bearing series of pyroxenites, comparable with the melteigites and melteigite-jacupirangites of the Fen District, Norway. Fragments of essexite and olivine-gabbro or pyroxene-granulite occur as inclusions in the hypabyssal intrusions.

The hypabyssal rocks include andesitic and lamprophyric types, which are really latites, or fine-grained equivalents of the monzonites, and which resemble some of the varieties outcropping at Milton, north of Mount Dromedary; also a series of aplitic and lamprophyric dyke-rocks and segregation veins.

A study of the field-occurrence and associations of these igneous rocks, and of their mineralogical and chemical compositions shows that probably they are all comagmatic, but that the degrees of consanguinity of the different groups vary. It is considered that the main monzonitic series composing the laccolith has been produced as a result of the differentiation of a monzonitic magma in place, by means of fractional crystallization and the sinking of crystals, and that the nepheline-bearing series may have been derived from some phase of the normal monzonitic magma as a result of secondary differentiation.

The origin of the garnet-bearing series is more obscure; it may be due to secondary differentiation of a basic phase of the magma, or it may be the result of assimilation of limestone by the monzonitic magma, with subsequent differentiation. At present no limestone is known to outcrop within 50 miles, so that the solution of the problem of the origin of the garnet-bearing rocks must await future investigation.

Direct evidence of the age of the intrusion is scanty, but the chemical similarity of the series as a whole to the monzonitic rocks of Milton and the latitic flows of the Illawarra District, indicates a probable late-Palaeozoic, Permian-Carboniferous age for the intrusion.

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For comparative purposes free use has been made of rock collections in the Geological Museum, Sydney University, of material from various parts of Norway; from the Monzoni district, Tyrol; from the Assynt district, and the Isle of Rum, Scotland; from the Highwood Mountains, Montana, and Magnet Cove, Arkansas; and elsewhere.

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EXPLANATION OF PLATES XXXV-XXXIX.

Plate xxxv.

Geological Sketch-map of the Mount Dromedary District; and generalized Section (natural scale) in an east-west direction through Mount Dromedary Trigonometrical Station and the village of Central Tilba.

Plate xxxvi.

1. Panoramic view from a hill south-west of Tilba Tilba village looking to the north-east, showing the foothills of Mount Dromedary, the Little Dromedary and Tilba Tilba Swamp.
2. Panoramic view from the top of the Little Dromedary looking westwards to Mount Dromedary, showing the villages of Tilba Tilba and Central Tilba, on the Main Southern Road or Prince's Highway.

Transparencies (Plate xxxvii) indicate the outcrops of some of the principal rock-types described in the paper.

Plate xxxvii.

1. Large tors of porphyritic monzonite on Montague Island. One in the central upper portion of the photograph was quarried for the construction of the Lighthouse.
2. View of the eastern coast of Montague Island, showing strong jointing of the porphyritic monzonite, and its intrusion by dyke-like masses of lamprophyre.
3. Coastal cliff-section near Mount Dromedary, showing folded and faulted quartzites of lower Palaeozoic age.

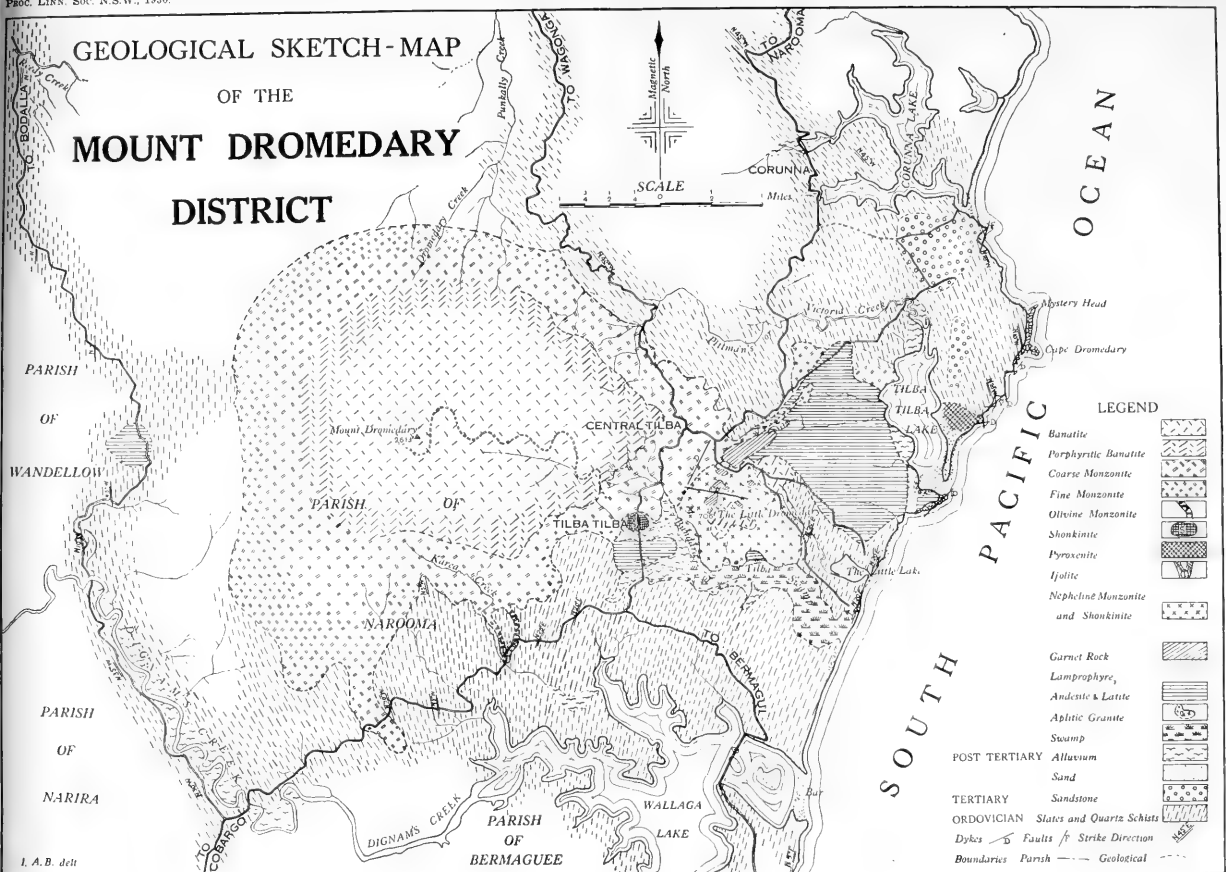
Plate xxxviii.

1. Banatite (M.402). Track from Tilba Tilba up Mt. Dromedary. Typical section. Crossed Nicols. $\times 17$.
2. Myrmekite-perthite in segregation vein in monzonite (M.439). Central Tilba Quarry. Plates of orthoclase intergrown with vermicular plagioclase of higher refractive index. Plane polarized light. $\times 13$.
3. Coarse Monzonite (M.440). Central Tilba Quarry. Showing monzonitic fabric. Crossed Nicols. $\times 13$.
4. Olivine-Monzonite (M.564). Cobargo Road, $2\frac{1}{2}$ miles from Tilba Tilba. Showing fine monzonitic fabric. Crossed Nicols. $\times 17$.
5. Olivine-Shonkinite (M.450). Tilba Tilba. Showing augite and orthoclase. Crossed Nicols. $\times 17$.
6. Covite (Olivine-Shonkinite) (M.458). Eastern Slope of Little Dromedary. Showing large plate of nepheline with inclusion of other minerals. Crossed Nicols. $\times 17$.

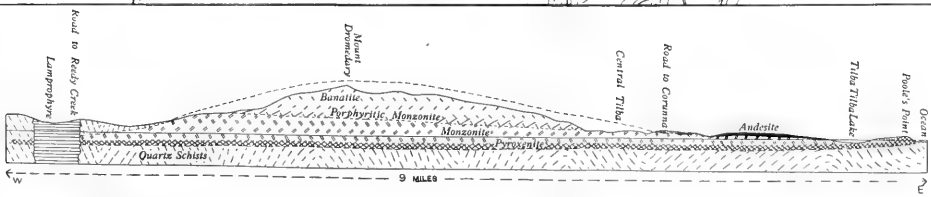
Plate xxxix.

1. Olivine-gabbro (Pyroxene-granulite) (M.663). Inclusion in latitic neck, west of Mt. Dromedary. Crossed Nicols. $\times 17$.
 2. Essexite (M.667). South-west of the Little Dromedary. Crossed Nicols. $\times 17$.
 3. Pyroxenite (Jacupirangite) (M.476). Poole's Point, north of Tilba Tilba Lake. Showing cleavages in augite. Plane polarized light. $\times 17$.
 4. Ijolite (M.553). Cobargo Road, $2\frac{1}{2}$ miles from Tilba Tilba. Showing colour-zoned pyroxene, melanite and nepheline. Plane polarized light. $\times 17$.
 5. Melanite-melteigite (M.492). East of Central Tilba. Showing melanite in close association with green pyroxene. Plane polarized light. $\times 17$.
 6. Melanite-melteigite-jacupirangite (M.497). South-east of Central Tilba. Showing large colour-zoned crystal of melanite, with a core of green pyroxene. Plane polarized light. $\times 17$.
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GEOLOGICAL SKETCH-MAP OF THE MOUNT DROMEDARY DISTRICT

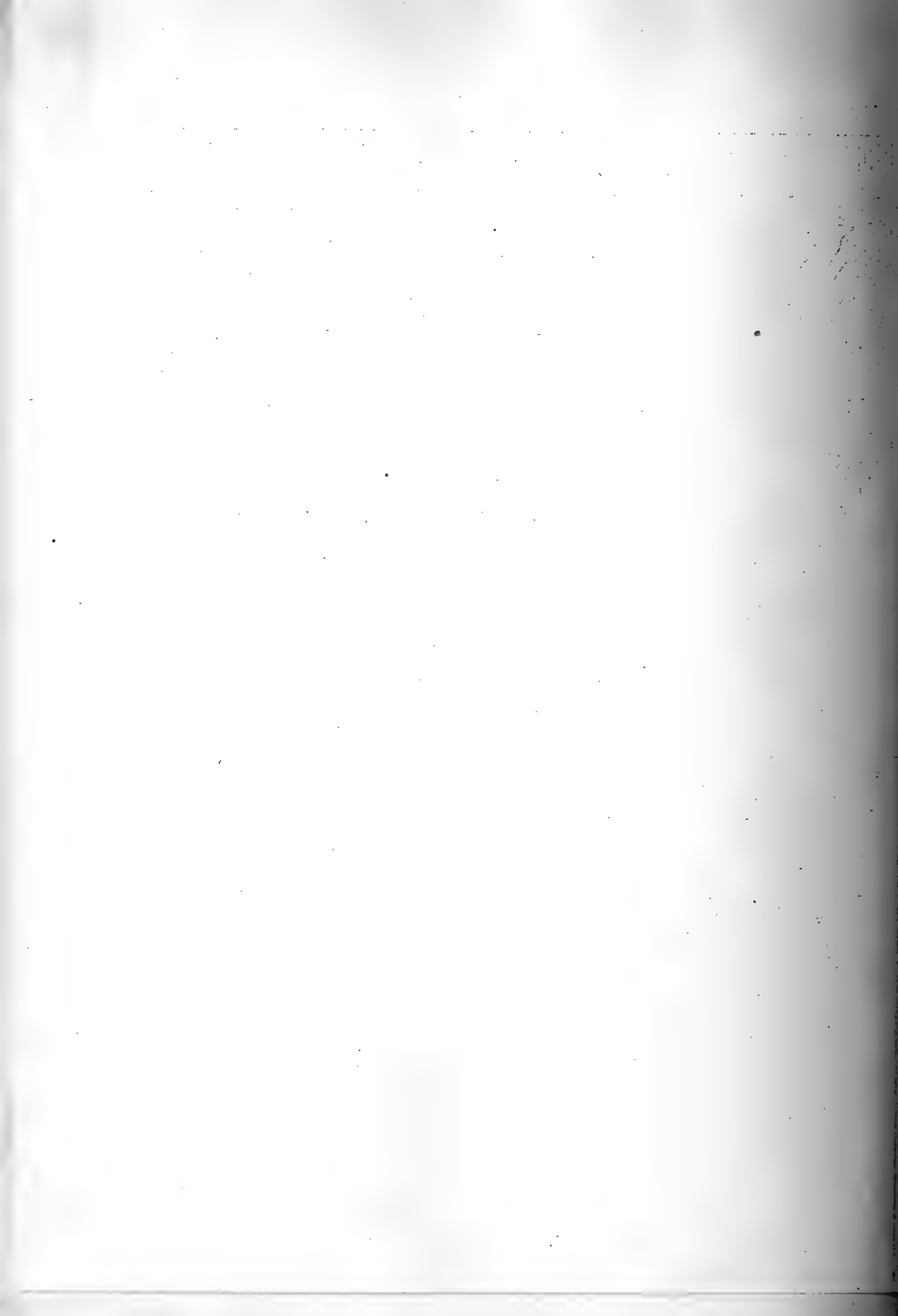


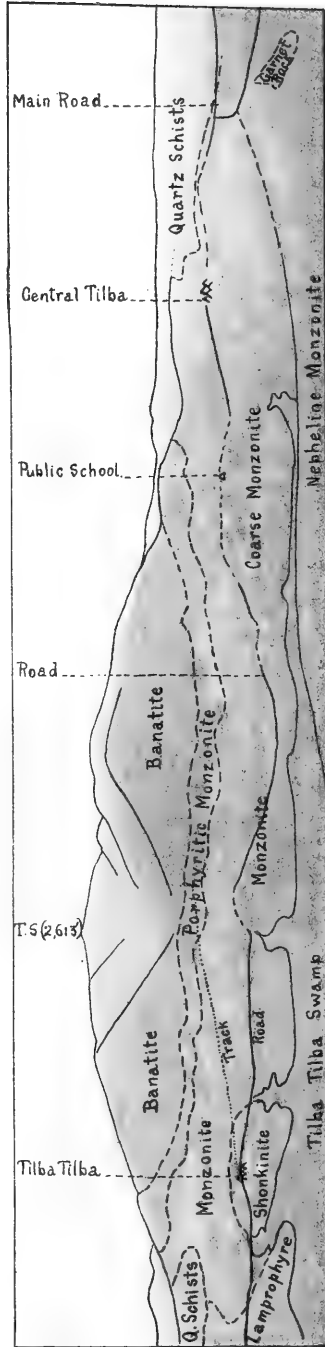
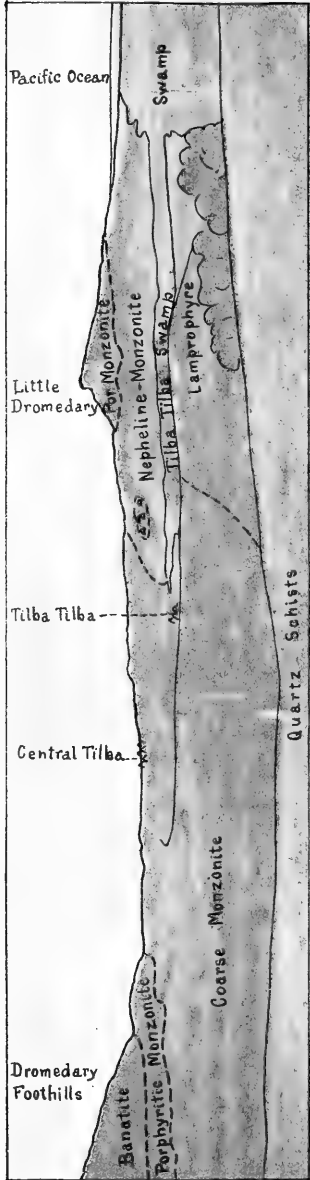
- LEGEND**
- Banatite
 - Porphyritic Banatite
 - Coarse Monzonite
 - Fine Monzonite
 - Olivine Monzonite
 - Shonkinite
 - Pyroxenite
 - Isfuite
 - Nepheline Monzonite and Shonkinite
 - Garnet Rock
 - Lamprophyre, Andesite & Latite
 - Aplitic Granite
 - Swamp
 - Alluvium
 - Sand
 - Sandstone
 - ORDOVICIAN Slates and Quartz Schists
 - Dykes
 - Faults
 - Strike Direction
 - Boundaries Parish
 - Geological



Generalized section in an east-west direction through Mount Dromedary Trigonometrical Station and the village of Central Tilba (Natural scale.)

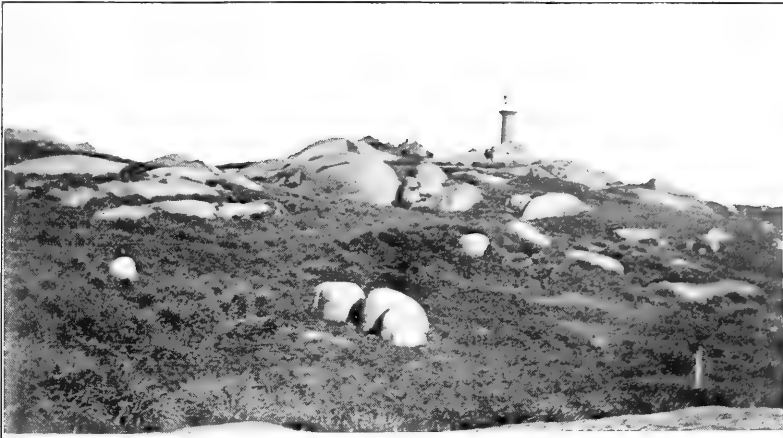
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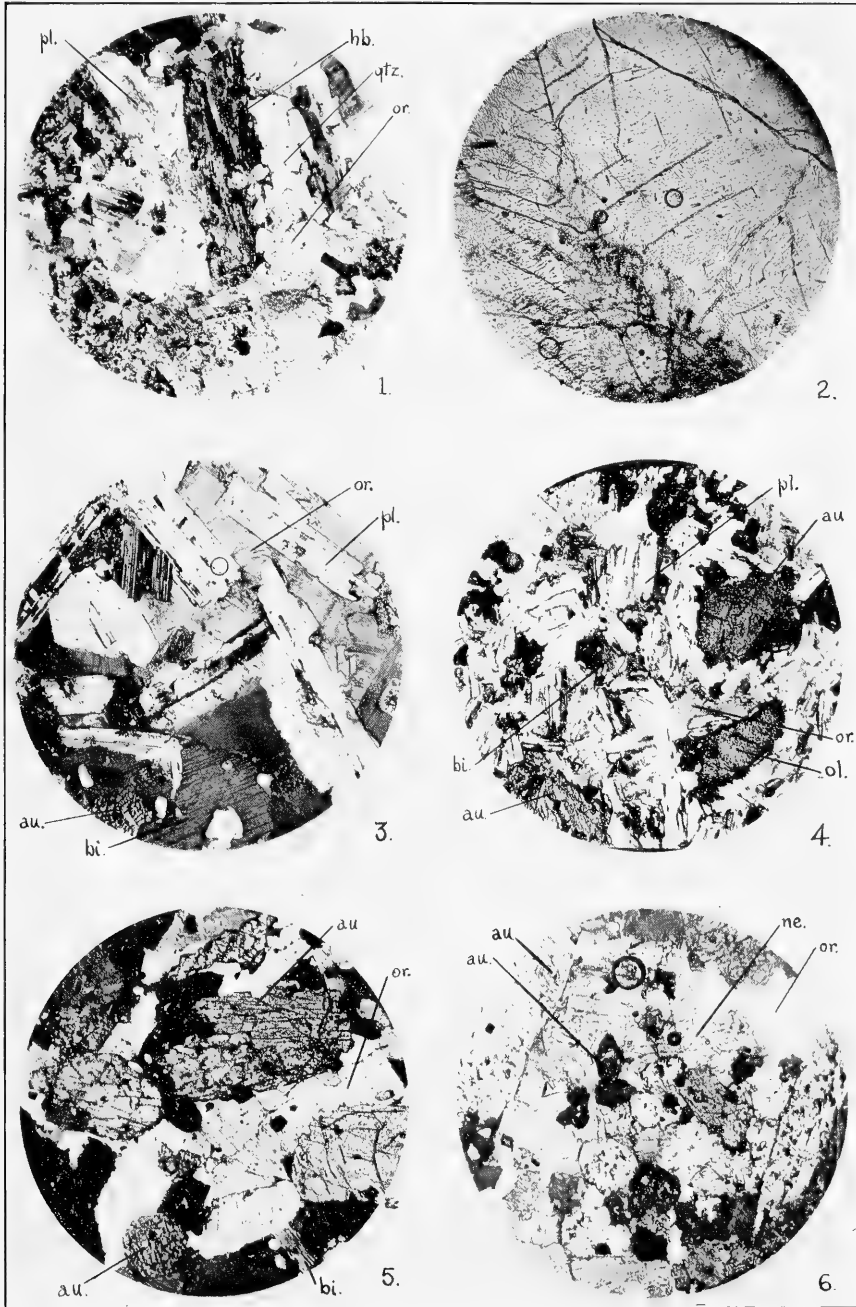


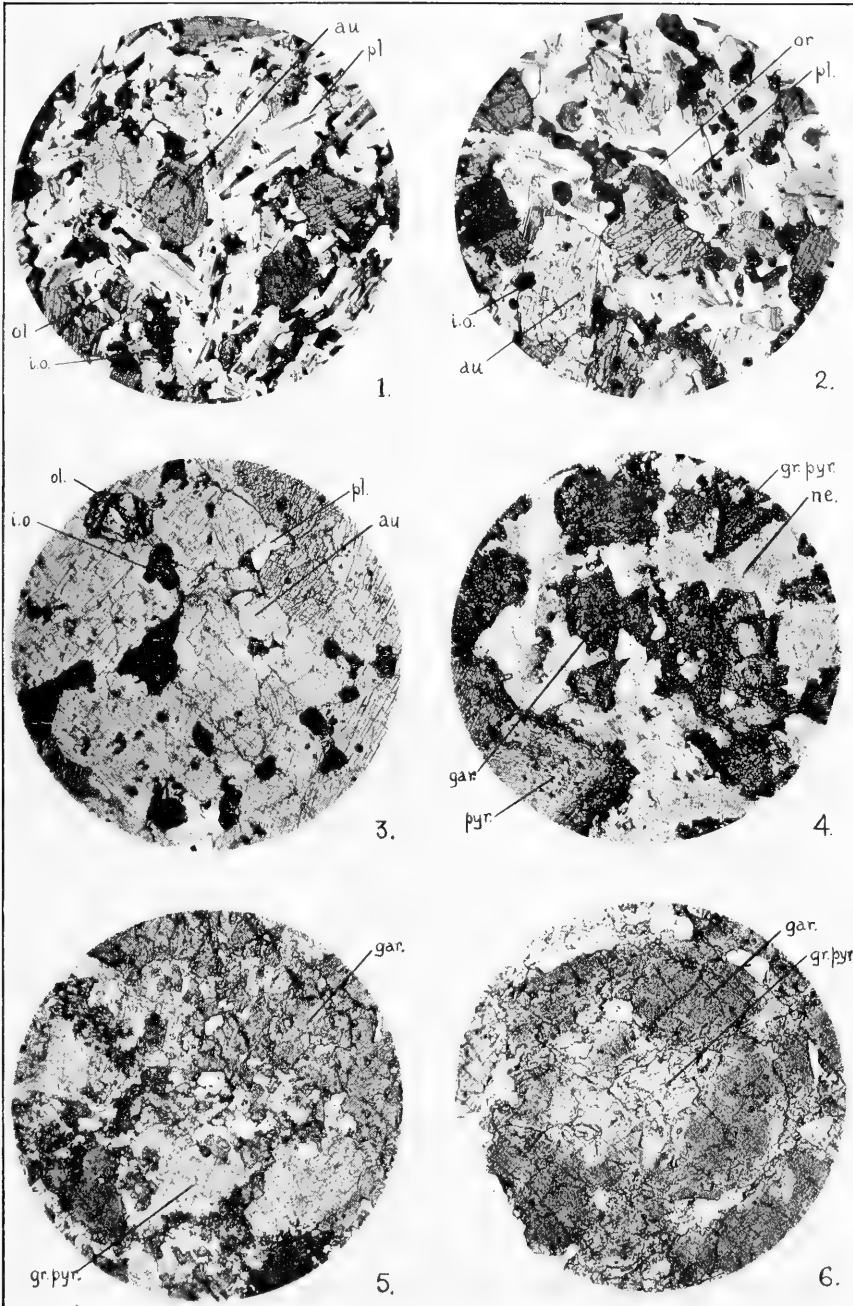
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3







NOTES ON A CELLULOSE-DECOMPOSING SOIL FUNGUS OF AN
UNUSUAL CHARACTER.

By H. L. JENSEN.

Macleay Bacteriologist to the Society.

(Plate xl.)

[Read 26th November, 1930.]

During the course of a study of the microbial decomposition of farmyard manure in soil (the results of which will be published elsewhere), the writer isolated a fungus of somewhat unusual properties. It was first found when platings were made on cellulose-agar from a neutral clay soil with addition of well-decomposed manure, for possible isolation of cellulose-decomposing bacteria. On most of the plates only actinomycetes developed, but in one instance there appeared a peculiar fungal growth which rapidly cleared the medium and transformed the fragments of cellulose into dark granules. On another occasion the same easily recognizable fungus was obtained by inoculating plates of cellulose-agar directly with half-decomposed bits of straw from the same soil with addition of manure + ground straw. The fungus could easily be obtained in pure culture from the cellulose-agar because of its rapidly spreading growth and the selective character of the medium. In plate cultures for counting the numbers of filamentous fungi in the soil (glycerin-sodium asparaginate-agar, see Brierley *et al.*, 1928) it was not observed. A cursory morphological examination showed it to belong to the Hyphomycetes, probably to the genus *Botryosporium*. In physiological respect it showed a marked sensitiveness to acid reaction, and in neutral or alkaline media it decomposed cellulose (pure cellulose in filter-paper as well as natural, lignified cellulose of straw) more actively than any of the microorganisms with which it was compared (*Penicillium* sp., *Aspergillus* sp., *Trichoderma* sp., *Mycogone* sp., *Stachybotrys* sp., various cellulose-decomposing bacteria). Owing to the pressure of other work at the time, a closer study of this, interesting organism could not be undertaken, but when an old agar culture was found still alive in May, 1930, it was thought desirable to re-examine the fungus.

Morphological and Cultural Characters.

On cellulose-agar (NaNO₃ 2.0 gm.; K₂HPO₄ 0.5 gm.; MgSO₄ 0.5 gm.; precipitated cellulose, prepared by the method of Scales (1916), 5.0 gm.; agar 15.0 gm.; tap water 1,000 c.c.; pH 7.2-7.4) very characteristic growth. In Petri dish cultures at 32° C. a thin colourless veil of cobweb-like mycelium is, after 2 days, seen creeping over the whole plate, and a few delicate filaments rise into the air. After 4-5 days a formation of small, dark, first greyish, later jet-black granules, each representing a fragment of cellulose, begins along the edge of the plate and proceeds centripetally. At the same time the thin aerial growth, which is most conspicuous on the central portion of the plate, becomes covered with small ash-grey tufts of spore-bearing hyphae.

The morphology of the fungus is conveniently studied on this medium. The vegetative mycelium consists in quite young cultures (2-3 days) of hyaline, septate hyphae of variable thickness, from 2.5-3.0 up to 8-9 μ . Clamp connections have not been observed, but anastomoses, giving rise to H-shaped figures, are frequently seen (Pl. xl, fig. e). The dark granules present in 4-5 days old cultures consist of clusters of chlamyospore-like cells with a coarsely granular content and thick, rough, dark-coloured cell walls. These cells vary in shape from globular to barrel-shaped, up to 13-16 μ in diameter and 30-35 μ in length (Pl. xl, fig. f). Besides these, there is a number of more or less swollen and darkened cells with granular content, representing all stages of transition down to the slender, hyaline cells with homogeneous content, which occur in young hyphae (Pl. xl, fig. f). These latter seem gradually to change into the dark, thick-walled, sclerotial cells which predominate in old cultures. When the dark granules are crushed under a coverslip and examined microscopically, the cells show an arrangement in long, parallel strands, apparently representing the hyphae from which the granules are formed, and in fairly young cultures (5 days at 30-32° C.) a most characteristic phenomenon is seen: the central cavities of the cellulose fibres are filled with these strands of dark, swollen cells, which are left behind as the cellulose fibres gradually disintegrate. This arrangement gives rise to the apparent transformation of the fibres into small sclerotia-like bodies which give the plate culture its characteristic spotted appearance.

The aerial growth is represented by conidiophores, consisting of richly branched hyphae, 2.8-3.3 μ thick, hyaline or slightly brownish. The terminal branches carry numerous laterally situated, roughly globular conidial heads, 8-11 μ in diameter (Pl. xl, figs. a, c). The arrangement of the conidia is only seen by direct examination under the microscope; when the material is mounted in water, the conidia fall off very easily, and the end branches of the conidiophores appear as irregularly bent, rather closely septate hyphae, each cell of which bears usually one wart-like projection, to which the conidia have been attached (Pl. xl, fig. d). The conidia are almost spherical to ovoid or slightly triangular, measuring 2.1-2.8 μ , sometimes only 1.8 μ broad, hyaline, with homogeneous content (Pl. xl, fig. b).

On filter-paper strip in test-tube, with mineral nutrient solution (same as in cellulose agar), there is, after 2 days at 32° C. or 1 day at 38° C., a loose, colourless mycelium floating on the solution and attached to the paper. During the next few days this mycelium spreads, and hyphae begin to creep over the exposed part of the paper, on which a dark colour appears just above the level of solution. This dark zone becomes, in 14-16 days, 1-2 cm. broad and completely black, and the paper in it seems almost to have disappeared and to be replaced by mycelium. In the same solution, with $(\text{NH}_4)_2\text{SO}_4$ instead of NaNO_3 , there is, after 7 days at 32° C., only a scant growth, consisting of loose, colourless flakes of mycelium in the liquid, but the paper appears quite strongly attacked, and breaks easily at the level of solution, when the tube is shaken. Addition of sterile CaCO_3 to the solution gives rise to a very abundant growth and a very strong decomposition of the paper which nearly disappears after 2-3 weeks at 32° C. The formation of dark mycelium is little pronounced here.

As to the identity of the fungus, the arrangement of the conidia in laterally-borne heads attached to wart-like spines would suggest the genus *Botryosporium*, as was first thought; on the other hand, the profuse branching of the conidiophores and the formation of sclerotia-like bodies seem to point to the genus *Botrytis*;

within this genus, the somewhat comb-like appearance of the end branches of the conidiophores might suggest the section *Cristularia* (Lindau, 1900). The genus *Botrytis*, however, is said never to form definite heads of conidia.

Physiological Characters.

Utilization of various sources of carbon was tested by culture in the above-mentioned mineral nutrient solution with 0.2% NaNO_3 + 1.0% carbon compound. Duplicate test-tube cultures were incubated for 12 days at 32° C. Dextrose, levulose, maltose, and starch, besides cellulose, proved to be good or excellent sources of carbon. A fair growth was also obtained with sodium acetate, galactose, lactose, inulin, and aesculin, while sodium malate and citrate, glycerin, mannite, dulcite, arabinose, xylose, saccharose, raffinose, tannic acid, and crude lignic acid were nearly or wholly unavailable. No acid was formed from any of the compounds, and the nitrate was not reduced to nitrite.

Utilization of various nitrogen compounds was tested by culture on filter-paper strips in test-tubes with mineral nutrient solution containing 0.2% of the compound to be tested. Besides with NaNO_3 and $(\text{NH}_4)_2\text{SO}_4$, as mentioned above, a good to excellent growth and destruction of paper was obtained with glycocol, asparagin, gelatin, uric acid, and especially peptone which seemed to be the most favourable source of nitrogen. Urea gave only a moderate growth and destruction, and in N-free solution there was only a very scant growth and no visible destruction of the paper.

Temperature relationships.—The optimum temperature seems to be 35–40° C.; at 18–20° C. the growth is still active, but much retarded. At 54° C. no growth takes place. The fungus is thus not termophilic.

Resistance to acidity.—The poor growth of the fungus in acid agar media, as well as the marked stimulation of the growth in $(\text{NH}_4)_2\text{SO}_4$ -solution by addition of CaCO_3 , suggested a marked sensitiveness to acid reaction—a property which, as is well known, is not common among the fungi. In order to get a more precise idea of this, the fungus was grown in the following solution: dextrose 10.0 gm.; peptone 5.0 gm.; K_2HPO_4 5.0 gm.; MgSO_4 0.5 gm.; NaCl 0.5 gm.; H_2O 1,000 c.c. The reaction was adjusted to pH values between 4.2 and 7.4 by means of hydrochloric acid. Duplicate cultures, on 100 c.c. solution in 300 c.c. Erlenmeyer flasks, were incubated for 14 days at 38° C. in a second series with only 3 pH values for 22 days at 32° C., after which time the mats of mycelium were filtered off, dried and weighed.

The results (see Table 1) are somewhat irregular, owing to difficulty of securing a uniform growth in the parallel flasks, but they still show that pH 4.5 is very nearly the most acid reaction at which the organism is capable of inducing growth, and a good growth does only occur at pH values above 6. As a further test the fungus was grown on a physiologically acid solution of the following composition: dextrose 20.0 gm.; NH_4Cl 5.0 gm.; K_2HPO_4 0.2 gm.; MgSO_4 0.5 gm.; NaCl 0.5 gm.; H_2O 1,000 c.c. Two sets of cultures were grown at 32° C.:

a.—Test-tube cultures, 10 c.c. of solution, for 5 and 10 days.

b.—Erlenmeyer flask cultures (100 c.c. flasks with 50 c.c. of solution), with and without CaCO_3 , for 20 days.

At the end of the experiment determinations were made of pH values, and of weights of mycelium in the Erlenmeyer flask cultures.

TABLE 1.

Growth of the Fungus in Dextrose Peptone Solution of Varying Hydrogen-Ion Concentration.

	Initial pH.	Weight of Dry Mycelium, gm.	Final pH.
I	4.2	No growth	—
	4.5	0.001	4.5
		0.001	4.5
	5.3	0.014	5.3
		0.013	5.3
	6.1	0.004	6.2
		0.007	6.2
	6.6	0.334	7.3
0.345		7.1	
7.0	0.283	6.8	
	0.097	7.1	
	7.4	0.318	7.3
II	5.8	0.040	}
		0.028	
	6.2	0.038	}
0.046		—	
	6.6	0.120	}
		0.087	

According to the results in Table 2, a pH value of 3.4-3.5 is the limit of acidity produced by the fungus. This is a somewhat higher acidity than that which inhibits the starting of the growth (Table 1); the explanation is probably that the mycelium, which has been formed before the solution becomes too strongly acid, has to some extent gradually adapted itself to a more acid reaction in the surrounding medium. The weights of the mycelia, however, show that the growth under these conditions is very poor in comparison with that at approximately neutral reaction.

The influence of reaction on the cellulose decomposing activity was tested by growing the fungus on cellulose in test-tubes with 10 c.c. of the following

solution: $(\text{NH}_4)_2\text{SO}_4$ 5.0 gm.; K_3HPO_4 0.5 gm.; MgSO_4 0.5 gm.; NaCl 0.5 gm.; H_2O 1,000 c.c. Cellulose was supplied as weighed strips of filter paper (0.15–0.2 gm.), Whatman's No. 41, in which the dry matter is represented by nearly pure cellulose. Some of the tubes received an addition of about 0.3 gm. of sterile CaCO_3 after sterilization. They were then inoculated and incubated for 20 days at 32° C. After incubation, the contents of the tubes were filtered through hardened filter paper, the residues were washed, first with dilute HCl , then with ammonia-free

TABLE 2.

Degree of Acidity and Amount of Mycelium Produced by the Fungus in a Physiologically Acid Medium with and without CaCO_3 .

Series I. Test-tube cultures.

Time.	Growth.	pH.
At start	—	6.6
5 days	Scant, consisting of loose granules floating on the surface	(a) 3.8
		(b) 3.7
10 days		(a) 3.4
		(b) 3.5

Series II. Erlenmeyer Flask cultures. (20 days 32° C.)

	Weight of Mycelium, gm.	Character of Growth.	Final pH.
- CaCO_3	(a) 0.026	Loose granules on bottom of flasks	3.7
	(b) 0.012		3.8
+ CaCO_3	(a) 0.156	Dark, coherent mat on surface	6.6
	(b) 0.171		6.5

water, and $\text{NH}_4\text{-N}$ was determined in the combined filtrates and washings by distillation with MgO . The residues (paper + mycelium) could quite easily be removed from the filters, even in the case of strong decomposition, because in this case the mycelium keeps the remains of paper together in an easily handled lump. The residues were then dried, and treated overnight with 80 c.c. of Schweitzer's solution ($\text{Cu}(\text{OH})_2$ in conc. ammonia). The solutions were then filtered through glass wool in order to remove the flakes of mycelium, and the extracted cellulose was precipitated by means of HCl , filtered off on a dried and weighed filter, and determined by weighing, after washing and drying at 98° C.

The results in Table 3 show that the cellulose decomposition has been roughly 10 times stronger in solution with CaCO_3 than in the unbuffered solution (60–84% of the added cellulose against 6–8%). The ratio of decomposed cellulose to assimilated N (43–57 : 1 in the tubes with CaCO_3 ; in the others the amounts

TABLE 3.

Cellulose Decomposition by the Fungus in a Physiologically Acid Medium with and without CaCO₃.

	Cellulose supplied, gm.	Cellulose recovered, gm.	Cellulose decomposed, gm.	NH ₄ -N at end of experiment, mgm.	NH ₄ -N assimilated, mgm.	Ratio of decomposed cellulose to assimilated N.
-CaCO ₃	(a) 0.161	0.152	0.009	9.1	0.6	(15 : 1)
	(b) 0.183	0.168	0.015	9.5	0.2	(75 : 1)
	(c) 0.158	0.145	0.013	9.4	0.3	(43 : 1)
+CaCO ₃	(a) 0.185	0.031	0.154	7.0	2.7	57 : 1
	(b) 0.168	0.068	0.100	7.4	2.3	43 : 1
	(c) 0.182	0.039	0.143	7.1	2.6	55 : 1
Control	(a) 0.149	0.146	—	9.7	—	—
	(b) 0.138	0.138	—	9.7	—	—

concerned are so near to the analytical error that this ratio cannot be calculated with any accuracy) is substantially wider than that given by Waksman and Heukelekian (1926) for a number of other cellulose decomposing soil fungi, viz., 31-34 : 1 for species of *Trichoderma*, *Penicillium*, *Citromyces*, *Aspergillus*, and *Fusarium*.

Comparison with other fungi.—Table 4 contains a compilation of the results of studies on tolerance of hydrogen-ion concentration shown by various fungi, so far as the author has been able to trace the literature. In cases where several media have been tested with different results, only those results which show the greatest tolerance to acidity have been reproduced here. We see that practically all fungi studied in this respect are able to grow at pH values lower than 4.0, and a large majority will tolerate a hydrogen-ion concentration of pH 3.0, or still more. So far our fungus seems unique*, but this should not be taken for granted. It is worth recalling, in this connection, that Brierley and co-workers (1928), in their experiments on standardization of the technique of counting soil fungi, obtained the maximum numbers of fungus colonies on agar of pH 5.6. This renders it quite probable that the soil may harbour a number of acid-sensitive fungi which are not easily detected on neutral agar media owing to the competition of bacteria and actinomycetes†. Their importance in microbial soil processes, considerable though it may be, can, of course, never be detected by the use of culture media such as that suggested by Waksman (1922) or that used by the author in another contribution (see above), in which the acid reaction acts as selective factor. In the present particular instance, where even agar of pH 4.8 was of no service, the use of cellulose agar proved helpful. This is an application of the principle suggested by Winogradsky (1929) for studying cellulose-decomposing soil-organisms, which can probably be extended to fungi as well as

* With the possible exception of a *Torula* studied by Pistor (1930), whose result, however, seems somewhat open to criticism.

† Cf. Pistor (1930).

TABLE 4.
Limits of Acidity for Growth of Various Fungi.

Organism.	pH Range or pH Value at which growth stops.	Author.
Phycomycetes.		
<i>Mucor plumbeus</i>	below 3.2	Pistor (1930)
<i>Mucor flavus</i>	below 4.0	"
<i>Mucor glomerula</i>	3.2-3.4	Johnson (1923)
<i>Mucor Ramannianus</i>	2.0-2.5	*Jensen
<i>Zygorhynchus Vuilleminii</i>	2.5-3.1	"
<i>Absidia cylindrospora</i>	1.4-2.0	"
Sterile Phycomycetous Mycelium	2.5	"
<i>Mortierella</i> sp.	below 3.0	Pistor (1930)
Fungi Imperfecti.		
<i>Coccospora agricola</i> (?)	3.7-4.3	*Jensen
<i>Oospora Citri-aurantii</i>	2.2-2.5	Camp (1923)
<i>Trichoderma Koningi</i>	2.0-2.5	*Jensen
"	2.1-3.0	Dubos (1928)
<i>Trichoderma</i> sp.	1.2-1.4	*Jensen
<i>Aspergillus fumigatus</i>	2.0-2.5	"
<i>Aspergillus niger</i>	1.4-1.6	Currie (1917)
<i>Aspergillus</i> sp.	below 2.2	Camp (1923)
<i>Aspergillus terricola</i>	1.6-1.8	Johnson (1923)
<i>Aspergillus oryzae</i>	1.6-1.8	"
<i>Penicillium italicum</i>	1.9-2.2	"
<i>Penicillium variabile</i>	1.6-1.8	"
<i>Penicillium digitatum</i>	2.5-2.7	Camp (1923)
<i>Penicillium stoloniferum</i>	below 2.2	"
<i>Penicillium</i> sp.	2.2-2.4	"
<i>Penicillium</i> sp.	2.1-3.0	Dubos (1928)
<i>Penicillium</i> sp.	1.2-1.4	*Jensen
<i>Citromyces</i> sp.	1.4-2.0	"
<i>Penicillium</i> sp.	3.0-4.0	Pistor (1930)
<i>Acaulium nigrum</i>	below 3.0	"
<i>Eidamia catenulata</i>	1.2-2.0	Horne and Williamson (1923)
<i>Eidamia viridescens</i>	1.0-1.2	"
<i>Botrytis cinerea</i>	1.4-1.7	Boyle (1924)
<i>Humicola</i> sp.	2.1-3.0	Dubos (1928)
<i>Mycogone nigra</i>	2.5-3.1	*Jensen
<i>Alternaria citri</i>	3.0-4.2	Camp (1923)
<i>Alternaria</i> sp.	2.7-3.0	"
<i>Fusarium bullatum</i>	2.0-2.2	Johnson (1923)
<i>Fusarium oxysporium</i> (syn. <i>orthoceras</i>)	1.8-2.2	"
"	2.0	*Jensen
<i>Fusarium</i> sp. (<i>falcatum</i> ?)	2.5-3.1	"
<i>Fusarium coeruleum</i>	3.0	Moore (1924)
<i>Fusarium moniliforme</i>	below 3.0	Kirby (1922)
<i>Fusarium vasinfectum</i>	below 2.5	Neal (1927)
<i>Fusarium avenacearum</i>	2.7	Lundegårdh (1923)
<i>Fusarium culmorum</i>	2.7	"
<i>Fusarium herbarum</i>	2.7	"
<i>Fusarium</i> sp.	3.0	MacInnes (1922)
<i>Fusarium</i> sp.	2.2-3.1	Boyle (1924)
<i>Phoma</i> sp.	3.1-3.7	*Jensen
<i>Phomopsis citri</i>	2.7-3.0	Camp (1923)
<i>Diaporthe Sojæ</i>	2.2-3.1	Lehman (1923)
Ascomycetes.		
<i>Saccharomyces cerevisiae</i>	1.5	Euler and Heintze (1919)
<i>Endothia parasitica</i>	about 4.0	Brightman <i>et al.</i> (1920)
<i>Sclerotinia Libertiana</i>	2.2-2.5	Camp (1923)
<i>Gibberella sarbinetii</i>	2.5-3.0	Hopkins (1922)
<i>Ophiobolus cariceti</i>	3.0-3.2	Kirby (1922)
<i>Daldinia concentrica</i>	3.4-3.8	Child (1929)
<i>Daldinia vernicosa</i>	below 3.0	"
<i>Daldinia</i> sp.	below 3.0	"
Unidentified ascomycete from dermatomycosis	3.2-3.4	Biltris (1929)
Basidiomycetes.		
<i>Merulius lacrymans</i>	1.7	Meacham (1918)
<i>Coniophora cerebella</i>	1.7	"
<i>Fomes roseus</i>	1.7	"
<i>Lenzites sepiaria</i>	1.7	"
"	2.8-3.0	Wolpert (1924)
<i>Schizophyllum commune</i>	2.8-3.5	"
<i>Pholiota adiposa</i>	2.8-3.0	"
<i>Daedaleia confragosa</i>	2.8-3.3	"
<i>Pleurotus ostreatus</i>	3.0-4.2	"
<i>Armillaria mellea</i>	2.0-2.5	"
<i>Polyporus adustus</i>	2.0-2.8	"
<i>Polyporus versicolor</i>	2.5-3.0	"
<i>Polyporus radiciperda</i>	3.0	Weis and Nielsen (1927)
Sterile Mycelia.		
<i>Rhizoctonia Solani</i>	2.6-3.0	Matsumoto (1921)
<i>Rhizoctonia silvestris</i>	below 3.4	Melin (1924)
<i>Mycelium radiciis atrovirens</i>	below 3.4	"

* Data from an unpublished paper, to appear shortly in *Soil Science*.

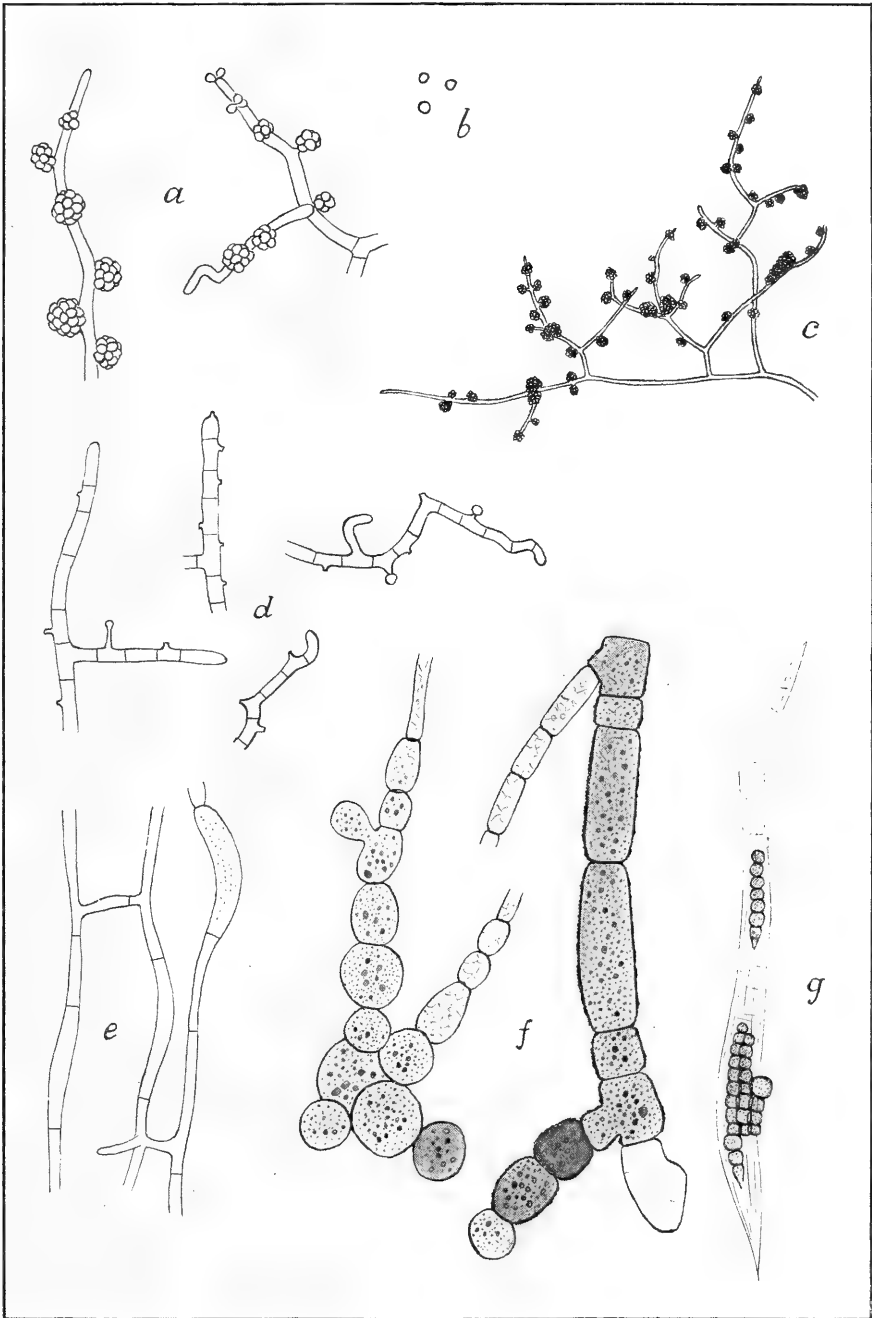
to bacteria. At any rate, the possibility of the presence of organisms of the type here dealt with should be given full attention in discussing the importance of fungi *versus* bacteria in biological processes of decomposition in the soil.

Summary.

A fungus, probably belonging to the genus *Botryosporium*, was isolated from an English field soil with addition of manure. This organism proved very sensitive to acid reaction, pH 4.5 being very near the limit of acidity at which growth could be induced; a good growth would only take place at pH values above 6.0, and an optimum zone seemed to stretch from pH 6.6 to pH 7.4 and possibly higher. In neutral or alkaline solution the fungus exerted a very strong cellulose decomposing activity, in unbuffered physiologically acid solution almost none. Its sensitiveness to acidity is greater than that of any fungus hitherto studied in this respect.

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EXPLANATION OF PLATE XL.

a and *c*, conidiophores with spore-heads; *b*, conidia; *d*, end branches of conidiophores (cellulose agar, 5 days, 32° C.); *e*, vegetative hyphae (cellulose agar, 2 days, 32° C.); *f*, chlamydospore-like cells in vegetative mycelium (cellulose agar, 7 days, 32° C.); *g*, cellulose fibre containing dark cells (cellulose agar, 5 days, 32° C.). Magnifications: *a*, *b*, *d*, *e* and *f*, approx. $\times 540$; *c* and *g*, approx. $\times 225$.

THE LEAF-BUDS OF SOME WOODY PERENNIALS IN THE NEW SOUTH WALES FLORA.

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(Seventy-five Text-figures.)

[Read 26th November, 1930.]

Part i.

Introduction.

Types of Leaf-Buds.

1. Scaly Buds: A, Laminar type; B, Stipular type; C, Epacridaceous type.
2. Intermediate Buds: A, Transition to normal leaves abrupt; B, Transition to normal leaves gradual; C, Type akin to a naked bud; D, Microscopic type.
3. Naked Buds: A, Protection by hairs; B, Protection by stipules, with or without hairs; C, Special cases of stipular protection; D, Microscopic buds.
4. Mixed Buds.

Variability.

Summary.

Part ii.

Brief descriptions of the buds of selected species.

PART I.

Introduction.

Leaf-buds have been studied in detail by morphologists in the Northern Hemisphere* so that our knowledge of the structure of the leaf-buds of the plants growing in those regions is extensive. As the trees and shrubs concerned are mainly deciduous, the scaly type of bud is characteristic of those cold temperate latitudes. Such a bud may be defined as one in which the young leaf rudiments are enveloped by a varying number of scales or cataphylls, these scales representing the modified parts of leaves, i.e., laminae, leaf-bases or stipules (e.g., Peach, *Aesculus*, *Fagus*).

As "it is only in exceptional plants that the uppermost axillary buds of the main shoot normally expand during the period of their formation without developing bud scales" (Foster, 1928), little attention has hitherto been paid to buds which are devoid of scales and are termed "naked".

In New South Wales, where the climate is fairly equable and the winters mild and short, there is no marked resting period in plant activity and such buds are very characteristic. A study of a representative number of them has revealed some interesting facts.

* Foster, A. S. (Salient features of the problem of bud scale morphology. *Biol. Rev.*, iii, 1928, 123) discusses the matter at length with full bibliography.

In the course of this study the morphology of the buds was examined by means of hand sections and dissection, combined with observation of the expanding buds and their resultant shoots. The features exhibited by expanding buds are highly characteristic and a bud cannot readily be classified under the following system unless the emerging shoot is also examined.

In the following paper a detailed account is given of the buds of certain selected species together with a brief discussion of the features that they show. This general account is followed by a second part in which brief descriptions are given of the buds of 140 species of New South Wales plants that have been examined in the course of the work.

The writer wishes to thank Professor Osborn for suggesting the problem in the first instance, and for his continuous interest and help throughout the course of the work.

TYPES OF LEAF-BUDS.

It is possible to divide the leaf-buds of woody perennials in New South Wales into four main classes. These classes are undoubtedly exceedingly artificial, for there is no sharply defined boundary between one class and another, and types can always be found which grade one into the other. The classes are as follows: (1) scaly buds, (2) intermediate buds, (3) naked buds, (4) mixed buds.

(1) A scaly bud is one in which the leaf-rudiments are enveloped by scales. As such a bud expands and lengthens into a young shoot the amount of growth shown by the successive foliar organs becomes progressively greater. The outermost organs or scales exhibit little or no growth; these are followed on the shoot by a series of foliar organs in which the form of the scale gradually or fairly abruptly gives place to that of the foliage leaf. At the same time the internodes, which do not elongate between the scales, become progressively longer between each succeeding node until the foliage leaf is reached. Those organs which lie on the shoot between the scales and the foliage leaves will be termed "transitional forms". This term was applied by Foster (1929) to essentially scale-like organs formed between the bud-scales proper and the leaves in the scaly bud of the Horsechestnut. In this paper the term will be extended to include all organs other than true bud-scales, whether they be scale-like or not, developed on the expanding shoot below the normal foliage leaves.

(2) An intermediate bud when dormant cannot be distinguished from a naked bud. On expansion, the outer organs show various degrees of development, but never as much as the normal foliage leaves. These organs, therefore, correspond to the transitional forms in a scaly bud.

(3) A naked bud is one whose foliar rudiments all develop fully when the bud expands into a shoot.

(4) A mixed bud is one which on expansion produces both flowers and leaves. Some species possess both leaf-buds and mixed buds, e.g., *Pittosporum undulatum*. However, in this paper, only those species in which all the growth is by potentially mixed buds have been described in detail.

Examples of all four classes occur on both shrubs and trees of all sizes; moreover, the bud types occur together in various habitats. So far as the present studies have gone it is not possible to associate types of bud structure with ecological conditions. On the other hand, whilst a bud type may be characteristic in certain families, in other families, or even genera, considerable variation in bud type may occur (see account of Variability below, page 726).

1. *Scaly Buds.*

Representatives of the class of scaly buds are not common in our flora, but they have been found in the Myrtaceae, Proteaceae, Pittosporaceae, Oleaceae, Lauraceae, Cupuliferae, and Epacridaceae. In some of the families mentioned, however, the scaly bud is characteristic of a few genera only (e.g., Myrtaceae, Proteaceae). Mesophytic-leaved genera, such as *Pittosporum undulatum*, and hardier types, such as *Hakea pubescens*, both envelop their leaf-rudiments in scales.

The scales may be fleshy (*Pittosporum undulatum*) or membranous (*Hakea pubescens*, *Leptospermum flavescens*), glabrous (*Hakea pubescens*) or hairy (*Leptospermum lanigerum*), and vary greatly in number from two (*Notelaea longifolia*) to as many as eighteen (*Callistemon lanceolatus*).

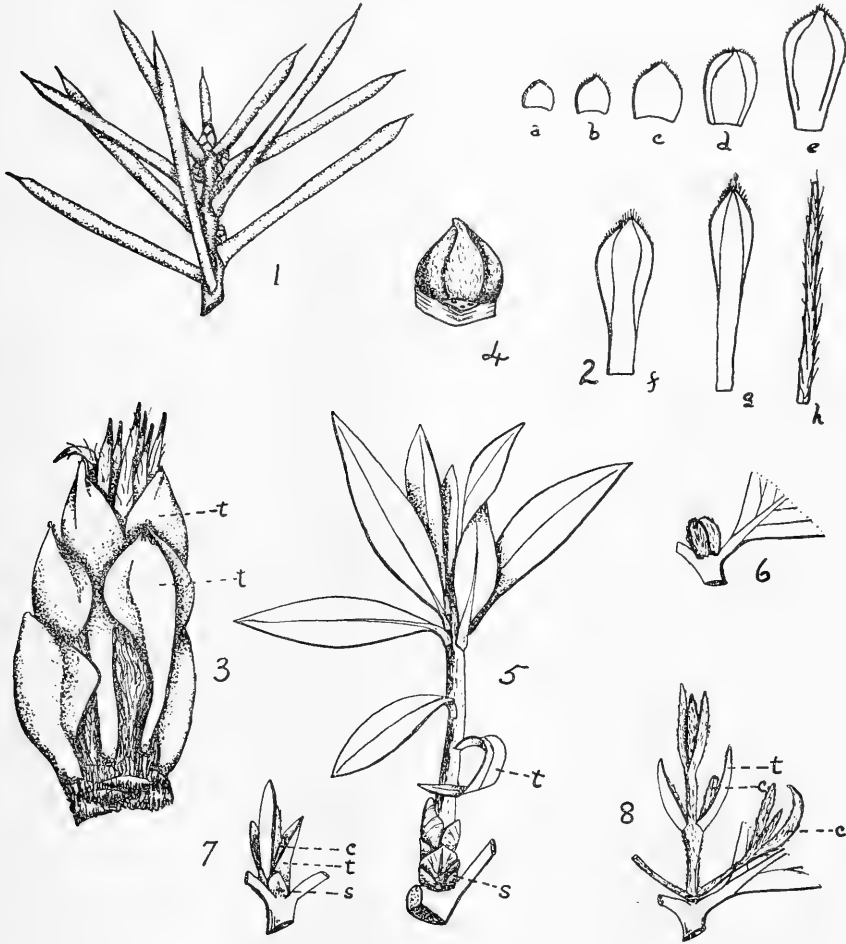
As in the Northern Hemisphere type, these scales represent parts of foliage leaves. Stipular scales occur in *Fagus Moorei*. Laminar scales, however, appear to be of most frequent occurrence (e.g., in *Leptospermum flavescens*, *Hakea pubescens*, *Pittosporum undulatum*, *Syncarpia laurifolia*). But as yet no example of leaf-base scales has been observed.

A. Laminar Type.

(i) *Hakea pubescens* Schrad.—The terminal bud is approximately 3 mm. in length and shows little dominance over the upper axillary buds (Text-fig. 1), many of which develop into vigorous shoots at the time of bud expansion. Each bud is covered by brown membranous scales, representing laminae, which by a series of forms (as shown in Text-fig. 2) pass into the characteristic leaves. There are approximately fourteen foliar organs developed before the leaves: the first two are as wide as they are long (Text-fig. 2, *a*); the next two show some increase in width (Text-fig. 2, *b*), but a more pronounced development in length. Each succeeding organ then shows a progressive increase in length (Text-fig. 2, *c*, *d*) combined with (after about the eighth) a decrease in width (Text-fig. 2, *e*, *f*, *g*). In these distal forms a central thicker region is developed and the membranous tissue becomes confined to the edges of the apical portion of each transitional form. Hairs are developed at the apex of the scales and become increasingly evident on the distal transitional forms. In the leaf, hairs are scattered over the whole surface (Text-fig. 2, *h*). However, the difference between the distal transitional form and the first leaf is soon well marked as the bud expands and the transitional forms fall away (Text-fig. 3). In addition, it is noted that, in this type, buds never occur in the axils of the transitional forms, between which the internodes are very short, almost negligible. The absence of buds in the axils of transitional forms has been observed by Marshall Ward in connection with all the developing shoots of English perennials with scaly buds. In *Hakea pubescens* and *Hakea pugioniformis*, all the leaves formed in the shoot are not initiated in the bud. In addition, if the growth is vigorous, shoots may develop without bud formation in the axils of the maturing leaves of the shoot arising from the bud.

(ii) *Pittosporum undulatum* Andr.—The terminal bud (Text-fig. 4) may or may not show a marked difference in size from that of the uppermost axillary buds situated just beneath it. Each bears laminar scales, usually ten in number. These organs are not membranous and bear an investment of both T-shaped and glandular hairs. One or two of the distal transitional forms (Text-fig. 5), which differ from the leaves only in size, bear minute buds in their axils. The latter

may be induced to develop by pruning the shoot back to these organs. Unlike *Hakea pubescens*, the transitional forms (usually four in number) develop chlorophyll as the bud expands, and the inner scales also become green. In



Text-figs. 1-8.

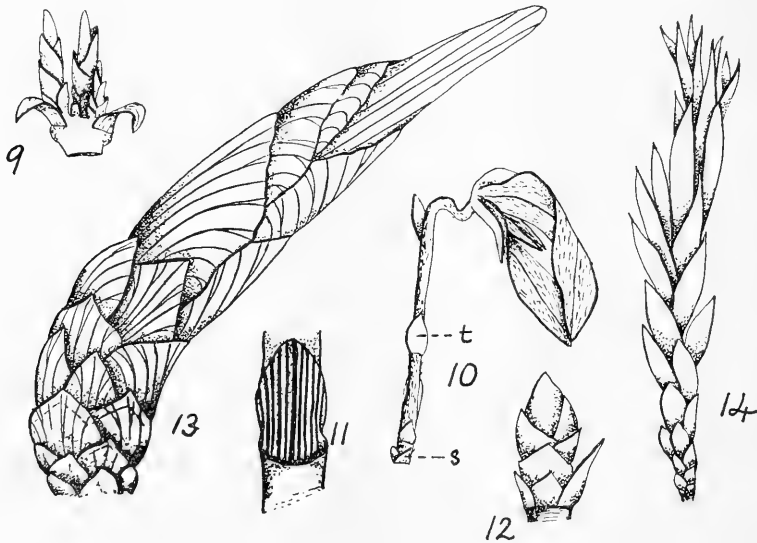
- 1.—Twig of *Hakea pubescens* showing axillary and terminal buds. ($\times 1$.)
- 2 (a-h).—Series of forms occurring in the transition from scale to leaf in *Hakea pubescens*. ($\times 5$.)
- 3.—Expanding bud of *Hakea pubescens* showing the inner scales and transitional forms. ($\times 7$.)
- 4.—Dormant terminal bud of *Pittosporum undulatum*. ($\times 3.5$.)
- 5.—Developing shoot of *Pittosporum undulatum* showing distal scales (s) and transitional forms (t). ($\times 0.7$.)
- 6.—Dormant terminal bud of *Syncarpia laurifolia*. ($\times 2$.)
- 7.—Expanding terminal bud of *Syncarpia laurifolia*. (s) scale, (t) transitional form, (c) axillary shoot. ($\times 0.8$.)
- 8.—Developing shoot of *Syncarpia laurifolia*. (t) transitional form, (c) axillary shoot. ($\times 0.8$.)

addition, a limited number of leaves only is formed on the expansion of each shoot. Under normal circumstances the rudiments of all these are present in the unexpanded bud.

(iii) *Syncarpia laurifolia* Ten.—The terminal bud (Text-fig. 6) is almost hemispherical and is partly protected by the petioles of the two uppermost leaves. The axillary buds next below the terminal are microscopic, those further away are a little larger, but do not usually expand. In each bud there are as a rule only four scales (two pairs) covered with unicellular woolly hairs, although one or even two additional pairs have been known to occur. As the bud expands, two or three pairs of transitional forms develop (Text-fig. 7). Although these transitional forms enlarge, and the distal ones show long internodes between them, they do not become green. They wither and fall away early, but in the axils of each of them, excepting occasionally the outermost pair, a vigorous shoot covered by a dense tomentum of hairs develops immediately, without going through a resting stage (Text-fig. 8). This strong development of axillary shoots from buds in the axils of transitional forms is unusual. It is seen in *Xylometum pyriforme* (intermediate bud) and *Ricinocarpus pinifolius* (mixed bud).

B. Stipular Type.

Platylobium formosum Sm.—In this genus the main growth is by axillary buds, more than one occurring in the axil of each leaf (Text-fig. 9). As the bud expands, each leaf-rudiment is seen to possess a pair of striated stipules which it pushes apart as it develops. Between the first leaf and the base of the



Text-figs. 9-14.

- 9.—Expanding axillary buds of *Platylobium formosum*. ($\times 3$.)
 10.—Developing shoot of *Platylobium formosum*. (s) scale, (t) transitional form. ($\times 2$.)
 11.—A transitional form of *Platylobium formosum*. ($\times 11$.)
 12.—Expanding bud of *Styphelia triflora*. ($\times 3.5$.)
 13.—Expanding bud of *Trochocarpa laurina*. ($\times 5.5$.)
 14.—Developing shoot of *Styphelia triflora*. ($\times 1$.)

shoot a number of structures occur (Text-fig. 10) which in appearance resemble membranous laterally-joined stipules (Text-fig. 11). There may be six such forms, which occur alternately, although the foliage leaves are opposite. The two proximal structures do not increase in size as the shoot expands, and there is no internodal elongation. They are therefore true scales. The other four have well-marked internodes and axillary flower buds, so may be termed transitional forms. Sometimes these organs are fewer in number and there are then no true scales.

C. Epacridaceous Type.

Buds of this type have laminar scales, but the expanding shoot is so characteristic that it merits special attention.

This bud type is confined to the Epacridaceae (Text-fig. 12). It differs from other laminar scaly buds in that there is a perfect series of transitional forms grading from the scale to the leaf. The true scales are small and few in number. In some instances, e.g., *Woolisia pungens*, the buds are minute. They are largest in types such as *Trochocarpa laurina* where they may be 2 mm. in length.

In all cases, however, the structure is essentially the same. Each successive foliar organ developed along the shoot is slightly larger and more like the mature leaf than the one initiated before it. At the same time there is a gradual progressive increase in internodal length, so that in an expanding shoot of *Trochocarpa laurina* (Text-fig. 13) or of *Styphelia triflora* 7 cm. in length (Text-fig. 14), the transition is so perfect that it is impossible to draw a line of demarcation between the first leaf proper and the last transitional form or between the first transitional form and the last-formed scale. Later, the scales and most of the transitional forms drop off.

Early in the growth of the shoot the transitional forms may be induced to develop axillary shoots by pruning or injury, although buds are not evident in their axils. An injured shoot (26 cm. long) of *Styphelia lanceolata* has been known to show buds developing in the axils of the scales as well as in the axils of the transitional forms.

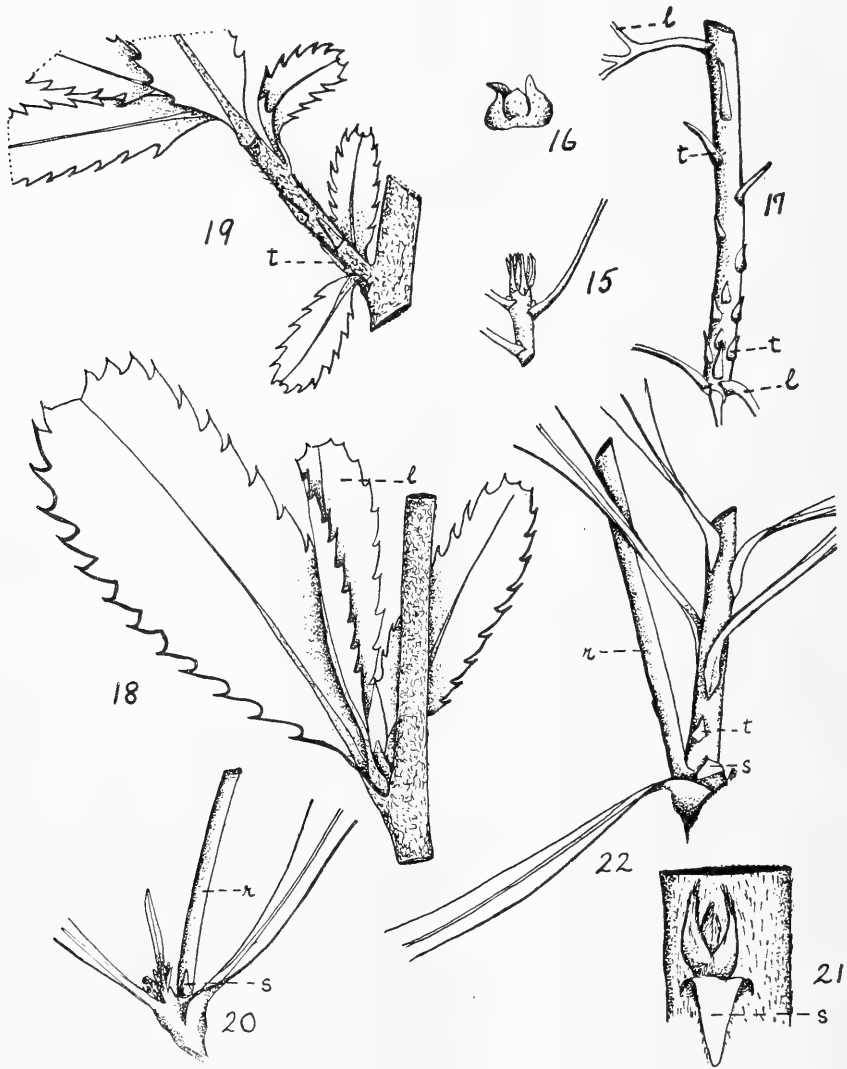
2. Intermediate Buds.

A bud of this type, when closed, has the appearance of a naked bud in that the foliar organs are protected by hairs, secretions or stipules and not by bud-scales, but, as the bud expands into a shoot, the outer organs are seen to belong to the same category as the transitional forms in a scaly bud such as that of *Pittosporum undulatum*.

Though leaf-buds of this class are characteristic of many New South Wales perennials, only one reference has been found to a bud of this type in Northern Hemisphere plants. Groom (*Trees and their Life History*) describes the bud of Holly as a naked one, but states that the outer organs do not fully develop.

A. Transition to normal leaves abrupt.

(i) *Petrophila pulchella* R.Br. is typical of the members of the class nearest to the scaly-bud type. The terminal bud (Text-fig. 15) may or may not be an inflorescence and the axillary buds are small (Text-fig. 16), bearing a few scattered hairs. As the bud expands a variable number of transitional forms occurs (sometimes as many as ten) which differ in size (Text-fig. 17).



Text-figs. 15-22.

- 15.—Terminal bud of *Petrophila pulchella*. ($\times 1.3$.)
 16.—Axillary bud of *Petrophila pulchella*. ($\times 3.4$.)
 17.—Base of a terminal shoot of *Petrophila pulchella* showing transitional forms. ($\times 0.9$.) (t) transitional form, (l) normal leaf.
 18.—Axillary bud of *Banksia serrata* showing the two early-formed leaves. ($\times 0.7$.)
 19.—Base of an axillary shoot of *Banksia serrata* showing transitional forms. ($\times 0.7$.)
 20.—*Conospermum longifolium* showing axillary inflorescence axis (r), with one scale-like organ (s) visible at the base. ($\times 0.9$.)
 21.—Leaf-bud lying in the axil of the scale-like organ (s) of Text-figure 20, of *Conospermum longifolium*. ($\times 3$.)
 22.—Dying inflorescence axis (r) and vigorous lateral shoot arising from it, in *Conospermum longifolium*. One transitional form (t) visible, (s) scale. ($\times 0.9$.)

The change from transitional forms, in which the lamina is apparently undeveloped, to the leaf is abrupt in most cases, but individuals do occur in which several transitional forms like poorly-dissected miniature leaves are found. The degree of elongation of the internodes varies also; sometimes it is only very slight between the proximal organs. When this is so the transitional organs might almost approach true bud-scales.

(ii) In *Banksia serrata* L. the buds are larger and the organs composing them are covered by a dense tomentum of rust-coloured unicellular hairs. The terminal bud often contains an inflorescence, in which case growth is continued by the numerous axillary buds. Sometimes, as an axillary bud is formed, the two outer rudimentary organs develop immediately during the same growing season into small-sized but otherwise normal foliage leaves, while the rest of the bud remains dormant (Text-fig. 18). When such a bud expands during the next growing season the first-formed structures are transitional forms, the laminae of which are suppressed (Text-fig. 19).

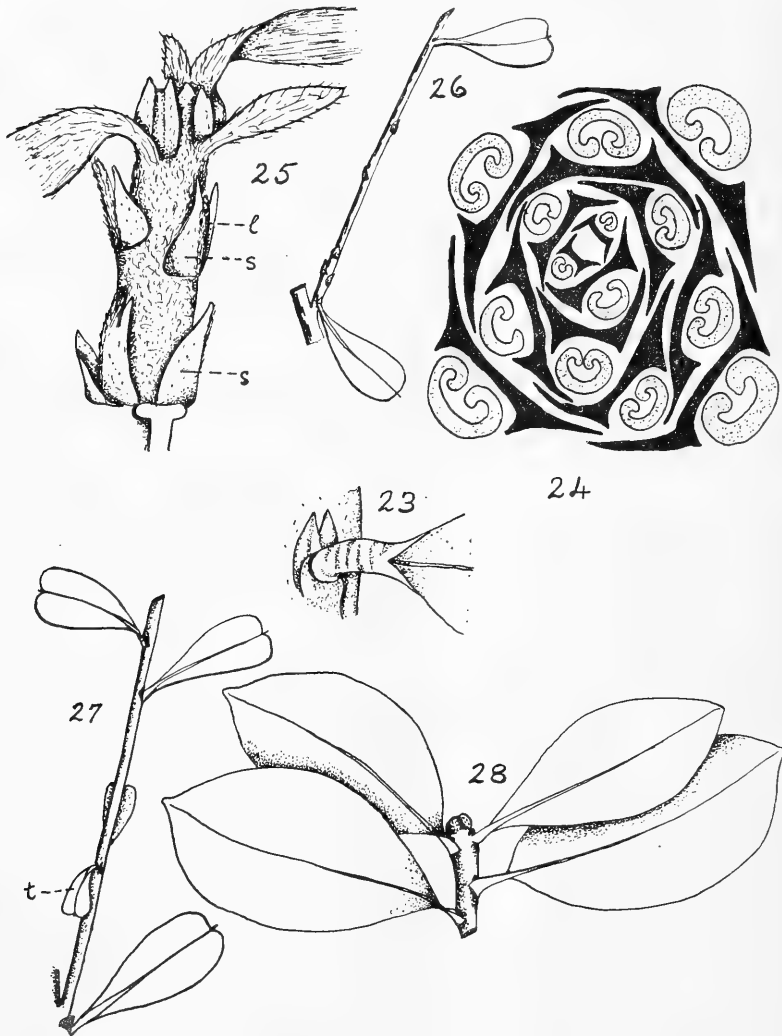
(iii) *Conospermum longifolium* Sm.—The terminal bud is a leaf-bud, the young rudiments enveloped by hairs, but it usually fails to expand. The main growth is from axillary shoots. In the axil of each leaf an inflorescence-bud occurs. This develops the characteristic long naked axis with a crowded terminal spike of flowers, but there are also two small scale-like organs developed close to base (Text-fig. 20). These latter hide small leaf-buds (Text-fig. 21). As the flowers die away, one of these buds develops to form a vigorous shoot, at the base of which are from 2 to 4 transitional forms (Text-fig. 22). This shoot soon becomes stouter than the inflorescence-axis which eventually dies away.

(iv) *Pultenaea daphnoides* Wendl.—In this species stipules are the protective feature. The terminal bud, which is a conspicuous feature of the shoot, produces the inflorescence. Vegetative growth is continued by axillary buds lying beneath the terminal. These buds are almost microscopic and are hidden between the stipules of the subtending leaf and the stem (Text-fig. 23). In the bud, each leaf-rudiment has a pair of stipules joined laterally by a band of membranous tissue thus forming a concave depression into which the leaf-rudiment fits. At the same time the later-formed leaf-rudiments inside the bud are protected by this double stipular structure. A transverse section of the growing apex of *P. ellipticum* (Text-fig. 24) indicates the relation of the stipular pairs to the leaf. As a result of this structure the first, i.e., proximal, leaves are exposed on their outer surfaces from their initiation. They possess a light covering of hairs and are afforded protection by the stipules of the leaf in whose axil they lie. The first leaves never develop fully. Generally the lamina of these transitional forms is quite rudimentary (Text-fig. 25) and the internodal elongation is reduced (Text-fig. 26). In one case, however, the first-formed leaves are only slightly smaller than the characteristic foliage leaves of the plant (Text-fig. 27).

B. Transition to normal leaves gradual.

(i) *Persoonia salicina* Pers.—In the following types the outer organs may show greater development and the change from transitional form to leaf is less abrupt. In *Persoonia salicina*, the terminal bud is approximately hemispherical and the axillary buds are flattened against the stem thus protected by the expanded bases of the petioles (Text-fig. 28). As in *Banksia serrata* the leaves of the bud are rather loosely arranged, the interstices between the rudiments being occupied by unicellular hairs which, on the outer leaves, develop a brown pigment. On



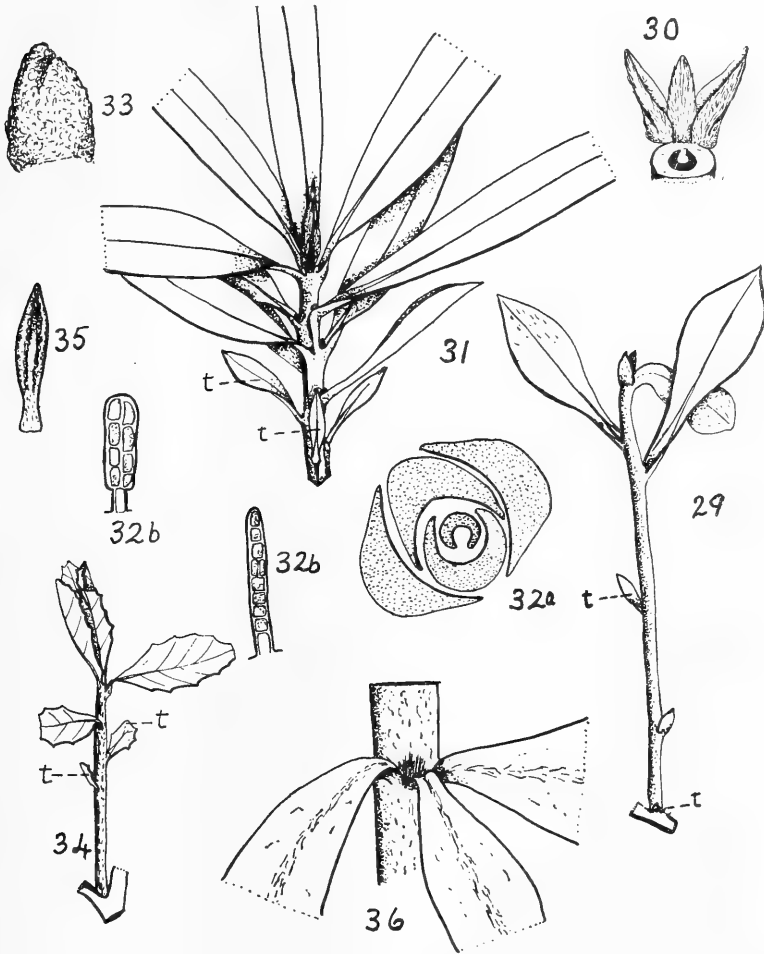


Text-figs. 23-28.

- 23.—Stipules of a leaf of *Pultenaea daphnoides* concealing an axillary bud. ($\times 10$.)
- 24.—Diagram of a transverse section of the apex of a developing terminal shoot of *Pultenaea ellipticum*.
- 25.—The base of an axillary shoot of *Pultenaea daphnoides* showing transitional forms; (s) stipule, (l) undeveloped leaf. ($\times 9.5$.)
- 26.—The base of an older shoot of *Pultenaea daphnoides* of the type indicated in Text-fig. 25. ($\times 0.8$.)
- 27.—An axillary shoot of *Pultenaea daphnoides* showing two transitional forms (t). ($\times 0.7$.)
- 28.—*Persoonia salicina* showing terminal and axillary buds. ($\times 0.8$.)

expansion, three to six transitional forms occur. The proximal one appears as a rudimentary lamina and, passing outward along the shoot, greater development of the lamina is exhibited by each succeeding form (Text-fig. 29). Well developed

buds occur in the axils of all these transitional forms, however small they may be. These buds may be foliar or flower buds.



Text-figs. 29-36.

- 29.—Developing axillary shoot of *Persoonia salicina* showing transitional forms (*t*). (× 0.7.)
- 30.—Expanding axillary bud of *Tristania laurina*. (× 3.)
- 31.—*Tristania laurina* showing expanding terminal and dormant axillary buds, also the transitional forms (*t*) of the terminal shoot of the previous growth period. (× 1.)
- 32.—*a*. Diagram of a transverse section of a bud of *Rapanea variabilis*. *b*. Glandular hairs which cover the leaf surfaces.
- 33.—An axillary bud of *Rapanea variabilis*. (× 8.)
- 34.—A developing axillary shoot of *Rapanea variabilis* showing transitional forms (*t*). (× 0.6.)
- 35.—A transitional form of *Banksia ericifolia*. (× 4.)
- 36.—An axillary bud of *Bauera rubioides*. (× 6.7.)

(ii) *Tristania laurina* R.Br. shows similar features. The terminal bud is an elongated one in which the leaves overlap one another. They are invested by long unicellular hairs in which a brown pigment is developed. The dormant and expanding axillary buds (Text-fig. 30) show similar features to those of the terminal. As indicated in Text-fig. 31, a number of transitional forms occur at the base of the shoot. The proximal one or two may be even more rudimentary than the figure shows, giving no indication of a leaf base.

C. Type akin to a naked bud.

Other types belonging to this class such as *Rapanea variabilis* and *Banksia ericifolia* more closely approach naked buds, showing on the expanded shoot no difference in shape and only a slight difference in size between transitional forms and the leaves. In these, as in the other species, variability is shown so that sometimes all the organs develop into full-sized foliage leaves in which case the bud might be deemed naked. So that, if a bud, on expansion, usually shows a few smaller leaves at the base of the shoot, it has been classed as intermediate, while, on the other hand, if all the leaves usually develop to the full size, the bud has been placed among the naked ones.

(i) *Rapanea variabilis* has an intermediate bud. It is covered with multicellular glandular hairs (Text-fig. 32, a, b) which are lost as the shoot matures. The terminal bud is about 3 mm. long (Text-fig. 33) and has the same morphology as the slightly smaller axillary buds. Usually the two outermost leaves do not attain the size of the later formed leaves (Text-fig. 34), and are termed transitional forms.

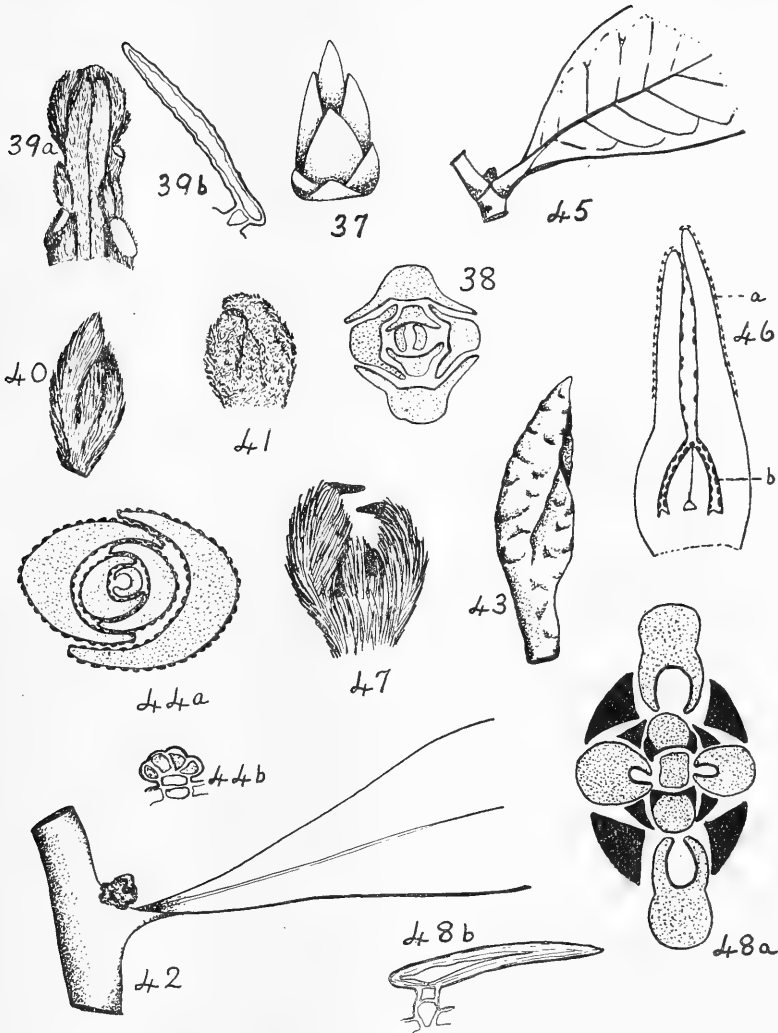
(ii) In *Banksia ericifolia* L. the terminal bud is usually an inflorescence, so the growth is continued in most cases by the small axillary buds close to the terminal. Buds are not evident in the axils of leaves lower on the shoot. The rudiments in the bud are covered with hairs as in *Banksia serrata*. As the bud expands, a variable number of the outermost leaves may not attain full size (Text-fig. 35), but in this species shoots showing full development of all foliar organs may be found on the same shrub as those which do not.

D. Microscopic buds.

Many plants belonging to microphyllous types possess no obvious bud structure in the axils of their leaves. The young leaves appear to differentiate and develop at a fairly rapid rate, without undergoing a resting period within any bud structure visible to the naked eye. However, examination with a binocular microscope reveals the fact that there is a papilla of tissue in the axil of each leaf, which may or may not show early stages of differentiation. This "bud" is usually well protected by or even hidden by the leaf-bases. The apical growing-point is usually surrounded by a tuft of leaves, as in *Bauera rubioides*.

It does not necessarily follow that, because a plant has such a "bud," all the leaves of the resultant shoot will be fully developed.

(i) *Bauera rubioides* Andr. has a compound leaf of three sessile leaflets. There is a tuft of white hairs in the axil of the leaf, which covers a short primordium on which the first leaflets may already have begun to differentiate (Text-fig. 36). Development of the shoot shows the first three or four leaves reduced in size. At the apex of each branch is a crown of leaves protecting the apical growing point.



Text-figs. 37-48.

- 37.—Developing axillary bud of *Angophora lanceolata*. ($\times 10$.)
 38.—A diagram of a transverse section of a developing bud of *Angophora cordifolia*.
 39.—a. Terminal and axillary buds of *Lomatia longifolia*. ($\times 2.5$.) b. Type of clothing hair found on the leaf rudiments.
 40.—A terminal bud of *Grevillea linearis*. ($\times 7$.)
 41.—An axillary bud of *Lasiopetalum ferrugineum*. ($\times 7$.)
 42.—An axillary bud of *Dodonaea triquetra*. ($\times 4.7$.)
 43.—An expanding axillary bud of *Dodonaea triquetra*. ($\times 7.5$.)
 44.—a. A diagram of a transverse section of a bud of *Myoporum tenuifolium*. b. Type of glandular hair found on young leaves.
 45.—A terminal bud of *Avicennia officinalis*. ($\times 0.7$.)
 46.—A diagram of a vertical section of a terminal bud of *Avicennia officinalis* showing glandular (b) and clothing (a) hairs.
 47.—An expanding terminal bud of *Oxylobium trilobatum*. ($\times 4$.)
 48.—a. A diagram of a transverse section of a bud of *Oxylobium trilobatum*. b. Type of clothing hair.

(ii) *Angophora lanceolata* Cav. shows only an ill-defined axillary swelling corresponding to the papilla characteristic of many microphyllous types, but during the actual growing season a bud structure is produced (Text-fig. 37), which proceeds immediately to expand, giving rise to a shoot on which the proximal organs do not develop fully. This occurs in spite of the fact that the foliar rudiments are coated with a characteristic rubbery secretion produced by papillate epidermal cells. This secretion, which is of the nature of caoutchouc, has been described by Welch (1923). In *A. cordifolia* Cav., the young leaf rudiments (Text-fig. 38) are covered by interlocking hairs and emergences.

3. Naked Buds.

As the classification of such buds depends upon one's conception of the meaning of the term "naked", it will be necessary to define a naked bud as one in which all the foliar organs forming it exhibit perfect development, i.e., there are no scales or transitional forms. The first leaf-rudiments may be visible on the outside of the naked bud or they may be hidden by their own stipules.

These buds form a large class in the New South Wales flora, and many and varied modes of protection of the young leaves are found, i.e., clothing or glandular hairs, secretions or stipules may occur, or even any combination of these protective features. Nevertheless, the bud is "naked" in that the leaves from the basal node itself are fully formed.

A. Protection by hairs.

In the Proteaceae, Monimiaceae, Sterculiaceae and Rutaceae buds are found in which the protection of the leaf-rudiments is effected by a dense tomentum of clothing hairs. These hairs more often than not hold brown or red pigments in their cell cavities, which are frequently reduced while the cell walls may be undulating or nodular.

(i) In *Lomatia longifolia* R.Br. (Text-fig. 39, *a*) the terminal and axillary buds are similar, the latter being closely appressed to the stem. In each the clothing hairs (Text-fig. 39, *b*) are directed vertically, forming a dense canopy over the leaf-rudiments and filling up the spaces between them. Brown pigment is developed to the greatest extent in those hairs which occur on the outer leaf-rudiments. This canopy of hairs is completely lost as the leaves mature.

(ii) *Grevillea linearis* R.Br. (Text-fig. 40).—In this case the leaves of the bud are loosely folded around one another, the interstices being occupied by T-shaped hairs, the head cells of which hold red pigment. At maturity hairs are found only on the lower surface of the leaves.

(iii) *Lasiopetalum ferrugineum* Sm. (Text-fig. 41).—In this genus the overlapping leaves bear on their lower surfaces a tomentum of stellate hairs which is never completely lost even at maturity.

Glandular hairs may occur instead of or in conjunction with clothing hairs as in *Dodonaea triquetra*, *Myoporum tenuifolium* and *Avicennia officinalis*.

(iv) *Dodonaea triquetra* Wendl.—Flowers are produced terminally. After the formation of the fruits, a bud lying in the axil of the uppermost leaf of the shoot begins to expand. Its strong growth soon places it in a terminal position. At the same time an accessory axillary bud lying in the axil of the same leaf may give rise to a normal axillary shoot. Many axillary buds develop. Each is a compact resinous mass lying in the leaf axil (Text-fig. 43). As the bud expands it becomes cylindrical (Text-fig. 43). Each leaf of the bud bears numerous multicellular

glandular hairs which secrete a resin, thus cementing the leaves of the bud together. These hairs, which are most closely set on the inner leaves, have been described in detail for another species of this genus, by Miss Collins (1920).

(v) *Myoporum tenuifolium* Forst. shows a tapering bud in which the overlapping leaves have both surfaces densely covered with multicellular glandular hairs which secrete a protective resin (Text-fig. 44, *a, b*). The hairs of this genus also have been studied by Miss Collins (1920). It has been noted that sometimes the first-formed leaves are not quite as large as those initiated later, a suggestion of the intermediate bud type.

(vi) *Avicennia officinalis* L. also exhibits glandular hairs. Each lateral bud is protected by the base of the leaf in whose axil it lies, while the terminal bud is half hidden between the leaf-bases and the uppermost pair of leaves (Text-fig. 45). The outer leaf-rudiments of the bud bear T-shaped hairs on those parts of the abaxial surfaces which are exposed. On the adaxial surfaces of these outer leaves and on both faces of the inner ones there are glandular hairs (Text-fig. 46). In this genus also the first few leaves of the shoot are sometimes slightly smaller than the others.

B. Protection by stipules with or without hairs.

In many cases the young leaves may be protected by stipules which may or may not be supplemented by hairs as in *Oxylobium trilobatum*, *Acacia elata*, *Elaeocarpus reticulatus*, etc.

(i) *Oxylobium trilobatum* Benth. is a typical example (Text-fig. 47). In both the terminal and axillary buds the leaves are folded inwards and their apices early become hard and glabrous. The stipules, a pair belonging to each leaf, fill up the spaces between the leaves and make the bud compact (Text-fig. 48, *a*). The leaves and the outer surfaces of the stipules are covered with a dense tomentum of hairs. These clothing hairs have one or two basal cells and a long tapering thick-walled terminal cell (Text-fig. 48). As the bud expands, the hairs are lost and the stipules, though persistent, have little function, unless it be to afford some degree of protection to the axillary buds.

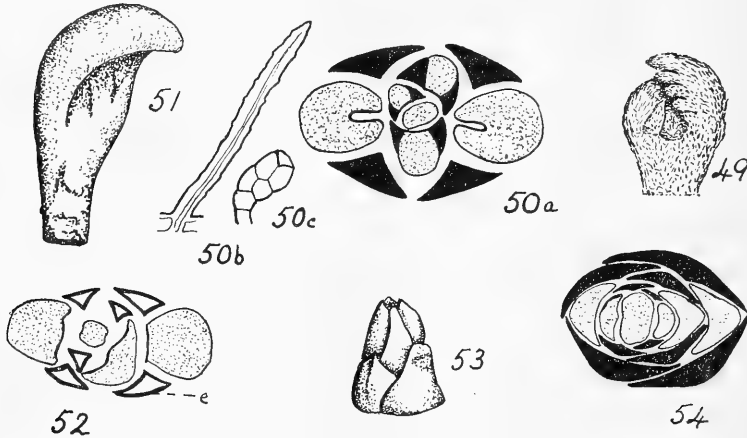
(ii) In true-leaved Acacias, e.g., *A. elata* (Text-fig. 49), the organs of the bud are composed of rudimentary leaves and stipules (Text-fig. 50, *a*). These are enveloped by a resin secreted by multicellular glandular hairs which have been described by Miss Collins (1920).

These glandular hairs (Text-fig. 50, *c*) vary in number in the various species. They occur most abundantly on the inner surfaces of the leaves, while in addition the leaves bear short pilose hairs (Text-fig. 50, *b*) which act as "pegs" on which to hang the secretion.

(iii) *Elaeocarpus reticulatus* Sm. (Text-fig. 51).—In both the terminal and axillary buds the rudimentary leaves are enveloped by long clothing hairs and are covered by a resinous secretion excreted from the epithelia which line the stipules (Text-fig. 52). As the bud expands, the stipules, their function being over, fall off. Occasionally the first two leaves of a shoot are smaller than those formed later.

In the cases just cited the stipules have not formed a marked major feature of protection, but in some buds they may do so, as in *Breynia oblongifolia*, *Vitis Baudiniana* and *Ceratopetalum apetalum*. These buds differ from true scaly buds of the stipular type in that a leaf expands from the node at which each pair of stipules is borne.

(iv) *Breynia oblongifolia* Muel.—Many axillary buds develop into vigorous shoots. Each bud occurring on the main branches lies in the axil of a reduced leaf and is protected by the pair of stipules belonging to that leaf (Text-fig. 53).



Text-figs. 49-54.

49.—An axillary bud of *Acacia elata*. (× 4.)

50.—a. A diagram of a transverse section of a bud of *Acacia elata*. b. Type of clothing hair. c. Type of glandular hair.

51.—An expanding bud of *Elaeocarpus reticulatus*. (× 15.)

52.—A diagram of a transverse section of a bud of *Elaeocarpus reticulatus*; (e) epithelium.

53.—An axillary bud of *Breynia oblongifolia*. (× 11.)

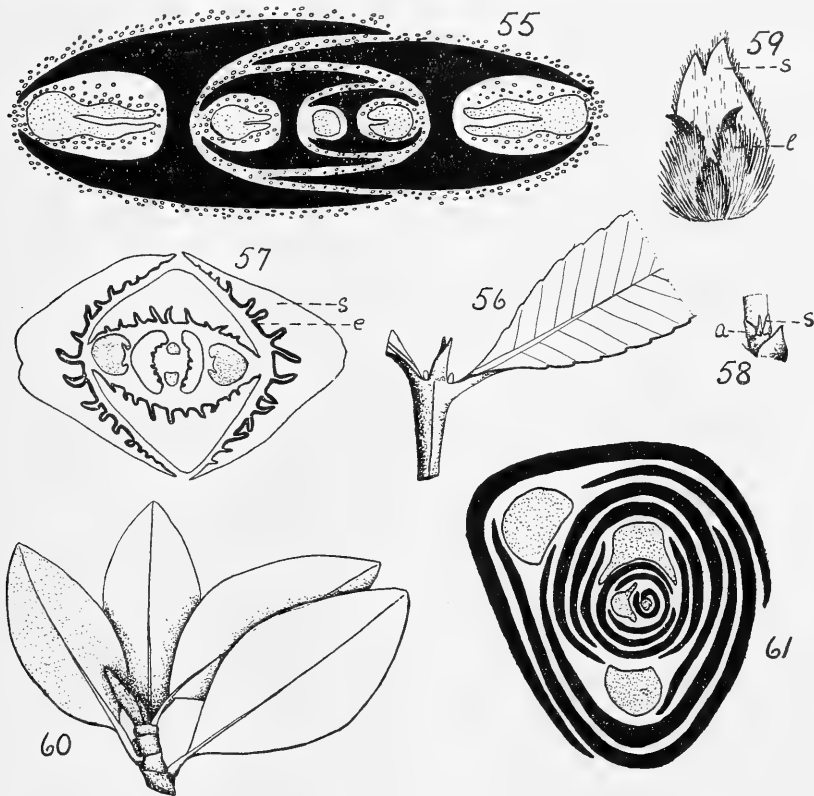
54.—A diagram of a transverse section of a bud of *Breynia oblongifolia*.

The leaf-rudiments in the bud are glabrous and protected by stipules, two occurring with each leaf, their edges just touching behind it, so hiding the leaf from view (Text-fig. 54). Examined externally, it may be mistaken for a true scaly bud, from which it differs by the fact that there are no intermediate forms; every node has a fully developed foliage leaf.

(v) *Vitis Baudiniana* F.v.M.—The terminal and axillary buds are alike flat and narrow, only the tomentose stipules being plainly visible. Each leaf has two stipules which stand erect, face to face, and are joined medianly by a narrow band of tissue at right angles to the stipules (Text-fig. 55). Thus the stipules are held close together, forming two chambers, into one of which fits the leaf belonging to these stipules, while the other chamber partly encloses the rest of the bud. Each leaf is not quite completely enveloped by its own stipules and on the exposed median abaxial part of the unfolded leaf the hairs, which occur elsewhere on the leaves, are densest. The stipules themselves bear on their outer surfaces numbers of hairs with short stalks and T-shaped heads, one of the arms of each terminal cell being greatly elongated and directed towards the apex of the bud. In an axillary shoot the first leaf is rudimentary. The rudiments of the tendrils may also be seen, each one densely covered with hairs and lying close to the base of the leaf initiated after it. Their growth in the bud is slower than that of the leaves.

C. Special cases of stipular protection.

(i) *Ceratopetalum apetalum* Don.—In the terminal bud the leaves are not visible. This is due to the fact that the stipules belonging to the terminal pair of leaves of the previous year's shoot hide them (Text-fig. 56). The stipules of *Ceratopetalum* are complex, being formed by the lateral fusion of one stipule from each of the opposite leaves. They are green and stand erect. Those of the terminal pair of leaves partly enclose the rudiments of the following year's growth, while each pair of leaves in the bud is also partly enveloped by its own stipules (Text-fig. 57). The whole structure is covered by a resinous secretion produced by the epithelia which line the fluted inner surfaces of the stipules. The axillary buds, on the other hand, receive no protection from the stipules of the leaves in



Text-figs. 55-61.

- 55.—A diagram of a transverse section of a bud of *Vitis Baudiniana*.
 56.—Terminal and axillary buds of *Ceratopetalum apetalum*. ($\times 0.75$.)
 57.—A diagram of a transverse section of a bud of *Ceratopetalum apetalum*; (s) stipules, (e) epithelium.
 58.—The base of an axillary shoot of *Ceratopetalum apetalum* showing the rudimentary leaf (a) and stipules (s). ($\times 1$.)
 59.—A terminal bud of *Callicoma serratifolia*. The outer stipules have been removed; (s) stipules, (l) leaf. ($\times 4$.)
 60.—A shoot of *Ficus rubiginosa* showing a terminal and axillary bud. ($\times 0.5$.)
 61.—A diagram of a transverse section of a terminal bud of *Ficus rubiginosa*.

whose axils they lie, so that the first pair of leaves on a lateral shoot usually remains rudimentary. There is, however, always a distinct bud in the axil of each of the rudimentary leaves of the proximal pair. There may only be a very slight elongation of the internode between this pair and the base of the shoot (Text-fig. 58).

(ii) *Callicoma serratifolia* (Text-fig. 59) exhibits a similar bud structure to that of *Ceratopetalum*, the only difference being that in place of the secretion the leaves and outer surfaces of the stipules are densely clothed with unicellular rusty hairs. These hairs are densest where the leaves are not covered by their stipules. The axillary bud is protected by the leaf-base and petiole of the mature leaf in whose axil it lies. Also, it is noted that all the leaves of a lateral shoot develop fully.

(iii) *Ficus rubiginosa* Desf. (Text-fig. 60) also belongs to this class. Most of the growth of a shoot is carried on by the terminal bud. Each leaf has two overlapping stipules lying inside it, so in this bud the first leaf is enveloped by the stipules belonging to the last leaf of the previous growth period (Text-fig. 61). A leaf develops for each pair of stipules and the latter are covered on their outer surfaces by unicellular hairs and the leaves may also bear a few.

The axillary buds do not often form, but if they do leaf-rudiments are absent within the first pair or two pairs of stipules, between which, however, a long internode appears as the shoot develops.

D. Microscopic Buds.

Microscopic buds are found in the class of naked buds, as they are in the class of intermediate buds, the only difference being that all the leaves show full development, the criterion of a naked bud.

(i) *Darwinia fascicularis* Rudge.—An inflorescence is terminal and the axillary buds are represented by papillae of tissue completely hidden between the leaf-bases and the stem (Text-fig. 62). Sometimes they are undifferentiated; at other times they may show the early development of the first two leaf-rudiments and, because of their protected position, they need and bear no protective organs (Text-fig. 63).

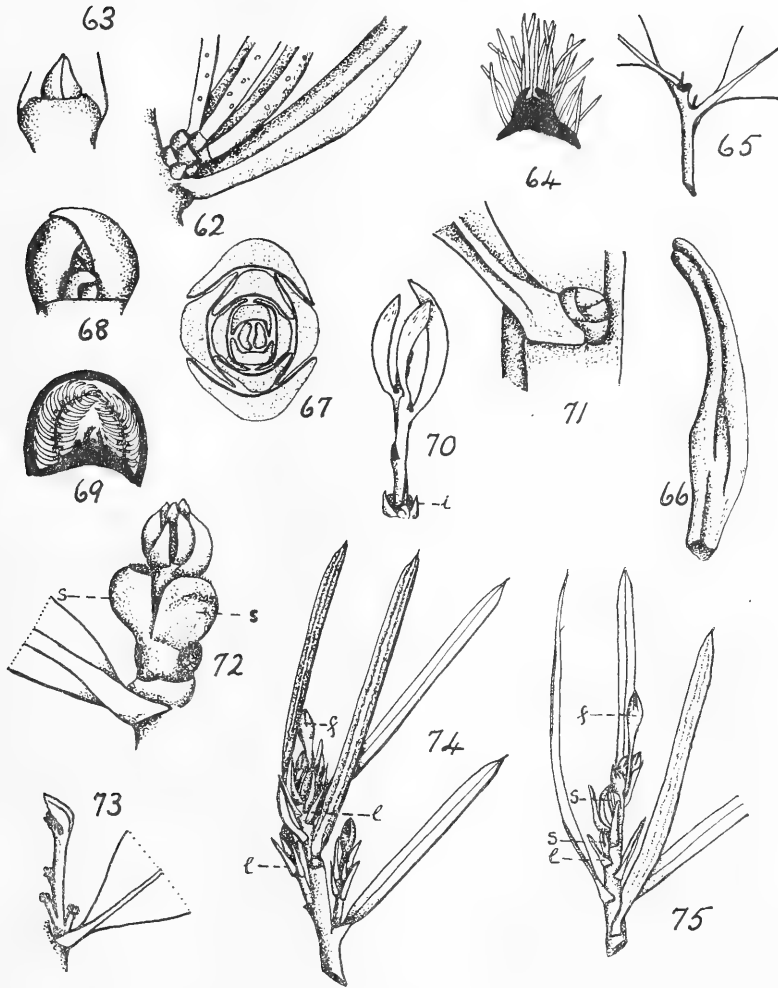
(ii) *Boronia pinnata* Sm.—The axillary buds are similar to those of *Darwinia fascicularis*, and the terminal is completely hidden between the bases of the uppermost pair of leaves.

(iii) *Westringia rosmariniformis* Sm.—The apical growing-point is protected by the surrounding leaves. The tuft of erect stiff white hairs which clothes each axillary papilla may be visible with the aid of a hand lens (Text-fig. 64).

(iv) Many Eucalypts such as *Eucalyptus corymbosa*, like *Angophora lanceolata*, show only an ill-defined swelling in each leaf-axil. But during the growing season a bud structure is developed (Text-figs. 65, 66, 67) which proceeds immediately to expand, giving rise to young leaves. The buds in the axils of these in their turn may produce axillary shoots without a resting period. Terminal and many axillary shoots develop each growing season. The young leaves are protected by a secretion which has also been described by Welch (1923).

4. Mixed Buds.

Mixed buds are those from which both leaves and flowers may develop. Such buds, as the only means of shoot extension, are of rare occurrence in our Flora. Some phyllodineous Acacias such as *Acacia longifolia* and *A. myrtifolia* and also a member of the Euphorbiaceae, *Ricinocarpus pinifolius*, have mixed buds.



Text-figs. 62-75.

- 62.—Developing axillary shoot of *Darwinia fascicularis* showing closely set leaf-bases. ($\times 8$.)
- 63.—Axillary bud of *Darwinia fascicularis*. ($\times 30$.)
- 64.—Diagram of a vertical section of a bud of *Westringia rosmariniformis*.
- 65.—*Eucalyptus corymbosa* showing initiation of bud structures during the growing season. ($\times 0.7$.)
- 66.—Expanding bud of *Eucalyptus corymbosa*. ($\times 4$.)
- 67.—Diagram of a transverse section of an expanding bud of *Eucalyptus corymbosa*.
- 68.—Axillary compound bud of *Acacia longifolia*. ($\times 7$.)
- 69.—Vertical section of a compound bud of *Acacia longifolia*. ($\times 7$.)
- 70.—Developing axillary shoot of *Acacia longifolia* showing inflorescences (i) at the base. ($\times 1$.)
- 71.—Dormant bud of *Acacia myrtifolia*. ($\times 7$.)
- 72.—Developing axillary shoot of *Acacia myrtifolia*; (s) scale-like organ. ($\times 5.5$.)
- 73.—Older axillary shoot of *Acacia myrtifolia*. ($\times 1.5$.)
- 74.—Developing shoots of *Ricinocarpus pinifolius*; (f) flower, (l) undeveloped leaf. ($\times 1$.)
- 75.—Older shoots of *Ricinocarpus pinifolius* showing the development of shoots (s) in the axils of the undeveloped leaves (l). ($\times 1$.)

(i) *Acacia longifolia* Willd.—In each leaf-axil the rudimentary shoot has, on one side or either side, a young inflorescence, the whole being enveloped by the two scale-like organs (Text-figs. 68, 69). As the shoot emerges from the bud the first phyllode may not develop. However, there is a long internode on the shoot between the axil of the phyllode in which the shoot is developing and the stipules which mark the position of the undeveloped phyllode. The inflorescences of the buds do not always mature.

(ii) *Acacia myrtifolia* Willd. has a mixed bud (Text-fig. 71). Flowers are produced terminally and the apical growth is then continued by an axillary bud. In the axil of each leaf are two or sometimes three buds. One of these is a pure inflorescence bud, the other two are potentially mixed buds.

Each bud is covered by scale-like organs. There may be one true scale at the base of the shoot followed by three scale-like organs, between which are distinct internodes (Text-fig. 72). In their axils inflorescences may, but do not always, appear. These are followed by the phyllodes (Text-fig. 73).

(iii) *Ricinocarpus pinifolius* Desf. (Text-fig. 74).—The main growth is by the terminal bud, the axillary buds are microscopic and hidden by the leaf-bases. As each expands, two to four foliar structures are first produced; the proximal one or two sometimes develop fully into normal leaves, the others do not. They are followed by several other undeveloped leaves in whose axils flowers arise. Flowers are also produced terminally. As the flowers mature, shoots develop rapidly in the axils of the first incomplete leaves which are then shed (Text-fig. 75).

Variability.

Variability exhibited by leaf-buds is in many cases very marked. Families such as the Proteaceae and Myrtaceae show great diversity of bud structure, including examples of all three classes, others are remarkably true to one type, e.g., Epacridaceae, Cunoniaceae. Yet again a genus may include species exhibiting different bud morphology. This is well illustrated in the genus *Hakea* for *Hakea pubescens* has a scaly bud, *Hakea eriantha* has an intermediate one, while *Hakea saligna* has a bud which may sometimes be intermediate and at other times scaly according to whether internodes elongate between the proximal organs or fail to do so.

Variability of bud type is shown within a single species, i.e., the degree of development of the outer organs often varies greatly, e.g., *Pultenaea daphnoides*, in which the first leaves sometimes do not develop after initiation and at other times are clearly recognizable (Text-figs. 30, 31), or *Petrophila pulchella* in which the number of transitional forms and their degree of development are variable.

This variability may even extend to the different branches of the one plant, for the number of scales and transitional forms is rarely constant and the degree of development exhibited by the transitional forms is extremely variable.

Foster (1929) suggests that bud structure and development may be controlled by the physiology of the shoot. The variability exhibited among species of the same family and even shown upon branches on the one plant seems to support this suggestion. Foster indicates that the formation of the "upper" transitional forms as well as that of the lower transitional forms of *Aesculus Hippocastanum* may be due to a change in physiological activity. The upper transitional forms are found on the shoot between the leaves and the bud-scales proper. The lower transitional forms occur between the bud-scales proper and the leaves, as has

already been mentioned. Organs indicating similar conditions are found in *Isopogon anemonifolius*, which has a bud like that of *Petrophila pulchella*. In this plant the leaves just beneath the terminal bud are smaller than those lower down on the shoot, indicating a slowing down of the metabolic rate. As the terminal bud expands, these small leaves are followed by transitional forms, each succeeding structure along the shoot showing slightly more development than the one preceding it as the metabolic rate approaches its optimum.

Again in *Petrophila pulchella* sometimes among the first transitional forms an odd one appears that is much more fully developed. Such a development indicates a temporary acceleration in the metabolic rate.

SUMMARY.

1. Leaf-buds in New South Wales can be divided into three classes: (a) scaly; (b) intermediate; (c) naked.

2. Scaly buds are poorly represented in the flora. Each bud consists of scales (representing laminae, or stipules) and transitional forms enclosing rudimentary leaves. The transitional forms are defined as those organs which lie on the shoot between the scales and the leaves proper.

3. *Hakea pubescens* has a typical scaly bud with laminar scales and transitional forms devoid of axillary buds. *Pittosporum undulatum* has laminar scales and the two distal transitional forms usually have minute axillary buds. In the Epacridaceae scales are few and there is a perfect series of forms from scale to leaf in the axils of any of which buds may be induced to grow by injury of the shoot.

4. Intermediate buds which, when closed, resemble naked buds, have outer foliar organs corresponding to the transitional forms of the scaly bud. There may be a marked difference between the latter and the mature leaves of the shoot as in *Petrophila pulchella*, or the change may be gradual as in *Persoonia salicina*, or yet again all the transitional forms may differ only in size, being slightly smaller than the leaves, e.g., *Rapanea variabilis*.

5. Many small-leaved types, e.g., *Bauera rubioides*, and a few large-leaved types, e.g., *Angophora lanceolata*, have microscopic bud structures. The growing apex in such cases is usually enveloped by a crown of mature leaves.

6. A naked bud is one in which, be the bud protection what it may, all the foliar organs of the expanded bud show perfect and full development. Such buds have the young leaf rudiments protected by hairs (e.g., *Lomatia*, *Grevillea*), secretion (e.g., *Myoporum*) or stipules (e.g., *Breynia*), or some combination of these protective features. In those types in which stipules form the main protective feature the young leaf rudiments are not visible.

7. Microscopic buds occur in this class just as frequently as among the intermediate buds, e.g., *Darwinia fascicularis*, *Eucalyptus corymbosa*.

8. Great variability of bud types is instanced among the genera of families, such as the Proteaceae and Myrtaceae, and among species of a genus, such as *Hakea*. Variability of development of a particular bud type is shown among the individual plants of a species, such as *Pultenaea daphnoides* or *Petrophila pulchella*, and, finally, may be shown among the buds on the one plant as *Banksia ericifolium*.

9. The evidence points to the fact that bud structure and development are influenced by the physiology of the shoot, as has already been pointed out by other writers.

PART II.

Brief descriptions of the buds of selected species.

The approximate length of each bud is given in millimetres.

Fagaceae.

Fagus Moorei F.v.M.—Scaly bud. Terminal (3 mm.) and axillary (1 mm.) alike. Bud roughly four-sided, its leaf rudiments covered by reddish-brown stipular scales. Erect glandular and a few simple hairs occur on scales, young stem and leaves. Stipules early deciduous. Mature stem has sparse covering of hairs, leaves glabrous.

Moraceae.

Ficus rubiginosa Desf.—Naked bud. See Part i.

Ficus stephanocarpa Warb.—Naked bud. Terminal (3 mm.) and axillary (1 mm.) alike. Bud morphology similar to that of *Ficus rubiginosa*. Leaves and lower part of stipules bear simple erect hairs. Axillary buds in this species are found in the axils of all leaves. A leaf rudiment occurs with the second pair of stipules on the shoot.

Proteaceae.

Banksia ericifolia L.—Intermediate bud. See Part i.

Banksia integrifolia L.—Intermediate bud. Terminal often an inflorescence. Axillary (1 mm.) like *B. serrata*. Bud is rusty tomentose and on expansion about six transitional forms occur on the shoot.

Banksia marginata Cav.—Intermediate bud. Terminal usually an inflorescence. Axillary buds (1 mm.) develop beneath the terminal. Organs of bud loosely compact, protected by pigmented woolly hairs. As bud expands a varying number of tomentose transitional forms occur which may be rather better developed than in *Banksia serrata*.

Banksia serrata L.—Intermediate type. See Part i.

Banksia spinulosa Sm.—Intermediate type. Terminal usually an inflorescence. Axillary buds (1 mm.) like *Banksia serrata*. Approximately 12 transitional forms shown in developing shoot. Lamina quite suppressed in proximal ones, but may be evident in distal ones.

Conospermum longifolium Sm.—Intermediate bud. See Part i.

Grevillea acanthifolia Cunn.—Naked bud. Terminal an inflorescence. Axillary buds (1-2 mm.) partly hidden in axils of leaves, only densely hairy apex showing. Silvery T-shaped hairs lost as foliage matures.

Grevillea buxifolia R.Br.—Naked bud. Flowers borne terminally, so shoots arise in axils of leaves just beneath them. Bud (1 mm.) like *Grevillea linearis*, foliar organs having dense canopy of T-shaped hairs. Occasionally some of the outer leaves do not develop fully.

Grevillea linearis R.Br.—Naked bud. See Part i.

Grevillea mucronulata R.Br.—Naked bud. Terminal (1-2 mm.) and axillary (1 mm.) like *Grevillea linearis*. Heads of hairs elongated, arms being reflexed.

Grevillea oleoides Sieb.—Naked bud. Terminal (3 mm.) and axillary (1-2 mm.) like *Grevillea linearis*. Tomentum exceptionally thick.

Grevillea robusta Cunn.—Naked bud. Terminal (4 mm.) and axillary (2-3 mm.) alike. Leaf rudiments densely covered with dark-brown T-shaped hairs. First two or three leaves on shoot usually fall away early, leaving well developed axillary buds.

Grevillea spachelata R.Br.—Naked bud. Terminal (2 mm.) and axillary (0.5 mm.) like *Grevillea linearis*. Sometimes a tendency towards the intermediate type.

Hakea dactyloides Cav.—Scaly bud. Flower buds also scaly. Terminal (2.3 mm.) and axillary (2 mm.) like those found in *H. pubescens*, except that transitional forms bear minute buds in their axils and internodal elongation is more pronounced. Leaves covered with T-shaped hairs which are lost as leaves mature.

Hakea eriantha R.Br.—Intermediate bud. Terminal and axillary (2 mm.) alike. Organs of bud covered by T-shaped hairs. On expansion, 5-6 transitional forms occur on axillary shoot, distal ones having appearance of small leaves.

Hakea pubescens Schrad.—Scaly bud. See Part i.

Hakea pugioniformis Cav.—Scaly bud. Terminal (2.3 mm.) and axillary (2.3 mm.) like *Hakea pubescens*. Scales are dark reddish-brown; flower buds scaly also.

Hakea saligna R.Br.—Intermediate bud. Terminal (2 mm.) and axillary (1 mm.) alike, covered with pigmented T-shaped hairs. Development of bud variable, proximal organs remain rudimentary and are followed on the shoot by transitional forms. Proximal organs have no axillary buds. Frequently the axis may elongate between them, when they may be termed transitional forms, or occasionally may not do so, when they may be called scales.

Isopogon anemonifolius R.Br.—Intermediate bud. Terminal may be an inflorescence. Axillary (2 mm.) always a leaf-bud. Bud like *Petrophila pulchella*. Foliar organs are sparsely covered with hairs and on bud expansion a variable number of transitional forms are seen.

Lambertia formosa Sm.—Intermediate bud. Leaf-bud (2.3 mm.) or flower-bud terminal. Axillary buds (1 mm.) similar to the terminal leaf-buds in development. Outer organs of leaf-bud (6-8 in number) are rather scale-like in appearance. These transitional forms seem to represent leaf-bases and petioles, laminae being suppressed, and occur in whorls of three, as leaves do. Internodes between them distinct. Transition to young leaves, which are densely clothed with unicellular hairs, is markedly abrupt.

Lomatia Fraseri R.Br.—Naked bud. Terminal (4 mm.) and axillary (2 mm.) like *Lomatia longifolia*. Buds occur in axils of all leaves. Leaf rudiments covered by reddish-brown hairs and may show a tendency towards intermediate type.

Lomatia longifolia R.Br.—Naked bud. See Part i.

Lomatia silaifolia R.Br.—Naked bud. Terminal (3 mm.) and axillary (2 mm.) like *Lomatia longifolia*. Base of latter hidden by leaf-base.

Petrophila pulchella R.Br.—Intermediate bud. See Part i.

Petrophila sessilis Sieb.—Intermediate bud. Terminal (3.4 mm.) like *P. pulchella*, except that no trace of lamina was apparent in the transitional forms of the specimens examined.

Persoonia lanceolata Andr.—Intermediate bud. Terminal (2 mm.) and axillary (1 mm.) like *Persoonia salicina*. Cell cavities in hairs reduced to a minimum.

Persoonia linearis Andr.—Naked bud. Terminal (3 mm.). Leaf rudiments overlapping, their apices sometimes twisted a little. They are densely covered by unicellular hairs. Axillary buds have only been observed close to the terminal and are just visible to the naked eye.

Persoonia nutans R.Br.—Naked bud. Terminal (1 mm.) protected by the bases of the surrounding leaves. It is like *Persoonia linearis*, only smaller and not so densely covered by hairs. Axillary buds microscopic, each protected by a tuft of hairs at the base of the leaf in whose axil it lies.

Persoonia pinifolius R.Br.—Naked bud. Terminal (2-3 mm.) like *Persoonia linearis*. Axillary buds microscopic.

Persoonia salicina Pers.—Intermediate bud. See Part i.

Xylomelum pyriforme Sm.—Intermediate bud. Terminal (4-5 mm.) and axillary minute. Former almost hidden between the bases of the uppermost pair of leaves. Exposed apex densely covered by unicellular rusty hairs directed vertically. Mature leaves glabrous. As the bud expands, from 2 to 6 transitional forms are revealed, in which the leaf-bases and petioles develop fully but the laminae (those tomentose portions of the bud) show no further growth. Vigorous shoots develop in the axils of all the transitional forms but the two proximal ones, although they may have axillary buds.

Santalaceae.

Exocarpus sp.—Naked bud. Growing apex protected by two overlapping reduced leaves. Axillary buds microscopic. Both shoot and flower bud may occur in one axil. There are no protective organs.

Olacaceae.

Olax stricta R.Br.—Intermediate bud. At apex of shoot the leaves are folded around one another without any protective covering. Axillary buds microscopic, showing initial differentiation of two leaves. When bud expands, the first two or three foliar organs do not attain the size of the characteristic leaves of the plant.

Aizoaceae.

Mesembrianthemum aequilaterale Haw.—Naked bud. The terminal is protected by the uppermost pair of mature leaves. In the growth season, in each leaf axil two succulent glabrous leaf rudiments arise. As the bud opens, these elongate with their surfaces closely appressed, for a time protecting the rudiments of the next pair of leaves initiated inside. Many axillary shoots develop. The terminal bud is similar to the axillary in form and development.

Monimiaceae.

Doryphora sassafras Endl.—Naked bud. Terminal (4 mm.) and axillary (2 mm.) alike. Young leaf rudiments folded inwards, their outer surfaces covered by short unicellular hairs. Oil is developed in the leaves.

Hedycarya angustifolia Cunn.—Intermediate bud. Terminal (2 mm.) and axillary (1.5 mm.) alike. Two buds in the axil of each leaf, upper one may produce an inflorescence. Organs of bud are protected by unicellular silvery hairs, lost as the leaves mature. First two foliar organs smaller than the characteristic leaf as in *Rapanea variabilis* type.

Lauraceae.

Cryptocarya obovata R.Br.—Intermediate bud. Terminal (3-4 mm.) and axillary (2-3 mm.) alike. Leaf rudiments covered by pilose unicellular hairs. Developing shoot of *Rapanea variabilis* type.

Cryptocarya patentinervis (?) F.v.M.—Intermediate bud. Terminal (3-4 mm.) and axillary (2 mm.) alike. Organs of bud covered by a tomentum of rust-coloured hairs. Oil present in the leaves. As the bud expands 2 or 3 of the leaves first formed do not fully develop, as in *Rapanea variabilis*.

Litsea dealbata Nees.—Scaly bud. Terminal (4 mm.) and axillary (2 mm.) alike. Leaf rudiments are covered by scales bearing brown unicellular hairs. About five or six transitional forms occur, between which there are well marked internodes, but the first may show as little development as the last-formed and so there may be a very abrupt change to the normal leaf. Each transitional form has an axillary bud.

Saxifragaceae.

Bauera rubioides Andr.—Intermediate bud. See Part i.

Pittosporaceae.

Billardiera scandens Sm.—Scaly bud. Terminal and axillary (1 mm.) buds alike. Flowers may be terminal. The bud has four membranous laminar scales bearing a sprinkling of hairs. Scales linked to leaves by a few transitional forms which, together with leaves, are covered with long silky hairs. Change from transitional form to leaf not abrupt.

Bursaria spinosa Cav.—Naked bud. Each branch terminates in a thorn, apex of which is covered by two microscopic laminae. At the base of the thorn are two leaves with axillary buds. Minute leaves occur alternately along the thorn. Each covers a small swelling which later produces a young shoot of the nature of a thorn. At the same time the minute leaf in whose axil the thorn is developing, enlarges and photosynthesizes.

Pittosporum revolutum Ait.—Scaly bud. Flower buds may develop terminally or in the leaf axils. Buds (3 mm.) like those of *Pittosporum undulatum*. Laminar scales densely clothed by rusty T-shaped hairs, together with a few glandular hairs. Transitional forms not well developed and do not photosynthesize as in *P. undulatum*. Transition to leaves abrupt.

Pittosporum undulatum Andr.—Scaly bud. See Part i.

Cunoniaceae.

Ackama Muelleri Benth.—Naked bud. Terminal (3 mm.) and axillary (1-2 mm.) alike. Structure like that of *Ceratopetalum apetalum*, except that the secretion is absent. It is replaced by hairs occurring on the leaves and outer surfaces of the deciduous stipules. Also the first pair of leaves of each axillary shoot show full development.

Callicoma serratifolia Andr.—Naked bud. Terminal (5 mm.) and axillary (2 mm.). See Part i.

Ceratopetalum apetalum Don.—Naked bud. See Part i.

Ceratopetalum gummiferum Sm.—Naked bud. Terminal (2 mm.); axillary (1 mm. or less). Bud structure as in *C. apetalum*.

Weinmannia rubifolia Benth.—Naked bud. Like *Ackama Muelleri*; tomentum dense.

Leguminosae.

Acacia decurrens Willd.—Naked bud. Terminal (3-4 mm.) and axillary (2 mm.) alike. Arrangement of the organs in the bud as in *Acacia elata* (see Part i), except that glandular hairs are more numerous.

Acacia decurrens var. *mollis* Lindl.—Naked bud. Terminal (2 mm.) and axillary (1 mm.) alike. Axillary bud protected by the base of compound leaf. Bud structure like *Acacia decurrens*, except that clothing hairs are very abundant and secretion seems to be absent.

Acacia discolor Willd.—Naked bud. Terminal (3 mm.) and axillary (2 mm.) alike. Bud like *Acacia elata* and *Acacia decurrens*, except that glandular hairs are more numerous.

Acacia elata Cunn.—Naked bud. See Part i.

Acacia juniperina Willd.—Naked bud. Leaf-bud not visible in the axils of phyllodes even with binocular microscope. Foliar and flower rudiments may arise side by side in the axil of a phyllode. Phyllodes originate in rapid succession and grow immediately to maturity.

Acacia longifolia Willd.—Mixed bud. See Part i. Phyllodes bear clothing hairs and a few glandular hairs which are lost as the phyllodes mature.

Acacia myrtifolia Willd.—Mixed bud. See Part i.

Bossiaea heterophylla Vent.—Naked bud. The leaf rudiments at the apex (1 mm.) are enveloped by small brown stipules. The stipules, two of which occur with each leaf, are pushed apart as each leaf appears. The petiole grows obliquely to bring the leaf well outside the stipules. Each leaf is covered by hairs which are lost as the leaf matures. The lamina of each leaf remains folded inwards for some time as the bud expands to give a measure of protection to the younger leaves. Axillary buds are microscopic.

Bossiaea microphylla Sm.—Naked bud. Like *Bossiaea heterophylla*.

Daviesia ulicina Sm.—Intermediate bud. Growth by axillary buds (0.5-1 mm.). Young rudiments in the bud have no protective covering. Red pigment is developed. On expansion 5-6 of the first initiated organs do not fully develop. These transitional forms vary from a scale-like organ to an attenuated form similar to very young leaf. A bud occurs in the axil of each. The leaf, unlike the transitional form, is very mucronate. Apex of the shoot is usually a spine.

Dillwynia ericifolia Sm.—Naked bud. Flowers terminal, axillary buds microscopic. Sometimes on expansion two transitional forms occur bearing a tuft of hairs at the apex.

Hovea linearis R.Br.—Naked bud. Terminal (3 mm.) and axillary (1 mm.) alike. The latter lies between two flower-buds which develop first. Young leaves enveloped by a dense tomentum of dark rust-coloured hairs and protection also afforded by small stipules. Arrangement of stipules and leaves as in *Oxylobium trilobatum*. First one or two leaves are sometimes smaller than those formed later.

Oxylobium trilobatum Benth.—Naked bud. See Part i.

Platylobium formosum Sm.—Scaly bud. See Part i.

Phyllota phyllicoides Benth.—Intermediate bud. Mature leaves protect the terminal growing point. Axillary buds, by which the main growth takes place, are microscopic. Each consists of 3 to 4 leaf-rudiments densely clothed with hairs and protected by the leaf-base. The number of transitional forms varies, as does also their degree of development.

Mirbelia grandiflora Ait.—Naked bud. Flowers terminal and axillary. Shoot growth by axillary buds (2 mm.) which may arise between the flower-buds and the leaf-base. Leaf-rudiments protected by a dense tomentum of hairs.

Mirbelia reticulata Sm.—Intermediate bud. Growth by axillary buds (1 mm.). Leaves of the bud protected by a tomentum of hairs. Varying degrees of development shown by the first few organs, which may be quite rudimentary or only a little smaller than leaves.

Pultenaea daphnoides Wendl.—Intermediate bud. See Part i.

Pultenaea elliptica Sm.—Intermediate bud. Growth by both terminal and axillary buds. Terminal growing-point enveloped by stipules which are large in comparison with the size of leaf and joined laterally. Stipules are fully developed when the leaves are only rudimentary and so effectively protect the latter.

Axillary bud minute and completely hidden by the stipules of leaf in whose axil it lies. Developing shoot of *Banksia ericifolia* type.

Pultenaea retusa Sm.—Intermediate bud. Terminal an inflorescence. Microscopic axillary buds just beneath terminal develop. Expansion as in *Pultenaea daphnoides*.

Pultenaea stipularis Sm.—Naked bud. Terminal an inflorescence, though leaves may grow out after development of fruits. Each axillary bud microscopic and hidden by a pair of large stipules, joined laterally. Outer one or two leaves sometimes not quite as large as those formed later.

Pultenaea villosa Willd.—Naked bud. Terminal (1.2 mm.) and axillary microscopic. In structure like *Pultenaea elliptica*. Stipules membranous and leaves villous.

Rutaceae.

Boronia pinnata Sm.—Naked bud. Terminal lies hidden between the bases of the uppermost pair of leaves of the previous growth period. Axillary microscopic and concealed by the subtending leaf-base. Leaf rudiments develop without any protective covering. Oil glands in leaves.

Boronia microphylla Sieb.—Naked bud as *Boronia pinnata*.

Correa alba Andr.—Naked bud. Terminal (3.4 mm.) and axillary (1.2 mm.) alike. Each leaf folded inward along the midrib, so protecting the younger leaves inside. Dense tomentum of stellate hairs on leaves. Sometimes a tendency towards the intermediate type.

Correa speciosa Andr.—Naked bud. Terminal (2 mm.) and axillary (1 mm.) like *C. alba*. The first two leaves of the bud are much further developed than the next two and they overlap one another.

Eriostemon crowei F.v.M.—Naked bud. Terminal (2 mm.) and axillary (0.5 mm.) alike, covered by a tomentum of sessile stellate hairs. Leaves of the bud loosely overlap one another. Sometimes a tendency towards intermediate type.

Zieria Smithii Andr.—Naked bud. Terminal (2 mm.). In the axil of each leaf are two buds; both may be flower-buds or one may later form an axillary shoot. The rudimentary leaves of the bud bear a few sessile stellate hairs and a thin coating of a secretion formed by multicellular glandular hairs which are few in number.

Tremandraceae.

Tetratheca ericifolia Sm.—Intermediate bud. Terminal (1 mm.) protected by the surrounding leaves. Axillary microscopic. On expansion the first two leaves do not develop fully as in *Rapanea variabilis* type. Flower and leaf bud may arise side by side.

Euphorbiaceae.

Breynia oblongifolia Muell.—Naked bud. See Part i.

Glochidion Ferdinandi Muell.—Naked bud. Terminal bud (2 mm.). The axillary bud (0.5 mm.) is completely hidden by the stipules of the leaf in whose axil it lies. Bud similar to that of *Breynia oblongifolia*; the stipules, however, overlap behind each leaf. There is a tendency for the elongation of the cells lining the inner surfaces of the stipules, although no secretion has been detected. Sometimes the first few leaves of the shoot are smaller as in the intermediate type.

Ricinocarpus pinifolius Desf.—Mixed bud. See Part i.

Meliaceae.

Synoum glandulosum Juss.—Naked bud. Terminal (3 mm.) and axillary (2 mm.) alike. Young leaf rudiments protected by a tomentum of unicellular hairs.

Celastraceae.

Elaeodendron australe Vent.—Naked bud. Terminal (3 mm.) and axillary (1 mm.) alike. The latter are partly protected by the persistent stipules of leaves in whose axils they lie. Bud compact, each leaf having a pair of small stipules lined by epithelia. The secretion thus formed protects the glabrous leaf rudiments.

Sapindaceae.

Dodonaea triquetra Wendl.—Naked bud. See Part i.

Rhamnaceae.

Pomaderris elliptica Labill.—Intermediate type. Flowers terminal. Axillary bud (2 mm.). Each leaf in the bud has a pair of stipules which overlap one another. The leaves and stipules bear long unicellular hairs and a few shortly stalked stellate hairs. As the shoot develops the proximal leaves remain slightly smaller than those formed later.

Pomaderris lanigera Sims.—Intermediate type. Axillary bud (2 mm.). The leaves of the bud are covered on their lower surfaces by a very dense tomentum of rust-coloured hairs. Each leaf has two thin membranous slightly hairy stipules which overlap one another on the inner side of the leaf and are very deciduous. Each pair is pushed off by the growth of the leaf inside it in the bud. Mature leaf slightly pubescent above, rusty tomentose below. The first two leaves are smaller than those formed later.

Pomaderris phillyraeoides Sieb.—Naked bud. Flowers terminal. Axillary bud (1 mm.) like *Pomaderris lanigera*, only smaller. Stipules not so deciduous and often, but not in every case, all leaves develop fully.

Vitaceae.

Vitis Baudiniana F.v.M.—Naked bud. See Part i.

Vitis hypoglauca F.v.M.—Naked bud. Terminal (5 mm.) and axillary (3 mm.) similar in structure. Like *Vitis Baudiniana* except that the edges of stipules overlap, completely enclosing the leaves in the bud. The first leaf of axillary bud does not develop.

Elaeocarpaceae.

Elaeocarpus reticulatus Sm.—Naked bud. See Part i.

Elaeocarpus holopetalus F.v.M.—Naked bud. Terminal (2 mm.) and axillary (1 mm.) like *E. reticulatus*, except that the unicellular hairy covering of the leaves is denser.

Sterculiaceae.

Lasiopetalum ferrugineum Sm.—Naked bud. See Part i. Terminal (3 mm.), axillary (1-2 mm.).

Lasiopetalum rufum R.Br.—Naked bud. Terminal (2 mm.), axillary (1 mm.); like *Lasiopetalum ferrugineum*.

Brachychiton populneus R.Br.—Intermediate bud. Terminal (1 mm.) and axillary (0.5 mm.) alike. Each leaf rudiment is protected by a pair of stipules, both stipules and leaves bearing stellate and glandular hairs. As the shoot develops the first two or three foliar organs, transitional forms, drop off and their axillary buds give rise to vigorous shoots. The stipules are very deciduous and the hairs are lost as the leaves mature.

Myrtaceae.

Angophora cordifolia Cav.—Intermediate bud. As in *A. lanceolata*, buds are represented by swellings which in the growing season produce bud structures in which the leaves, loosely folded, are held together by the interlocking of the shaggy hairs and emergences which occur on their surfaces. The first six may be transitional forms, the proximal one being quite rudimentary.

Angophora lanceolata Cav.—Intermediate bud. See Part i.

Backhousia myrtifolia Hook. and Harv.—Intermediate bud. Terminal (2 mm.) and axillary (1-2 mm.) alike. The leaf rudiments overlap one another and are covered by silvery unicellular hairs. Fewer hairs occur on the proximal 2 or 3 pairs which are transitional forms. The proximal pair usually remains quite rudimentary.

Baeckea brevifolia DC.—Naked bud. Terminal growing-point protected by mature leaves, axillary buds microscopic and completely hidden in the leaf axils.

Baeckea linifolia Rudg.—Naked bud. Terminal growing-point protected between the leaf-bases of the two uppermost leaves. Axillary buds microscopic and hidden in the leaf-axils. The first-formed leaves of the axillary shoots are occasionally smaller than those formed later.

Callistemon lanceolatus DC.—Scaly bud. Terminal (4 mm.) and axillary (2 mm.) alike. Former roughly hemispherical and may be a flower-bud. The formation of a spike of flowers does not terminate the growth, which is continued by a long shoot. The axillary buds are usually pure leaf-buds. Reddish-brown laminar scales are numerous (12-18) and are followed by transitional forms (16-12) which gradually become longer and narrower (as in *Hakea pubescens*), more closely approximating to the leaf. The young leaves bear a dense tomentum of silky hairs.

Darwinia fascicularis Rudge.—Naked bud. See Part i.

Eucalyptus corymbosa Sm.—Naked bud. See Part i.

Eucalyptus paniculata Sm.—Naked bud. Like *E. corymbosa*.

Kunzea corifolia Reichb.—Scaly bud. Terminal (1 mm.) like *Leptospermum flavescens*, only the scales are fewer in number and minute. The laminar scales soon fall and are followed on the shoot by a few transitional forms. Scars left by scales are indistinct, or even obliterated. Axillary bud, when it occurs, is minute.

Leptospermum attenuatum Sm.—Scaly bud. Terminal (2 mm.) and axillary (1 mm.) covered by laminar scales which, by a series of forms, grade into the leaves. Scales are brown and membranous. The internodes between the transitional forms are almost negligible, as in *Hakea pubescens*.

Leptospermum flavescens Sm.—Scaly bud. Terminal (2 mm.) and axillary (2 mm.) alike. From 8 to 14 foliar organs before the leaves, like *Leptospermum attenuatum*. Leaves covered by silky hairs.

Leptospermum lanigerum Sm.—Scaly bud. Terminal (3 mm.) and axillary (3 mm.) alike. From 14 to 18 laminar protective organs (scales and transitional forms) which are covered on their outer surfaces by woolly hairs. Axis also hairy, so when scales and transitional forms drop off scars are hidden. Sequence as in *Leptospermum flavescens*.

Leptospermum parvifolium Sm.—Scaly bud. Terminal (1 mm.) and axillary (1 mm.) with morphology like that of *Leptospermum attenuatum*.

Leptospermum stellatum Cav.—Scaly bud. Terminal (2 mm.) and axillary alike. Laminar scales brown, membranous and slightly hairy. About 8 foliar organs (scales and transitional forms) developed between the silvery tomentose leaves and the base of the shoot. Like *Leptospermum attenuatum*.

Melaleuca ericifolia Sm.—Scaly bud. Flowers are terminal. After flowering, one or two shoots may continue the terminal growth. Axillary bud (1 mm.) has from 6 to 8 laminar scales and from 6 to 10 transitional forms.

Melaleuca nodosa Sm.—Scaly bud. Flowers are terminal. After flowering, two shoots may continue terminal growth. Axillary buds (1 mm.) protected by the leaf-bases. Scales and transitional forms fewer than in *Melaleuca ericifolia*. Young leaves sparsely covered with long white hairs.

Melaleuca thymifolia Sm.—Scaly bud. Terminal sometimes a leaf-bud, but more often a flower-bud. After flowering, a shoot may continue the terminal growth. Axillary buds (1 mm.). Two or four laminar scales followed by two transitional forms which often closely approximate to leaves and bear buds in their axils.

Rhodamnia trinervia Blume. Intermediate bud. Terminal (2-3 mm.) and axillary (2 mm.). Organs of bud bear dense tomentum of brown hairs and on expansion first four do not fully develop. The first pair is rudimentary, but each transitional form has an axillary bud, second pair is only little smaller than the normal leaves. Many axillary shoots develop.

Syncarpia laurifolia Ten.—Scaly bud. See Part i.

Tristania laurina R.Br.—Intermediate bud. See Part i.

Ericaceae.

Gaultheria hispida R.Br.—Scaly bud. The terminal and upper axillary buds are flower-buds. Shoot growth is continued by the lower axillary buds (2 mm.). The laminar scales, 4-6 in number, are brown and membranous. They grade into transitional forms, of which there are 8-10. Inner ones are like small leaves and bear buds in their axils.

Epacridaceae.

Acrotiche aggregata R.Br.—Scaly bud. Buds (1-2 mm.) typical of Epacridaceae. Many axillary shoots develop.

Epacris microphylla R.Br.—Scaly bud. Typical bud of the Epacridaceae (as described in Part i), only minute.

Epacris pulchella Cav.—Scaly bud. Axillary buds barely visible to the naked eye and of type found in *Styphelia triflora*, only the number of transitional forms is far fewer.

Styphelia humifusa Pers.—Scaly bud. Terminal (1 mm.) surrounded by mature leaves. Axillary buds are developed in the axils of the upper leaves only. Bud a typical one of the Epacridaceae. The organs of the bud are mucronate. The transitional forms develop a tendency towards serration which is characteristic of the normal leaf.

Styphelia lanceolata Sm.—Scaly bud. Bud of Epacridaceous type. Axillary (1 mm.) almost hidden by the hairs of the stem and protected by the subtending leaf-base. Transitional forms few in number. They develop the ciliate hairs characteristic of the leaves.

Styphelia richii Labill.—Scaly bud. Bud is very small; the transition from scale to leaf is not as perfect as it is in many members of the Epacridaceae. There are fewer forms, so the change is more abrupt.

Styphelia triflora Andr.—Scaly bud. See Part i.

Styphelia tubiflora Sm.—Scaly bud. Small buds with a morphology like that of *Styphelia triflora*.

Styphelia viridis Andr.—Scaly bud. Bud like *Styphelia triflora*, except that fewer forms are developed before the normal leaves.

Trochocarpa laurina R.Br.—Scaly bud. Terminal (2 mm.) and axillary (1-2 mm.) alike. Typical bud of Epacridaceae.

Woollisia pungens F.v.M.—Scaly bud. Typical bud of family, but very small and only a few transitional forms between scales and leaves.

Myrsinaceae.

Rapanea variabilis Mez.—Intermediate bud. See Part i. Terminal (3 mm.), axillary (2 mm.).

Oleaceae.

Notelaea longifolia Vent.—Scaly bud. Terminal (3 mm.) and axillary (1-2 mm.). Two buds in the axil of each leaf. Both may be flower-buds or one a leaf-bud. Each bud has two brown scales covered with pilose hairs. There are two transitional forms slightly smaller than leaves. Leaf rudiments also hairy.

Verbenaceae.

Avicennia officinalis L.—Naked bud. See Part i.

Clerodendron tomentosum R.Br.—Naked bud. Terminal (2-3 mm.) and axillary (1-2 mm.) alike. Leaf-rudiments clothed by multicellular uniseriate hairs.

Labiatae.

Prostanthera marifolia R.Br.—Naked bud. Apical growing-point protected by surrounding leaves. At the base of each leaf is a tiny papilla of tissue protected by long 2-celled hairs.

Westringia rosmariniformis Sm.—Naked bud. See Part i.

Solanaceae.

Solanum sodomaecum L.—Naked bud. Terminal (2 mm.) and axillary (1 mm.); young leaves covered by stellate and glandular hairs. Prickles develop later.

Solanum xanthocarpum Schrad.—Naked bud. Like *Solanum sodomaecum*.

Myoporaceae.

Myoporum tenuifolium Forst.—Naked bud. See Part i.

Compositae.

Helichrysum diosmifolium Don.—Intermediate bud. Flowers terminal. Growing-point enveloped by leaves. Axillary buds microscopic and, on expansion, the first two leaves are smaller than those formed later.

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FLETCHER MEMORIAL LECTURE, 1930.

JOSEPH JAMES FLETCHER, AN IDEALIST SECRETARY.

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[Delivered 15th September, 1930.]

In July, 1926, the Council of the Linnean Society of New South Wales decided as the best means of perpetuating the memory of its late Secretary and President, Mr. J. J. Fletcher, to establish an Annual Fletcher Memorial Lecture, to be delivered in Sydney upon some branch of Natural History. This resolution was arrived at four years ago, and Sir Baldwin Spencer, F.R.S., was invited to be the first lecturer. It was hoped that the lecture would be delivered in 1927, but the long postponement has been caused first by Sir Baldwin's prolonged absence from Australia, and then by his lamented death in Patagonia. Thus deprived by Fate of the distinguished services of that eminent and brilliant investigator, the Council has invited me, as for long a close friend of Mr. Fletcher, to give the first lecture. Naturally I do so with fear and trembling.

Sir Baldwin was also a close friend of mine from the time he arrived in Australia to occupy the Chair of Biology in the Melbourne University. I was intimately associated with him both at the University and in the Royal Society of Victoria, and I may say that it was entirely owing to his urge that I wrote books on Botany and Zoology. Though diffident enough of my own powers, I cannot but feel that it is in some degree appropriate that one who was intimate with both Mr. Fletcher and Professor Spencer should endeavour to set forth the life and work of the one in the spirit of the other. For it seems right that the First Fletcher Memorial Lecture should have as its subject the Life and Work of J. J. Fletcher.

Joseph James Fletcher was born in Auckland, New Zealand, in 1850. He was a son of the manse, for his father was the Rev. Joseph Horner Fletcher, a Methodist clergyman, at that time Headmaster of the Auckland College. In March last, under the title "A Man of Ideals," the *Sydney Morning Herald* published a full and appreciative account of his life and work, forty years after his death. He was a man of culture and was for twenty-two years President of Newington College. He was prominent in his Church, having charge of the Theological Institute, and being elected President of the General Methodist Conference of Australia. To him, doubtless, his son owed much of his serious outlook on life and duty, his terse language, and perhaps some of his whimsical humour.

His school days were spent first at the Ipswich Grammar School and then at Old Newington on the Parramatta River, where his father was the President. The school building was the old homestead of the Blaxland family, a large two-storied house facing the river. The playground was the fine estate of the Blaxlands, comprising acres of gigantic trees, acres of scrub and acres of marshes. There was no science taught in schools in those days, but Old Newington taught

its own science. Wild birds were in abundance, wild duck frequented the marshes and wild life in general was in profusion. There was variety in plant life, too. The boys amused themselves with bird-nesting, catching opossums, rambling around and bathing in the creek. It was a happy, healthy life, and we may think of him, as of Agassiz—

And he wandered away and away
With Nature the dear old Nurse,
Who sang to him night and day
The rhymes of the universe.

He passed from Newington College to the Sydney University where he read for the Arts course, taking his B.A. in 1870. Under the tuition of the famous Dr. Badham, he gained a well-grounded knowledge of Latin and Greek. Dr. Badham must have been considerably impressed by his aptitude for the tongues for, when, on the occasion of the visit to Sydney of H.R.H. the Duke of Edinburgh, the University decided to give a representation of the Phormio of Terence in the Latin, he selected Fletcher to play the important part of Nausistrata.

The *Sydney Morning Herald* says of him: "This gentleman's impersonation of the angry and jealous wife excited much merriment." Dr. Badham, too, complimented him on his rendering and elocution. His compeers on the stage became afterwards famous, Sir Pope Cooper as Chief Justice of Queensland and Sir Edmund Barton as the first Prime Minister of Australia. But it was not as an actor or as a lawyer, still less as a politician, that Fletcher was to win his days.

After taking his degree, he decided to devote himself to teaching, and for several years, first at Wesley College, Melbourne, and, with a break, later on at his old school, Newington College, he was a practical schoolmaster in full work. At Wesley he had for his chief Martin Howy Irving, the son of Carlyle's great friend, Edward Irving. The son had resigned his position as Professor of Classics in the Melbourne University to take the head-mastership of Wesley. I have often heard Fletcher speak of his firm discipline and stimulating teaching. He gave wise counsels to the young master. Some of his fellow masters survived to my time at Wesley and they spoke of Fletcher as a good and kindly, if somewhat eccentric, colleague, who had ways of his own in the classroom. While at Wesley he read for his M.A. degree, which he obtained in 1876. The teaching of elementary chemistry was in those days an extra, like drawing and music, and Irving entrusted it to Fletcher. Whether from this accident or not, he was now strongly attracted to natural science so that, after taking his higher degree, he resigned his post at Wesley and betook him to London to enter on a science course.

He had chosen just the right time. The School of Cuvier and Owen had done its work and passed. Biology was being studied and taught by new methods. At Oxford Rolleston had introduced into his laboratory the dissection of a graduated series of animal types, from the lower to the highest, and Huxley at South Kensington adopted and improved on his methods. Work with the microscope had become prominent in the laboratories, where the introduction of microtomes and of a whole battery of differentiating reagents extended the scope of biological research. The views of evolution of Darwin and Wallace, wholeheartedly adopted by Huxley and Joseph Hooker, had won a general acceptance in the scientific world and provided fresh avenues of research. The deep-sea investigations of Wyville Thomson and the "Challenger" had made known the existence of a world of new and strange forms of life. The importance of the

study of the development of living animals as bearing on the theory of evolution became evident, and at Cambridge, Francis Maitland Balfour, brother of Earl Balfour, devoted himself and attracted his students to work out the details of embryology in the different groups. The whole biological world was fermenting in an unprecedented spirit of enthusiasm.

Fletcher joined Huxley's classes at South Kensington, where, as Spencer says in his memoir, "it was possible for a student to listen to the leading exponent and protagonist of the evolution theory, and at the same time gain by practical experience a first hand knowledge of plant and animal morphology". He also in London had the good fortune to meet Professor Balfour, who was so struck by Fletcher's keenness and capacity that he invited him to visit Cambridge as his own guest, and Fletcher spent three months in the University. In both London and Cambridge he worked with many who afterwards occupied Chairs of Zoology or Biology in British universities at home and in the Dominions—his great friend G. B. Howes, Jeffrey Parker, Milnes Marshall, Haddon, S. F. Harmer, J. J. Lister, Adam Sedgwick and others, all well-known names in biological science. It seems as if he, too, might have looked forward to the congenial life of a Professor of Biology in some British university. But it was not to be, and the Linnean Society was to be the richer. He remained in England for five years, working hard all the time and obtaining the degree of B.Sc. in the London University.

Before leaving England he published his first paper in conjunction with J. J. Lister, who was then a demonstrator in the Cambridge Laboratory. It appeared in the *Proceedings of the Zoological Society of London*, and dealt with some features of the genital organs of the macropodidae. He had felt that the first duty of an Australian biologist was to attempt to solve some of the problems presented by the Australian fauna and flora. He would gladly have given his life to the study of these problems, but unfortunately no opening offered for a life exclusively devoted to research. It was not till later that chairs of biology were founded in the universities of Australia and New Zealand and there were no research fellowships available. Accordingly, when he returned to Australia in 1881, he had again to betake him to teaching.

He joined the staff at Newington College, of which his father was President. We know more of his Newington than of his Wesley career. Though his scientific aspirations were unsatisfied, he faced his work with determination and energy. At first as Acting Headmaster and then as one of the senior men he earned a reputation for thoroughness. "It's dogged as does it", had said Darwin, and Fletcher accepted the motto and lived up to it. One old pupil, a professor of philosophy, speaks of "the well-known austerity of his rule". Another says, "He made his class work hard but he worked hard himself", and again, "Chronic shirkers had a pretty rough time with him. He told them in so many words, and not once only, that they were robbers; if they didn't work, they were robbing their parents". Hence his class, a large one, became known in the school as "The Forty Thieves", a title in which they rather gloried as boys, and over which they often chuckled when they were men. He would open proceedings by some such address as "This is the time for work, so put away all story books, playthings, kickshaws, gewgaws, jimjams, sampans, catamarans, anything else irrelevant . . ." (He had a quaint vocabulary but one can imagine that the boys were listening.) He made it his rule never to tell his pupils anything which they could find out for themselves. He believed in starting research early. But in the case of triers

his help and advice were always available. His discipline was inflexible, and occasionally in grim humour he "made the punishment fit the crime". Naturally he was not popular at the time, but when he left Newington the Sixth and Fifth Forms made him a spontaneous presentation and expressed to him their sincere gratitude and affectionate esteem, and in later years when his old pupils still more realized all that he had done for them, they spoke of him in terms of respect and affection.

He was not forgetful of the claims of biology and introduced into his class-work an elementary course of anatomy and physiology. Later on, after his happy marriage, he would invite older boys to tea, and after tea would show them some of the wonders and uses of the microscope. A large number of these—seven of the very "Forty Thieves"—became doctors, some of them foremost in their profession. Thus Sir Herbert Maitland told Mr. Horner Fletcher, J. J.'s elder brother, that he put down his effective career to the inspiring influence—and the hard discipline—of his old master. Not all of the seed sown in this way by Fletcher fructified, for some fell on stony ground, to wit, of boys destined to be lawyers. Still one even of these is well known as a lover of our native birds and is an authority on their habits.

As a schoolmaster Fletcher might have gone far, but presently an opportunity offered for returning to his true love. He was at Newington from 1881 to 1885. While there he joined the Linnean Society, then in its early days, and Sir William Macleay soon recognized his quality and accordingly offered him the position of Director and Librarian of the Society. So Fletcher took leave of Newington and schoolmastering, and entered on his duties under Sir William on 1st January, 1886. He had found his *métier*. He felt that the Society could carry out Macleay's aims, and they coincided with his own, for active research on the Australian fauna and flora, much more effectively and on a much larger scale than any single-handed investigator could hope to do. Sir William all his life gave him his confidence and his friendship. And never was a man more loyal to his work and to his friends than was Fletcher. As Spencer writes, "No task, however great or however small, that he thought touched on the honour of the Macleays or the welfare of the Society was left undone, no matter what it cost him in time and thought." He served the Linnean for 33 years, for seven as Director and Librarian and for 26 as Secretary, but whatever was the designation of his office he was always the hub of the Society.

As Secretary he carried on the business of the Society with minute care. There were intricate legal negotiations in connection with the inauguration of the Macleay Bacteriologist and the establishment of the Macleay Research Fellowships, and he ever kept a jealous eye on the exact execution of the terms of Sir William's bequests. All meetings, council, ordinary, annual, committee, came on as by clockwork. I cannot recall a single occasion on which his minutes were challenged.

As Librarian he watched lovingly over the rare and valuable books presented by Macleay and kept the many and ever accumulating periodical journals all in order and place so that members could readily consult them. And he noted their contents and kept them in mind for use by himself and others. In 1884 he had published a catalogue of papers and works relating to the mammalian orders Marsupialia and Monotremata. But his bibliographical work was on a much wider scale. In a huge folio office-book he kept account of books and articles on all natural history topics which might be of interest to Australian workers, and thus it happened that, whatever branch a man was studying, an appeal to Fletcher

seldom failed to bring out something of value, which had escaped the investigator. He was often appealed to by workers in other States.

As Editor of the PROCEEDINGS he did an immense amount of work, correcting with particularity the MSS. submitted, verifying references, and making it clear to authors that nothing doubtful or slipshod would be admitted. (Perhaps there was just a touch of the schoolmaster here.) Dr. W. G. Woolnough, in his Presidential Address to the Royal Society of New South Wales, said of him, "Many of us gained our first experience in publishing the results of scientific investigations under his guidance and if we sometimes resented his insistence upon what at the time appeared to us to be trivial details, we have lived to be thankful for the lessons so given us." J. H. Maiden once said laughingly to me, "He rules us with a rod of iron". But he could surprise an author in quite another way. When he sent me the proofs of my list of Australian marine algae, I found that he had compiled a complete index of the genera, and added it to the paper. How many editors would have taken the trouble?

He protected the finances of the Society with a meticulous, even Aberdonian carefulness. He would make out his indexes on any old scrap of paper. He again and again declined the well-meant offers of the Council to provide him with effective assistance in the office. He would only accept the services of a succession of boys, whom he painfully trained in the art of addressing envelopes decently and whom he saw depart almost as soon as they had been licked into shape and become really useful. More than once the Council pressed upon him an increase of salary but he refused it point blank, and there was no turning him. Surely a most unusual and most disinterested officer.

While still at Newington he had published three more papers on the urogenital organs of certain species of kangaroos. He obtained most of his material in the neighbourhood of Bathurst, assisted by his sporting friends, Capt. F. Morley and the Webbs. But to continue this work satisfactorily he had need of the use of a laboratory with its appliances, and this was not available. He therefore turned his attention to research among the more accessible land forms which he saw were being continually ousted by the opening up of the country and the incoming of exotic forms. He used to say "Marine things will be little disturbed and can wait". He began with the earthworms. Spencer, who also worked on the earthworms, says: "From 1886-1894 he published six papers in which he showed the unexpected richness of Australia in this group. He described some seventy new species, belonging to nine genera, five of which, as determined by him, were new and confined to Australia. His work was not simply systematic, but included careful field observations in regard to habits and distribution, and the results of anatomical investigation." His note-books still survive and we can see how he had collected far and wide, and had found helpers and correspondents—A. G. Hamilton, T. G. Sloane, Professors Tate and Stirling—who supplied material from distant localities; how closely he observed, comparing many specimens of the same kind, measuring, counting setae, dissecting hundreds of individuals; and how he kept himself acquainted with the world's literature of the subject.

Those earlier years at the Linnean comprised the period of his most active research work. In 1887, beside two papers on the earthworms, he published two on planarians. Darwin and Moseley had aroused his interest in this group. Fletcher came across an exotic species, *Bipalium kewense*, which had been introduced into Sydney gardens, and his first paper was on this species. But presently it became evident that these handsome worms, often brilliantly coloured, blue,

yellow, olive-green or rubicund, with prominent longitudinal stripes of deeper tints, existed in Australia in great plenty, both of individuals and species. They occur on damp ground, as under logs and stones in shaded gullies, and form conspicuous members of what Dendy termed the Cryptozoic Fauna. His second paper was written in conjunction with A. G. Hamilton, and in it were described eight new species of *Geoplana* and six of *Rhynchodemus*, a genus not before known in Australia.

Let us glance into his notebook of the time.

Jan. 5, 1888.—“In the paddock at Burrawong under a log I found what looked like a Planarian cocoon and I took it as such. This afternoon it hatched out and turns out to be *G. rubicunda*. The cocoon is about 6×4 mm., and is certainly a large one. Six young ones are visible; about 8×1 mm. contracted, 10 to 14 mm. long when crawling. They lie coiled in a circle with the head resting on and above the tail. . . I looked at this one in glycerine to see the eyes. Four may be said to be on the anterior extremity and a little further apart than those succeeding them. I can count over 80 on one side only. In order to see the eyes in this specimen it has to be looked at from below.”

Feb. 2, 1888.—“*G. caerulea*. The blue colour of the under surface is not somewhat—as Moseley says—but decidedly lighter in colour. The blue of the dorsal surface is so dark as frequently to look almost black. [Indigo above and Prussian below would be more like it.]

“*G. coxii*. Brought home one of many specimens seen, but it escaped yesterday.”

And the saddest entry of all—

Nov. 13, 1888.—“Planarians are cannibals. A *G. purpurascens* has just done for a *G. variegata* (from Field of Mars put in for comparison) and swallowed more than half of him. The latter was a vigorous specimen, and was crawling about until I noticed the *G.p.* enwrapping him, and, on stirring up, he crawled off; but the *G.v.* was disintegrated and the greater part of him wanting. When the *G.p.* crawled away it took with him a piece of the *G.v.* in its concave under surface and I saw this piece actually being sucked into the pharynx and swallowed. The difference in the *G.p.* is noticeable externally.”

Peripatus was another Cryptozoan very popular at the time. Adam Sedgwick, one of Fletcher's fellow students under Balfour, had published a beautifully illustrated monograph in the *Quarterly Journal of the Microscopical Society*, and Moseley had also written on it. Fletcher obtained and wrote on a species from New South Wales and Dendy recorded observations on a species from Victoria. Both assumed that the species was *P. leuckartii* Sanger. But their observations on the method of reproduction were contradictory. Fletcher saw young larvae in company with their parent and no eggs, and concluded that *P. leuckartii* was viviparous; Dendy found eggs in the oviducts, and free eggs apart from the parent, which eggs developed later into undoubted *Peripatus* larvae, and concluded that *P. leuckartii* was oviparous. It was clearly unlikely that the same animal should be both viviparous and oviparous. A rather unfortunate controversy followed in which Fletcher showed some heat. At length, however, Fletcher and Dendy met, and talked the matter over, and in 1895 they published a combined paper in which Fletcher described three forms of *P. leuckartii* and proved that it was viviparous, as were all the other species whose reproduction was known; and Dendy described the eggs and development of his species, which both agreed must be new and distinct, and he called it *P. oviparus*, remarking that the sculpture of the egg shell showed an important affinity to the Insecta. Thus all ended in a graceful agreement.

Fletcher's studies on the frogs probably show him at his best in zoologic work. After his death *Nature* said of him, “His knowledge of the Australian Amphibia was unsurpassed.” He published his first paper “On the Oviposition and

Habits of Certain Australian Batrachia". Later he wrote three papers describing new species, and five others on the geographical distribution. I happened to be working up the Victorian frogs and toads about the same time as his first paper appeared, and I can remember how charmed I was with it and how I marvelled at the wealth of observations. It was, as Spencer suggests, like reading extracts from an Australian Gilbert White.

In England there is but one indigenous frog and there are only two kinds of toad. In Australia 50 species of Batrachians had been recognized before Fletcher began to study the group. So that a wide field lay before him. The species already known had been described from spirit material sent home, and ludicrous mistakes were made by the museum naturalists. Thus our common large green *Hyla*, as green as young grass or "the green mantle of the standing pool", was christened *H. caerulea*, for the green had turned blue in the spirit. Fletcher himself described three new species, and G. A. Boulenger, of the British Museum, described two others forwarded to him by Fletcher. One of these he named *Phanerotis fletcheri*, making a new genus for the purpose.

Fletcher by no means confined himself to the morphology and taxonomy of the species and genera, but closely studied the habits and the voices, hibernation and aestivation, the latter much more marked in our climate, the phenomena of spawning and development, the burrowing habits of *Chiroleptes*, the water-holding frog, and *Heleioporus*, and the acrid excretions and warning colours of *Notaden*, the Catholic Toad, as well as the distribution of the Amphibia all over Australia. Nearly all his observations were new.

What had been written before was often very wide of the mark. Thus a highly distinguished professor of natural history had said: "With the exception of the common green frog (*Ranhyla aurea*) they are rarely seen or heard—the true tree-frogs (*Hyla*) inhabiting the lofty gum-trees and the *Limnodynastes tasmaniensis*, *L. dorsalis* and *L. affinis* burrowing in the sand during the day." Fletcher falls upon him. The *Hylas* never climb to the tops of the trees, though *H. ewingii* may shelter under the lower bark. *H. caerulea* and *H. ewingii* are often found on the ground among damp herbage. *Limnodynastes tasmaniensis* does not burrow, but is met with on the edges of pools or under stones. *H. aurea* often leaps from overhanging low boughs of trees and shrubs as you move along the banks of a creek and disturb it. "As for hearing the frogs, in the evenings in October, and later after rain, in the western suburbs of Sydney, wherever there are paddocks and waterholes, one may hear the croaking of individuals belonging to at least half a dozen species in the course of as many minutes." He could recognize most of the common species by their distinctive notes.

His notes on spawning are very full and informative. From what he saw in the years 1885-1886 he states: "Some frog spawn was met with in every month of the calendar." "In whatever month the frogs spawn they do so as soon as the weather clears up after rain." He says, "My most instructive round in one of the suburbs of Sydney included a visit to an old quarry, a brickyard, a deserted tanyard and three waterholes in paddocks used for watering cattle; these five (? six) spots were frequented during some period of the year by at least eleven species of frogs." "If in the whole of these I found from 100 to 200 patches of spawn I considered it to be a brisk season."

"All the spawn observed by me has been

- (1) White frothy looking more or less circular floating patches larger or smaller according to the species, deposited in water,

- or (2) Small submerged bunches of ova enclosed in clear transparent jelly, attached to blades of grass, or reeds, or twigs of dead branches,
- or (3) Numerous separate ova, not laid in the water, but under stones or débris in reed or grass tussocks on the edges of pools."

To the last class belong the ova of the little toads, *Pseudophryne*. They are larger and fewer than the aqueous ova. Fletcher notes the difference in habit between the two County Cumberland species, *P. australis* lively and perky, *P. bibronii* dull and sluggish. *P. australis* spawns in summer, *P. bibronii* in autumn. In both the embryo leaves the egg in the perfect air-breathing form.

A last note: "*Limnodynastes dorsalis*, judging by the number of croakers, must be one of our most abundant Sydney frogs, yet it is precisely one of the species of which under ordinary circumstances it is most difficult to procure specimens, a condition which is probably due to its nocturnal and burrowing habits. Once, and once only, I found a specimen under a stone; the only other way in which I have obtained specimens about Sydney is by going into the water after them when breeding, as at such times they often allow themselves to be caught without much difficulty."

You will remember Izaak Walton's cruel treatment of his frog as bait and his exhortation to "use him as if you loved him, that he may live the longer". Fletcher had no such mocking love for his frogs. He may have dissected some but only after putting them peacefully to death with chloroform, but he sympathized with the difficulties of their lives and lent them a helping hand where he could.

One extremely hot summer's day, in company with W. W. Froggatt and F. A. Skuse, he made an investigating and collecting trip. They walked from Waterfall to Sutherland, a ten miles tramp. They came to a pool of shallow water, a hundred yards or so from the river, and when they halted they found that the pool was swarming with gasping tadpoles. From the heat of the weather it was plain to Fletcher that the pool would soon dry up and the poor tadpoles perish. His heart was touched, and, anxious to show mercy and to preserve the species for the State, he prevailed on his friends to join him in ladling out the tadpoles with the billy and conveying the lot to the river, so that, set free in the stream, they might have a chance of attaining to the full fruition of frog life.

He showed his affection for his less-gifted fellow mortals, too, in the case of some ring-tailed opossums which made their nest in the roof of his home in Hunter's Hill. Undisturbed by their racket, he and Mrs. Fletcher used to carry food to them in the roof, climbing up and down a ladder to do so. The pretty animals became very familiar with him, would come along and take bread from his hand, and when the young were big enough the female would bring them with her on her back to show him. They bred in the roof for several seasons.

In January, 1900, he was the President of the Biology Section of the Australasian Association for the Advancement of Science. He chose for the subject of his address "The Rise and Early Progress of our Knowledge of the Australian Fauna". He devoted to its preparation all his spare time of the preceding eighteen months, describing himself in a letter to Spencer as "one President with his coat and weskit off and his pantaloons tied round with string just below his knees, mentally perspiring—I hope to some purpose—if there were not about 1,500 books that I want to see and don't know how to find". However, the result, as Spencer says, was "the compilation of a record of great value to all students interested in the historic aspect of Natural History in Australia". He used to lament the neglect shown by British zoologists to the valuable collections submitted to them in the

early days and to mourn over the failure of Robert Brown and his companion naturalists to describe the life and customs of the Tasmanian blacks, so soon to perish from the face of the earth.

The Address appeared in 1901 and was his last publication on zoological subjects. After this he turned his more intensive attention to the plants. He already possessed an intimate knowledge of the flora of New South Wales, obtained by many excursions and expeditions to different parts of the State, alone or in company with his botanical friends, Betche, Maiden, Deane, Musson, Hamilton and others. He left taxonomic work to them, and occupied himself with peculiarities of growth and more general relationships. He published little, three papers in all during his lifetime: (i) On Polycotyledony in *Persoonia*, 1909; (ii) On certain shoot-bearing Tumours of *Eucalyptus* and *Angophora*, 1918; (iii) On the correct interpretation of the so-called Phyllodes of the Australian Phyllodineous Acacias, Presidential Address, 1920. A fourth paper "On a case of Natural Hybridism in the genus *Grevillea*" was completed and published after the death of Fletcher, by his friend and fellow-worker, C. T. Musson.

He was greatly interested in the Loranths and their parasitism, and piled up in his home literally stacks of gum boughs carrying Loranths, but he unfortunately never published his projected paper on "Eucalypts and Loranths in the relations of Host and Parasite" (Title read, 1896).

Polycotyledony is abnormal on the face of it, and is extremely rare, in the great class of Dicotyledons, so that any occurrence of more than two cotyledons in a Phanerogam is striking. Botanists, from Baron von Mueller back to Robert Brown himself, had noticed this peculiarity in some of the species of *Persoonia*. Fletcher set himself the task of investigating these forms with his usual painstaking thoroughness. He studied hundreds of embryos and young seedlings, of 10 species, and his conclusion was "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 dicotylous ancestor by the splitting of the two seed-leaves". He points out that the Proteaceae are a group of considerable antiquity, and that "it is remarkable that out of an Order comprising about 49 genera and 950 species, only what promises to be the majority of a solitary genus should furnish the sole exception to the statement that dicotylous embryos are characteristic of the Order".

In their paper on the Tumours, Fletcher and Musson showed that the tumour originated in the axil of the cotyledons, or in a few pairs of leaf axils just above them, from proliferating cambium cells, and was due to infection by some parasitic soil organism. They conclude: "the so-called 'mallee root' is not a root, but, in its extreme form, a great tumour, from which apparently, though in reality only enclosed by it, stems and roots arise."

The term Phyllode has been long applied to the vertical apparent leaves of those Australian Acacias which do not, when mature, produce bipinnate leaves. The botanical text-books define a phyllode as the petiole of a leaf of which the lamina or blade never develops, the petiole itself expanding into an apparent or pseudo lamina. Thus Kerner and Oliver "In many of the vetches of the Southern European flora (*Lathyrus*, *Nissolia*, *Ochrus*), but especially in a large number of Australian shrubs and trees, principally Acacias (*Acacia longifolia*, *myrtifolia*, *melanoxylon*, etc.) it is the leaf-stalks which are extended like leaves placed vertically, and then the development of the leaf-lamina is either entirely arrested, or has the appearance of an appendage at the apex of the flat green leaf-stalk or

phyllode, as it is called." After laboriously studying many Wattles in all stages, especially hosts of seedlings, and availing himself of Cambage's detailed study of *Acacia* seedlings of many species, Fletcher came to the conclusion that the textbook view was incorrect, that it was not the petiole or leaf-stalk merely, but the whole rachis or leaf-axis, of a pinnate leaf, which had become vertically flattened and had lost or never developed its pinnae. He says: "I propose to call them" (these organs or members) "Euphyllodia or Euphyllodes in the sense that they are something more than is implied in the accepted definition of phyllodes".

It happens but rarely that an unquestionable natural hybrid is met with in the bush. Fletcher claimed that *Grevillea gaudichaudii* of Robert Brown was such a hybrid, between *G. acanthifolia* of Cunningham and *G. laurifolia* of Sieber. Both *G. acanthifolia* and *G. laurifolia* are common in the higher parts of the Blue Mountains, the former in the swamps and the latter on the dry plateau. Where these approach one another *G. gaudichaudii* appears between them, with characters palpably combining those of the two parents. It is curious that Robert Brown does not seem to have seen either of the parent plants, though he described the hybrid, and curious, too, that Cunningham and Sieber do not appear to have recognized the hybrid as such. Musson, speaking of Fletcher's work on this *Grevillea*, says "The amount of detail he got together was remarkable. He covered 50 or 60 quarto sheets with detail, hundreds of figures merely dealing with lobing of the leaves".

In a paper read at the last meeting of the Linnean Society, Dr. McLuckie gave a first instalment of the results he has obtained in an independent investigation of the subject. He accepts Fletcher's conclusion that *G. gaudichaudii* consists of hybrids between *G. laurifolia* and *G. acanthifolia*. He succeeded in dividing the hybrids into two classes, which he considers to represent the progeny of *laurifolia* ovules fertilized by *acanthifolia* pollen, and *vice versa*. He confirms his contention by numerous comparative measurements of all parts of the hybrids and their parents. And to verify the ample circumstantial evidence, he has been able to produce artificially seedlings which agree in characters with one of the groups of natural hybrids, by using the pollen of *acanthifolia* applied to the stigma of *laurifolia*. Thus the fact of hybridization detected by Fletcher seems to be proved up to the hilt.

Any portraiture of Fletcher would be very incomplete if it did not include some reference to his literary side. We have seen that he had a classical upbringing and literature, especially poetry, strongly appealed to him. I remember his delight when Francis Thompson first swam into his ken. He recognized the Shelleyan pinions of that impassioned poet. He would transfer to his note-book poems that touched him, which he found as he browsed on the higher class magazines, *Contemporary*, *Blackwood*, *Scribner*, *Century*, especially poems dealing with beautiful aspects of Nature, drawing from them Wordsworthian lessons of philosophy and hope.

Thus we find a translation from the *Century* of a poem by old Walther von der Vogelweide:

I heard a fountain brimming,
And saw the fishes swimming.
And marked what in the world did pass:
Forest and field, rush, leaf, and grass;
All things that fly and creep,
And beasts that run and leap;
And saw that of all forms of life
Not one there is lives free from strife:

Wild beasts and creeping things
 Have all their quarrelings;
 The birds, too, fight right angrily,
 Yet in one thing they all agree:
 That none would live content
 Had they no government.

And, on a higher plane, Blanco White's sonnet on Night:

Who could have thought such darkness lay concealed
 Within thy beams, O Sun! or who could find
 Whilst flow'r and leaf and insect stood revealed,
 That to such countless orbs thou mad'st us blind?
 Why do we then shun Death with anxious strife?
 If Light can thus deceive, wherefore not Life?

He preserved the gargoyles as well as the arches of his cathedrals. Like Browning, it pleased him to treasure the odd and the grotesque.

Once he showed me with great glee an amusing macaronic poem composed by Robert Lowe, while an undergraduate at Oxford, on the occasion of a visit to the University by the Duchess of Kent and the young Princess Victoria in 1833. It is entitled "Poema Canino-Anglico-Latinum", and is a clever compost of Virgilian idioms and frank British fun, done into rolling hexameters. As

Rainy dies aderat; decimam strikantibus horam
 Jam clockis, portae panduntur—then O what a rush was Musa velim memores—
 Et quam shoutarunt Undergraduates atque Magistri,
 Et quantum dederit Vice-Chancellor ipse refreshment.

I imagine that he had found the copy of verses amongst Macleay's papers, which passed into his custody. Macleay was Lowe's most intimate friend while the latter was living in Sydney in the 'Forties.

He gave me a copy of Rev. W. B. Clarke's rhymes on *Ceratodus forsteri*, which I will pass on to you from Fletcher. The great geologist writes, in the style of John Gilpin:

Just seven and twenty years ago
 Did naturalists discuss
 The finding of some horny teeth
 Thence called *Ceratodus*.

No bones (if fish true bones possess)
 Of head, or tail, or sides—
 No scales or vertebrae had they
 To be their certain guides.

All that they learn'd was that the teeth
 In middle life-time grew,
 Yet fourteen species were assigned—
 To what they hardly knew.

Of these the generous Agassiz
 A dozen gave to Trias
 (With one reserved to Stonesfield Slate);
 All borrowed from the Lias.

But never since that period,
 As all the books avow,
 Did scientific eyes behold
Ceratodus till now.

Lucullus ate *Muraena* rare,
 In Rome the daintiest dish,
 And squatters on the Burnett dined
 On geologic fish.

But all the while no savant knew
 More than the squatter guessed,
 Who ordered a *Ceratodus*
 To be for *salmon* dressed.

So things went on till Forster's act
 No further question left,
 By sending down the fish itself
 To be described by KREFFT.

Thus, in Australia we behold
 Another instance found
 How in the far Antipodes
 Science completes her round.

The long-continued strain of his close application to work told at last. Towards the end of 1918 we find him writing to Spencer: "I have not had a holiday since Easter, 1915, and my eyes and brain are very tired, and I am retiring from the Linnean on 31st March, 1919. . . I began to realize that thirty-three years was going to be about as much as was good for me. So I decided to give notice of my retirement." Accordingly at the Annual General Meeting in March, 1919, he performed his last task as Secretary. His old colleagues combined to bear their testimony to his long and invaluable services to the Society, and to voice the strong sense of loss which they experienced at the conclusion of his labours as Secretary. Enthusiastic appreciation and deep gratitude were the notes of the occasion. His portrait was hung in the Hall and he was presented with a handsome chair and desk.

At the same meeting he was elected President of the Society and he occupied the Chair during the years 1919-20 and 1920-21. In his first Presidential Address he spoke of the climatic problems which confront the Australian agriculturist and suggested the preparation and dissemination of a manual which should give scientific methods of grappling with the droughts.

At a Special General Meeting held in June, 1920, to commemorate the centenary of the birth of Sir William Macleay, he delivered an address on "The Society's Heritage from the Macleays". It was a long address, filling 68 pages of the PROCEEDINGS, but this only dealt with the lives and the public and scientific services of the three elder Macleays. The second part, dealing with Sir William's life and benefactions, was published after Fletcher's death by his successor, Dr. A. B. Walkom, who faithfully and laboriously compiled it from the multitude of notes which Fletcher had collected for the completion of his history.

His Presidential Address in 1921 was devoted to a strongly argued protest against the abuse by the University authorities of their trust in regard to the Macleay Museum, so that "one of his great enterprizes, potentially so fructifying, if properly managed, has become bankrupt". Thus to the last he was loyal to the memory of the man to whom he felt Australia owed so much.

In 1921 the Royal Society of N.S.W. awarded him the Clarke Memorial Medal, a graceful recognition of his work. But now the shadows were beginning to close around him. Owing to an accident he was forced to abstain from anything like strenuous exertion, but he kept up his association with the Linnean and his intimacy with his friends and acted as a Trustee of the Australian Museum. He was still able to take delight in the natural beauty of his surroundings at Lane Cove. Characteristically, he was thinking of how best he might distribute his books and collections so that they should be of most service after he was gone, and

he took measures accordingly. To the Australian Museum he gave "A very large and valuable collection of Frogs", 1923; "An interesting collection of Marsupial Skulls and Foetal Material", 1926; and we find a grateful acknowledgment, signed by nine members of the scientific staff, of a valuable series of scientific papers, 1924. To the Mitchell Library he gave 361 books and pamphlets, 1924, and a large number of more general works to the library of Wesley College, within the University of Sydney. Thus engaged, and happily spared a lingering or painful illness or a protracted period of helplessness, the end came suddenly on 15th May, 1926. He would have said with Mrs. Barbauld the poet:

Life! I know not what thou art,
But know that thou and I must part;

Then steal away, give little warning,
Choose thine own time;
Say not Good Night—but in some brighter clime
Bid me Good Morning.

I have tried to bring the man and the nature of his work before you. The man has passed, but so long as the Linnean Society endures the names and the work of William Macleay and Joseph James Fletcher will never pass away.

(Issued 15th April, 1930.)

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Part 1.

No. 227.

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FOR THE YEAR

1930.

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(Issued 15th May, 1930.)

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CORRIGENDUM.

Pages 137 to 139, for *Apistomyia indica* read *A. trilineata*.

(Issued 15th July, 1930.)

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No. 229.

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[Plates x-xviii.]

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Genus OCHTHIPHILA Fallen.

This genus is almost as widely distributed as *Leucopis*, but it is unknown to me from Australia and its life-history details have not been clearly established.

Genus CHAMAEMYIA Panzer.

This genus occurs in the old world and I have taken it in the United States. It was for many years considered as a synonym of *Ochthiphila*, but it is quite distinct.

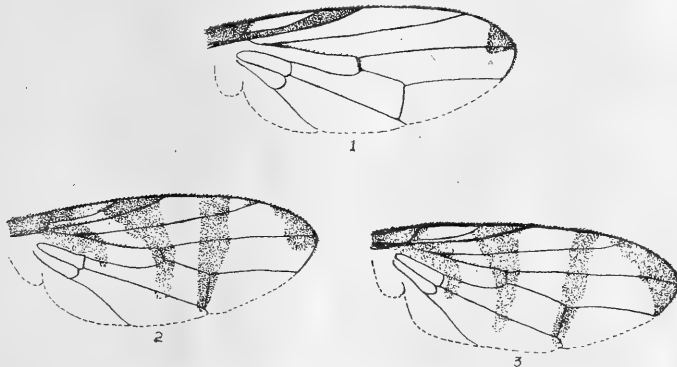
Family ORTALIDAE.

Genus RIVELLIA Robineau-Desvoidy.

Up to the present time I have seen three species of this genus from Australia. They may be distinguished from each other as in the key presented below.

Key to the Species.

1. Wing without black fasciae, with only the following black marks: Along costa to slightly beyond humeral cross-vein, in the entire subcostal cell, and a spot on tip of third vein touching costa which extends from about midway between apices of second and third veins to a little below apex of latter, but never to fourth vein (Text-fig. 1) *connata* Thomson.
- Wing with more extensive black markings, the basal and apical marks much larger, and two complete, or almost complete, fasciae centrally, one over inner cross-vein, the other over outer cross-vein 2
2. Apical dark mark on wing never encroaching on tip of marginal cell, though there may be an isolated dark spot there, and not extending more than midway across first posterior cell near its apex, costal cell almost uniformly dark; femora and tibiae black, knees yellow (Text-fig. 2) *isolata*, n. sp.
- Apical dark mark on wing more elongate, always encroaching upon apex of marginal cell, and extending over entire apex of first posterior cell to apex of fourth vein, apical half or more of costal cell hyaline (Text-fig. 3); legs generally yellow *virgo* Hendel



Text-fig. 1.—Wing of *Rivellia connata*.
 Text-fig. 2.—Wing of *Rivellia isolata*.
 Text-fig. 3.—Wing of *Rivellia virgo*.

RIVELLIA CONNATA Thomson.

I have already recorded this species from Australia. It occurs in the Samoan and Fiji Islands.

RIVELLIA VIRGO Hendel.

This species is very similar to the next one, comparative characters being given under the description of the latter and in the foregoing key. Wing as Text-figure 3.

Locality: Herberton, N. Qld., January, 1911, 3,700 feet (Dodd). In Lichtwardt collection, Deutsches Entomologisches Museum, Berlin-Dahlem, Germany.

RIVELLIA ISOLATA, n. sp.

♂, ♀. Frons brown, becoming orange in front, orbits white-dusted except on the upper fourth which, like the ocellar triangle, is shining black; face orange, infuscated above, and slightly grey-dusted; antennae dull-orange, third segment darkened apically; aristaе black; palpi fuscous, paler at apices. Thorax dark metallic-blue, slightly obscured by grey-dusting. Abdomen concolorous with thorax, without dusting, the surface roughened or granulose, and rather densely covered with decumbent black hairs. Legs black, apices of coxae and femora, and all tarsi except their apices, fulvous yellow. Wings hyaline, with black markings as in Text-figure 2. Calyptrae pale. Halteres missing in type material.

Vertex with four strong bristles, the outer pair divergent, inner pair cruciate; two orbitals present on each side, which are much shorter than the verticals; ocellars very short and fine; aristaе bare; third antennal segment extending to the mouth-margin. Thorax with well developed humeral bristle, one pair of prescutellar acrostichal and dorsocentral bristles, and four strong marginal scutellars. Legs normal, mid femur of male with a series of pale bristly hairs on the posteroventral surface.

Length, 4-4.5 mm.

Type, female, Illawarra, N.S.W.; allotype, Botany Bay, N.S.W. (H. Peterson). Material submitted to me by C. F. Baker some years ago and in my collection.

Most nearly related to *virgo*, but readily distinguished from it by means of the wing markings. The wing figured is that of the female type, the male lacks a well defined black dot at apex of the marginal cell, but possibly this character is variable and not a sexual one.

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[Plates xviii-xl.]

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Corrigendum.

Page 499, line 24, for *Atriplex acutivalvum* read *Atriplex acutibractum*.

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